PERSONAL HYGIENE

DESIGNED FOR UNDERGRADUATES

ALBERT A. WOODHULL

Personal Hygiene

Designed for Undergraduates

BY

ALFRED A. WOODHULL, A.M., M.D., LL.D. (Princ.)

Brigadier General U. S. Army, Retired

Lately Colonel, Medical Department, U. S. Army

FIRST EDITION

SECOND THOUSAND.

NEW YORK

JOHN WILEY & SONS

LONDON: CHAPMAN & HALL, LIMITED

PRESS OF
BRAUNWORTH & CO.
BOOK MANUFACTURERS
BROOKLYN, N. Y.

TO

The Princeton Class of 1906

AND ITS IMMEDIATE SUCCESSORS,

IN CORDIAL RECOGNITION OF THEIR APPRECIATIVE

RECEPTION OF THE SPOKEN WORDS.

Preface

THIS book is intended for undergraduate students and contains the substance of lectures on Personal Hygiene given at Princeton during the last few years. It is published because the oral delivery of its material has been accepted so pleasantly as to suggest that it may be useful elsewhere in this form. Abstract physiology has been kept at the lowest point, and as far as possible technical phrases have been avoided. The constant aim has been to present actual conditions in the simplest language. One lecture, on the Avoidable Diseases, is not printed. A little First Aid was mingled with the Hygiene in the lecture-room, but that is omitted here because it is an independent subject on which admirable books are readily accessible.

As the subject is public property and the lectures were prepared without thought of publication, no record of the authorities drawn upon was kept; so that in some instances their very words may have been appropriated. As far as possible credit is now given,

but doubtless coincidences of expression may be found. A part of the discussion of alcohol, a general position held for years, is a paraphrase of the admirable Report of the Committee of Fifty on the Liquor Problem.

PRINCETON, December, 1905.

Contents

Personal Hygiene

I

The Skeleton

THE study of Personal Hygiene has an immediate, direct and personal application, and this presentation of it contains very little that is speculative or that bears upon any future profession of the student. It offers certain ascertained conditions of the physical organism and of exercise, food, clothing, habits, and similar matters of daily individual concern. That the principles upon which Personal Hygiene depends may be appreciated, some elementary points of anatomy and physiology must be presented, but these will be only those absolutely necessary to its reasonable understanding. "It is no part of a university education to be showered with disconnected facts." There are certain ultimate conditions which cannot be, or have not been, explained, such as the saltness of salt, or the power of gravitation; but such conditions obtrude

very little in this subject, and one should not be satisfied until the reason for, as well as the method of, any process, mechanical or physiological, is understood.

Anatomy is the science of organized bodies; and human anatomy explains the structure of man, as human physiology explains the operation of his vital functions. The human organism is roughly separable into the cavities of the head and the trunk containing the organs of life, and the extremities or limbs, solid appendages which are the organs of touch, prehension, and transportation. The latter, which are not essential to life, exist for the care and convenience of the former. The man is contained within the cavities, and the removal of all the limbs should leave the vital functions unimpaired.

Extremities

The skeleton, a bony frame clothed with flesh and supporting other soft structures, protects the vital organs from violence and serves as a base for the functions of grasping and movement. It is made up of about two hundred bones, varied in shape so as to be adapted to their respective uses, which are compact on the surface and cancellated within and thus combine lightness and strength to the best advantage. The shaft of a long bone is approximately a hollow cylinder, which secures a maximum of strength with a minimum of material; and its extremities, which endure pressure or play upon other parts, have their cancellated plates geometrically arranged to sustain strain without being unduly heavy. All the short bones are cancellated within and are relatively light.

Bones

The vitality of all bones is chiefly maintained through the periosteum, a closely-adherent, very tough membrane rich in blood-vessels. When a part of the periosteum is removed or dies as the result of either violence or disease, the bone next to it dies also. The leg-guards that protect the exposed shins in kicking games, besides defending against fracture guard the periosteum from bruises that may be more serious than the mere pain they cause. On the other hand, the periosteum throws out the new material that reunites broken bones, as shown in the knot of extra callus remaining from excess of the fresh bone after a fracture. Besides the periosteal action, bones, particularly the long ones, arise from several centres; and the various parts are not always sufficiently united before adult life to prevent them from being pulled apart occasionally under violent exertion. In early life bones are actually softer, and the long bones then are liable to bend under the weight of the body; and as old age approaches they become more rigid and brittle.

Periosteum

Centres

The spinal column is not a solid cylindrical body, as the name might imply, but consists of twenty-four separate bones called vertebræ, lashed together by tough ligaments. Each vertebra is capable of slight rotation, the sum being considerable, allowing flexibility in all directions. This flexibility is not only useful in common life, but makes easy the deformities due to the carelessness of youth as seen

Vertebræ

in bent and twisted spines. It also, fortunately, allows their rectification when taken in time. Each vertebra is pierced for that great extension of the central nervous system known as the spinal cord. Between every two vertebræ an elastic cartilage takes up shock in walking or leaping, and by the close of the day each is sufficiently compressed for the sum to make a measurable difference in the height of the person. It is the gradual wasting of this elastic tissue, not of the bone, in addition to the stoop of careless or feeble old men, that leads to the diminished stature common to advanced years.

The first two are the only vertebræ requiring special notice. The first is substantially a shallow ring which supports the skull, and hence its name, atlas. The skull rests upon two broad facets, which allows the nodding motion. The second vertebra has an upright part, or process, which extends directly against the inner side of the front of the atlas at right angles to the rim. This is restrained from slipping backward by a tough ligament, and as the atlas plays around this projection it becomes literally an axis, as it is called. By this play we move the head over a considerable arc of a circle, much farther than we can turn the body. In a legal execution by hanging, the intention always is to break this projection, with the consequence that the spinal cord is also torn or crushed.

Atlas

Axis

The cranium or skull rests on the spinal column.

The skull and the bones of the face make up the head. The brain, enclosed by the skull, is directly continuous with the spinal cord.

Chest

Twelve enclosing ribs spring from the spine on each side and unite directly or indirectly, except the lowest two, with the breast-bone. The ribs, the spinal column, and the breast-bone combine to make the flexible cage known as the chest, which contains the heart and lungs.

Collar-bone

The bones of the chest are reinforced above by the collar-bones (clavicles) and behind by the shoulder-blades (scapulæ). The curved and slender collar-bone assists in keeping the shoulders the proper distance apart. It is easily broken by direct violence and usually heals promptly but with some deformity, for the edges invariably overlap from the drawing together of the shoulders and there is usually new bone, callus, thrown out in excess from the torn periosteum. As the collar-bone is outside of the chest-walls, this common accident has no direct effect upon the chest as a vital receptacle.

Shoulder-blade

The shoulder-blade is an irregular flat bone lying across the back outside of the chest, with two tips that overhang the shoulder-joint. The body of the shoulder-blade is never broken except by a crushing force which ordinarily would destroy life. Either of the tips is liable to fracture by direct or by indirect violence.

The upper limb, or extremity, contains one bone in the arm, two in the forearm, and numerous small ones

in the wrist and hand. Popularly the arm extends from the wrist to the shoulder, but proper exactness limits the arm to the part above the elbow, and the forearm to that between the elbow and the wrist. The arm-bone (humerus) is semi-spherical at its upper end, and the socket, against which it may revolve throughout an entire circle, is so shallow that dislocations—out-of-places—are frequent. These usually occur downward and inward into the armpit, an accident that treated at once may usually be promptly relieved. Such relief, however, is beyond the sphere of hygiene.

Arm

There are two bones in the forearm: the radius on the thumb side, the ulna on the little-finger side. The ulna hooks into the lower part of the arm-bone and has only the up-and-down motion. But the radius rolls upon the ulna near the elbow and carries in its rotation the hand, which is attached to its lower end. The practical interest lies in the fact that when the radius is so damaged that it cannot revolve, or when after breaking it grows to the ulna, the rotation of the hand is interfered with. If the radius fails to revolve, the hand can no more be turned, except as the humerus itself turns, than the mouth may be closed by bringing down the upper jaw. Should the forearm be broken, it is important to avoid deranging the proper relation of the fragments; and to that end it should be carried horizontally with the thumb up and pains be taken not to disturb the padding arranged to keep the bones apart after they are dressed.

Forearm

The various troubles attributed to the elbow in baseball and tennis practice usually depend upon excessive use of the muscles which move the radius, and not to real trouble in the joint itself. The part of the ulna that hooks into the humerus, or the projections at the sides, may be chipped off by a fall or a blow; but the ordinary tennis elbow, for instance, is a strain of the soft parts about the joint. It is a common fault in tennis to depend too much upon the forearm and wrist, and to neglect the shoulder from which the arm may swing freely in every direction.

The hand and wrist require no comment beyond attention to the thumb, in which lies the special physical distinction between man and the higher apes that bear a general resemblance to him. The thumb is the potential factor of civilization, for it enables man to perform those mechanical arts upon which civilization depends. It qualifies its possessor for spinning, for drawing the bow, and for all those acts of grasping which require opposition within the hand itself (Whitehead). Closely as they resemble man in other ways, the higher types of monkeys and apes have no capable thumb.

Thumb

At the lower end of the spinal column are the sacrum and the coccyx, made up respectively of five and four rudimentary vertebræ consolidated. The coccyx is really a rudimentary tail, curved forward. Together they form a wedge tilting to the front, which is the back of the bony basin. The remainder of the pelvis consists of two large irregular bones,

Pelvis

one on each side, originally consisting of three apiece. These are the innominate or haunch bones, sometimes called the hip-bones, and we sit on their lower parts. These bones arise from several centres and slowly weld together, solidification being deferred until the twelfth, and sometimes until the twenty-fifth, year. This has no immediate bearing upon the health of either sex, but deferred ossification, which permits changes of form under privation and stress, is liable seriously to interfere with the most important physiological function of the mature female and to render the male inefficient for such heavy work as requires vigorous use of the lower back and the lower limbs. The submerged classes with chronically impaired health are those most liable to this deformity, but it may occur in any station where the bones do not coalesce normally and are affected by disease with or without strain. The female pelvis should be, as it is, flatter and broader than that of the male. The conception of a broad pelvis is essentially associated with female beauty, just as a truly vigorous man is deep-chested, broad-shouldered, straight-legged. The willowy young women with tenuous hips, celebrated by ignorant writers and figured by untaught illustrators, are malformed; and taste should be cultivated along the lines of nature and not be vitiated by an approval of disproportion.

The pelvis supports the spinal column and is itself supported by the thigh, the leg, and the foot, which together make up the lower extremity. The thigh-

bone (femur) is single like the arm-bone (humerus) and moves at the hip by a ball-and-socket joint, as the arm at the shoulder. **Femur**

The leg-bones, like those of the forearm, are two, the tibia and the fibula, and meet the thigh-bone in a hinge-joint at the knee. The tibia (shin-bone) is relatively large, and the fibula is very slender. Occasionally the tibia is broken by gunshot, or otherwise, while the fibula remains intact until the subject bears his weight upon it. It is important, therefore, after such an accident not to attempt to walk until expert opinion is had as to the extent of the injury; otherwise there will be serious risk of sacrificing the natural splint that nature supplies to assist in maintaining the normal length and direction of the broken limb. The fibula is the outer and the tibia the inner of these two bones, and their lower extremities are popularly known as the outer and inner ankle-bones. The ankle strictly is the joint, and the only true ankle-bone is a curved small bone, the astragalus, upon which the leg-bones play. This is never broken except by a crushing force. The common expression "a small bone of the ankle" has no foundation in fact, and fractures of the ankle are breaks of the slightly enlarged lower tips of the leg-bones. The foot resembles the hand; except that the instep, partly corresponding to the wrist, supports the weight of the body and therefore its strength and elasticity are important, and the toes lack the prehensile power of the fingers. **Leg-bones** **Ankle**

The great toe corresponds, in a degree, in importance and anatomically to the thumb, but it may not be opposed, as the thumb, to the rest of the foot. But the act of progression largely depends upon the pressure of the ball of the foot and of this toe against the ground as the body is thrown forward.

Great toe

Pressure at the base of the great toe from a tight shoe or from one too short may positively displace the member and almost certainly causes at the joint a tender swelling, a bunion. This is very obstinate, and is a grave impediment in prolonged walking. The short shoe, which does not allow free expansion of the foot forward, is probably as hurtful as the tight shoe, which bears the popular blame. In some unshod or loosely shod races the great toe remains disjunctive and almost prehensile. Certainly were our feet less cramped by special clothing, their shape and comfort would be much enhanced.

The arch of the foot, the instep, assists the act of walking by its form and elasticity, qualities that grow with its freedom. An ingrowing nail, usually of the great toe, is very painful and disqualifies for serious work. In the intervals of professional treatment the nail should always be cut straight across and not round at the corners, which is the constant temptation. The lesser toe-nails should always be carefully trimmed, to avoid wounding the neighboring toes. One's feet should be bathed at the close of the day as regularly as his teeth should be

Ingrowing toe-nail

brushed. The dust and perspiration that cling about the toes are apt to be more offensive than those in other parts of the person. The fœtid perspiration that afflicts the feet of an occasional victim is a disease deserving of commiseration and treatment, not of censure or obloquy.

The skeleton exhibits prominences, ridges, grooves, where the contractile agents that govern motion, the muscles, are attached. In prehistoric bones these are sometimes excessive, indicating a much greater development of the active muscles.

As a *résumé* remember that in early life bones may bend and in old age they are brittle, and that some are not consolidated before the age of twenty-two or later. It is thus possible for the epiphyses in the young to separate under severe strain. The moral is that political maturity and physical maturity are not attained simultaneously. The statute but not the physical law bestows majority at the age of twenty-one; but nature's work is not complete when the ballot is conferred.

Physical maturity

A practical example is found where immature men are allowed to attempt severe continuous labor, as when recruits at the age of eighteen or a little more are accepted, as legally permitted, for active military service. It is equally true that in academic life the immature cannot bear continued strain, whether of mind or body, with impunity. An exploit of memory in class or a dash upon the track is no evidence of capability of endurance before time gives lasting

power. It is not a disgrace to be immature, but it is a sign of mental weakness not to recognize the significance of immaturity.

Strain and sprain

The bones are bound together, with varying degrees of play between them, by strong inelastic fibrous bands, the ligaments. A strain is the stretching of one of these from stress; a sprain is a severe strain, sometimes a tearing. The difference is more of degree than of kind. A badly stretched ligament may be permanently weakened, and a sprain from its liability to recur should be respected for a long time. The best immediate treatment for a sprain is prolonged immersion in hot water, or hot applications, followed by careful rubbing toward the body. When ligaments are torn, as by direct force, complete, not imperfect, rest should be steadily maintained. A joint once weakened may be a life-long infirmity, and a severe sprain may be much worse in its consequences than a break.

To distinguish between a dislocation and a fracture, whose names explain themselves, it must be remembered that, in general terms, a bone which has motion where it should not is broken. When a limb does not move where it should, it is out of place.

II

The Muscular System

ROUGHLY, one-half of the weight of an adult is flesh. In a child it is somewhat less. This is found in independent sections of varying shapes called muscles. These, through their contractility, carry on the more conspicuous mechanical operations of life. All appreciable movement occurs by their action, which is always accompanied by change of form. No change of posture, even no play of feature, happens without muscular action and consequent changes of outline. That a muscle grows with its exercise is as applicable to those which mark expression as to those that carry on labor. The face as well as the back is covered with muscles, and the dominant disposition is shown in their development as clearly as the work of the blacksmith or of the porter is displayed by the arm or the loins. Nearly all the muscles have a fixed attachment to bone, which limits their movement; but there are a few known as the sphincters, mere fleshy rings to which other muscles are attached. The muscle surrounding the mouth is the most obvious example, both of their

Muscles

essential nature and of the influence brought to bear on them. On the table muscle is known as meat.

Tendon

Fibrous tissues or sinews (gristle), attached in sheets or strings, make muscles fast to other structures, usually bone. These tendons are inelastic and grow disproportionately with age, which is the main reason why an elderly person whose strength is not seriously impaired may not rival a younger one in agility. Nevertheless continual practice, far short of severe exertion, will maintain high efficiency to an advanced period. It is not an object to burden oneself with masses of muscle, any more than with fat, as evidence of health. The design should be to preserve the active efficiency of all the bodily functions, including those of the muscular system.

There are about four hundred muscles, diverse in shape and size, concerning which it is sufficient simply to understand their more conspicuous work and to recognize their general character. A general classification, having a microscopical but also a functional distinction, is the division into plain and unstriped muscle. All muscle is irritable and contracts under stimulation. This contraction involves a change of form, not of volume. Practically the stimulus to which muscle responds is exercised through the nervous system.

Speaking generally, the striped are the voluntary muscles; that is, those whose operation is con-

Striped muscle

trolled by the exercise of the will or ordinarily are moved by the voluntary nerves. For instance, the muscles of the arm, the leg,

or the face remain quiescent although themselves intact, when the nerves going to them are disabled. The energy passes through the nerves; the muscles do the work. When the nerve is severed by a knife, or disabled by disease, the muscle cannot contract.

Plain, or unstriped, muscle is not under the influence of the will, but is controlled by the organic (or sympathetic) nervous system, of which later. Unstriped muscle contracts and relaxes more slowly and more persistently than the striped muscle; but it must never be forgotten that its operation is also controlled by the nervous system, although not by that part of the nervous system which acts through the will. Hence the regulation of the whole nervous system is of prime importance. For instance, unstriped muscular fibres encircle the blood-vessels, and when by their contraction the diameter of those vessels is lessened the quantity of blood flowing through them is diminished. Now one of the effects of nicotine upon the nervous system is for the latter to cause the muscle to contract, which in turn diminishes the bore of the minute blood-vessels and reduces the blood-supply. This is one of the ways by which those who use tobacco prematurely or in excess dwarf their bodies and reduce the normal supply of nutriment to the brain. Unstriped muscles make up a part of the blood-vessels, the most of the hollow viscera, and the walls of the intestines. They carry on the automatic changes in the capacity of the lungs, and they form the bulk of the heart. Hence if the general nervous system is dis-

Unstriped muscle

turbed, these concealed but important organs may be correspondingly affected. We influence the unstriped muscle not by the will but by our care or want of care of the organic nerve.

Muscular work in its ultimate analysis represents the transformation of energy, through the transmutation of food into muscle and other constituents of the body. The manifestation of muscular work is in great part governed by that form of nervous energy which we speak of as "spirit," or "grit," and two vital machines cannot be compared until this factor is estimable.

III

The Lungs and Respiration

IMMEDIATELY behind the palate, from the common vault in which the cavities of the mouth and nose unite, two distinct channels descend. The windpipe (trachea) in front goes to the lungs, the gullet (œsophagus) behind it to the stomach. That all one's food and drink doesn't pour into the lungs depends upon the automatic closure of the larynx, at the top of the trachea, during the act of swallowing. Whatever else may happen in a case of drowning, for example, water does not ordinarily enter the lungs before actual death, even if it does then. That is to say, a person does not drown by the lungs primarily filling with water. The chest (thorax) is separated from the belly (abdomen) by the diaphragm (midriff), a broad, thin, curved muscle, and it contains the heart and lungs.

Windpipe and gullet

The respiratory organs are one windpipe and two lungs. The windpipe divides at the depth of $4\frac{1}{2}$ inches into two smaller tubes (bronchi), one for each lung. These subdivide rapidly into very

Organs of respiration

many smaller tubes which end in minute pouches, whose walls are hollowed into still more minute ves-

Vesicles, or alveoli

icles (alveoli) whose presumed number is 750,000,000, each having an average diameter of $\frac{1}{100}$ inch. The walls of these subdivided tubes are of almost inconceivable delicacy, and their essential object is to support, as would a frame, an innumerable

Capillaries

multitude of microscopical blood-vessels (capillaries). The essential nature of respiration will be explained under the circulation. The important point to remember now is that the air must be in contact with the walls of the capillaries, so that respiration may go on. These blood-vessels ramify over all the little pouches or vesicles at the extremities and in the course of the air-tubes. The popular conception seems to be that a lung is a soft, semi-solid mass through which the air drifts as it might through loose sand. That is entirely wrong. The lungs are

Lungs

a symmetrical collection of correlated cavities which exist not merely at the extremity of some particular line of tubing, but branch from all the tubes, as microscopical as they are themselves, in all directions, so that a rude illustration might be that of a tree in full leaf. The tubes, therefore, through which the outer air enters are not the lungs; the cavities, that is the air-spaces, are not the lungs; but the very

Lung-membrane

delicate membrane which is the end and limitation of the labyrinth may be thus regarded. It is in this membrane that occurs the deposit of tubercle which causes consumption. This

delicate membrane is the mechanical support of the invisibly minute blood-vessels which completely overlace its surface, and it has an available exposure to the air variously estimated at from 870 to 2140 square feet. The surface of the body runs from 16 to 21½ square feet, so that the unfolded lung-sheet would be from 50 to 100 times the area of our skins. The lungs may be thought of as two collections of delicate film arranged in a wilderness of minute tubes, and covered with a close network of microscopical blood-vessels, so that the air passes on both sides of this supporting membrane and bathes the vessels' walls.

Area

Lungs

The mechanical action of the lungs is this: The chest-walls, the ribs covered with muscles, are flexible and the chest capacity may be altered laterally and perpendicularly by their movement and that of the diaphragm. The air enters the lungs by atmospheric pressure as the walls expand, and it is forced out as they contract. As the windpipe is merely a supply-pipe, to cut it and thus make an additional entrance for air is not fatal as popular fiction sometimes represents.

Mechanism of breathing

As the membrane that forms the finer air-channels is elastic and the chest-walls are movable, when more air enters these passages they expand and may be stretched. When the air escapes or is not present in fair amount, they contract. Hence they may be strained under severe exertion, so as to fail to contract normally afterward. This condition in man is called

Straining of air-passages

emphysema, in horses heaves. When inadequately supplied with air, particularly after unusual development, as in athletic training, they may come together and in the outer portions of the lung may even collapse. But the ordinary evil is insufficient expansion, so that the aerial tide fails to bathe all the recesses.

Collapse of air-passages

What is the object of respiration, and how is it accomplished? The enormously extended and proportionately plicated pulmonary membrane, which sustains and exposes to the air the innumerable microscopic blood-vessels, has no active function. Respiration effects the purification of the blood by the action of the air directly through the capillaries. The capillary blood-vessels are somewhat elastic, microscopic tubes filled with blood, whose walls are so thin and their structure so simple that, within the lungs, carbon dioxide (CO_2) contained in the blood is given out as a gas and oxygen (O) is absorbed directly from the air through them. Such elimination of gaseous waste and absorption of fresh oxygen is an essential condition of animal life. The carbon dioxide taken up by the blood in its passage through the body (to be explained later) is carried to the lungs, where it simply escapes. The lungs afford the blood this opportunity to purify itself, and respiration is essentially the absorption by the blood of a vital quality from the fresh air and the emission of impurities into that air. Why this is necessary will be explained in another chapter; but

Capillaries

Respiration

the special point is, always to regard breathing as connected with blood-making. The quantity and especially the quality of the air we breathe is more important than that of the food we eat. Respiration is essentially a vital process, whose cessation quickly terminates life. To take in impure air or insufficient air is a step toward not breathing at all.

Breathing is better carried on through the nose with the mouth closed. In cold climates the air is somewhat warmed, gross floating particles are strained out, and some offensive impurities may be detected by the sense of smell. The rate of respiration varies with the age. It is about once in four seconds for an adult man sitting quietly, that is, from fourteen to sixteen times a minute. It is greater in youth and still greater in childhood. It is very readily disturbed by emotion; or by muscular activity; a small man breathes a little more frequently than a large one, and a woman than a man. The rate is less when sitting than standing, and when lying than sitting. It is about one-fourth less when sleeping, and it increases a little after meals. All this shows its relation to the circulation, and remembering that respiration means blood-renovation, it is evident that as the heart beats faster we must breathe faster. As compared with the throb of the pulse, adult undisturbed respiration is about one to four, and between the ages of fifteen and twenty it is one to three and a half.

Nose-breathing

Rate of respiration

The range of voluntary modification of respiration

is very limited, and it is quite impossible to commit suicide by holding one's breath, although choking by violence is quickly fatal. It is not so generally appreciated, but it is perfectly true, that impure or insufficient air, whether the insufficiency is due to a really inadequate supply, to imperfectly expanded lungs, or to a vitiated atmosphere, diminishes strength and deteriorates health. All the air in the lungs is constantly changing, and "tidal air" means the volume which comes and goes in ordinary respiration; "complemental air" is the additional amount that it is possible to inspire; and "residual air" is the quantity that always remains in the lungs, is directly charged with the interchange of gases from the blood, and which cannot be expelled.

Modified respiration

Nomenclature

The extent of the breathing space is important. It is the measure of air that can be expired after forcible inspiration, and is known as the vital capacity. It represents the entire volume of air concerned in forcible respiration exclusive of the residual air, and is, not the measure of what ordinarily *is* respired, but, of what *may* be respired, of what a person may depend upon in an emergency, and it bears a relation to height so nearly fixed that a standard table may be formulated. The factors determining vital capacity are chest measurement, which is the circumference of the chest at the points of the shoulder-blades in extreme expiration, and chest mobility, which is the difference over the same circle between the extremes of forcible expiration

Vital capacity

and inspiration. Of these chest mobility is much the more important, for in taking chest measurement allowance cannot well be made for an excess of fat, or occasionally of muscle. For convenience, the normal weight in proportion to the height is added. All the figures represent the subject stripped. To obtain approximate weight when clothed, add ten pounds. The present military standard for recruits, which is rather below the ideal, is:

TABLE OF VITAL CAPACITY AND WEIGHT.

Height in Inches.	Chest. Measurement.	Chest. Mobility.	Weight in Pounds.
64–67	$\frac{\text{height}}{2} + \frac{1}{2}$ inch	2 inches	2 to the inch
68–70	$\frac{\text{height}}{2}$	$2\frac{1}{2}$ inches	2 to the inch
71 and above	$\frac{\text{height}}{2} - \frac{1}{4}$ inch	$2\frac{1}{2}$ inches	plus 5 for every inch above 5 ft.
72 and above	$\frac{\text{height}}{2} - \frac{1}{4}$ inch	3 inches	7 in.

The contents of the chest, the heart and lungs, generate the steam that drives the animal mechanism, and the capacity of the chest is a measure of vitality. The fuel-box is below the diaphragm. Arms and legs are mere accessories, of no vital importance. Excess of stature from long legs and a long neck is a physiological blemish, rather than an advantage. The physical essentials of a sound heart and capacious lungs are worth all possible exertion to secure and retain. But to attempt to increase capacity beyond the standard of the particular type is an error, for strain may damage the elasticity of the air-vesicles. So, when they

Importance of the chest

Over-strain

suddenly pass into disuse after unusual development, there is risk that they may collapse upon themselves and yield opportunity for the deposit of tubercle and the development of consumption. Boating contests and the racing-track furnish ultimate victims from this very cause, and the football contingents are not always free from this unhappy record. The general lesson applicable to all physical exercise is, not to develop the chest to the point of strain, and after training always to resume ordinary, and especially sedentary, occupations gradually.

Continued exercise

With age the costal cartilages stiffen and the ribs lose part of their mobility; but systematic exercise will preserve the elasticity of the chest into mature and even advanced years, so that it should not be abandoned when youth has passed.

IV

The Heart and the Circulation

BESIDES the lungs, the chest contains the heart. This is a hollow muscle, approximately the size of the fist, divided into four chambers, and enclosed in a bag (pericardium) whose lower part is attached to the diaphragm. The muscular walls of these four chambers are woven together so as to form two pumps. One of these pumps sends the blood through the lungs for purification by the air; the other impels it through the body at large, carrying nutriment to and waste from all parts. Lying in two pairs, side by side, these chambers are conveniently known as the right and left hearts. The upper cavities are the auricles, the lower the ventricles—designations having no application to their functions. The blood that has just made the round of the body flows into the right auricle. When nearly full, this contracts and the blood passes through an opening guarded by valves into the right ventricle. When the ventricle is full, it contracts and the blood escapes into an artery which carries it to the lungs. After passing through the lungs it enters in

The heart

Course of the blood

succession the left auricle and ventricle and then into a very large artery for distribution, through subdividing arteries, throughout the body. When the blood reaches the extremities of the arteries, whether those carrying it to the lungs or to the body at large, it enters very minute vessels known as capillaries, and from these it passes into the veins and so back to the heart. The only special feature of the circulation important to remember in this connection is the valves, why they exist and how they may be damaged. The right and left hearts have no direct intercommunication, but there is necessarily an opening between the auricle and ventricle of each pair. These openings are protected by valves which shut very much like folding doors, or like the gates of a canal-lock, yielding at the proper time to the natural, but closing against the reverse, current. Should they become impaired by disease or damaged by strain, a backward current might be set up. Now it is possible, either from overfilling or by extreme pressure under exertion, for a valve to be stretched or strained so that it may leak a little; and one form of valvular disease of the heart begins in exactly that way, by mechanical strain. This vital organ, the heart, which cannot be tampered with with impunity, develops very irregularly. It grows rapidly in infancy; between the ages of 7 and 14 its annual increase is only about 8 per cent.; but during the period of puberty it doubles in volume, and after puberty it increases in capacity and strength

Valves

Growth of the heart

until the age of 25, sometimes of 30 years. A knowledge of these changes is important to the young. The demands upon the heart of the growing age, and immediately thereafter, are very great. As with all organs that have grown rapidly, there is usually a lack of reserve energy in the youthful heart for special emergencies. This is particularly the case with those who have grown very quickly, and especially for those much above the common height. Besides, during this period the heart is especially susceptible to agitation through disturbance of the general nervous system by vices connected with the reproductive apparatus, by the premature use of alcohol, and particularly by tobacco poisoning, of which that due to cigarette smoking is peculiarly pernicious. Through these artificial and damaging influences the heart becomes irritable, easily excited, and does not soon recover its steadiness; and an irritable heart is always a serious handicap. Besides, the growing heart has normally little reserve force. It may easily be strained by racing, whether on foot or on the wheel, by cross-country runs when carried to exhaustion, and by injudicious gymnastics and unregulated athletics. There is also danger from simple feats of strength when unduly prolonged. In the young recovery fortunately occurs after prolonged abstinence from such exertion, but it is unwise to risk the integrity of the heart by exertion recognized as extreme. It is probable that some heart is damaged in every great athletic contest when the participants are young, and

Irritable heart

Heart-strain

among those who fail to qualify for such undertakings actual or threatened physical harm is quite as sure a factor as mere inaptitude. Even the considerable honor of class numerals, or a 'varsity letter, does not warrant the risk of weakening a valve or dilating a chamber with an overcharge of blood. This serious warning as to reasonable caution is not intended to deter those tempted into the arena who are properly equipped, still less to discourage systematic gymnasium work, which every man physically qualified should pursue under competent supervision. It is admonition against wrong methods, and especially against exhausting effort, for fear of consecutive heart-strain. A particular condition, however, does call for a special caution. Inflammatory rheumatism is liable, not certain, to damage a valve, although not painfully, at the same time that the joints are affected. This is not unfrequent in childhood, and a youth who has had that disease should not indulge in exhausting, or even in very violent, exertion without being assured by competent medical examination that his heart is sound. It is much better to forego a moderate pleasure and to relinquish a minor triumph than to run a serious risk. But the occasional painful twinges in the chest-walls after sharp gymnastic effort are not to be confounded with harm done the heart. These are merely the stretching or tearing of some trifling muscular fibre, and are of no consequence. Strain of the heart, or valvular disease, is rarely marked by pain. There may be

Inflammatory rheumatism

Tearing of muscular fibres

breathlessness upon moderate exertion and a sense of oppression; seldom, if ever, sensitiveness.

Blood-vessels

Blood-vessels are of three distinct classes, arteries, veins, and capillaries. For all vital purposes the capillaries are by far the most important. The blood passes from the heart by way of the arteries through the entire body and returns to that centre by way of the veins. Both of these are mere passive channels. They are important as channels, but they do not contribute directly to vital changes. Every artery divides in its course into two others each of more than half its own capacity, or the main stem gives off branches which collectively have a greater diameter than the parent vessel. The cross-section of all the minor arteries exceeds that of those from which they are derived, consequently the friction is less and the flow of blood is facilitated. The reverse is true with the veins. The smaller veins coalesce into larger ones as they approach the heart. The walls of the arteries are relatively thick and elastic and do not collapse when cut across. Upon this elasticity depends the phenomenon known as the pulse. A pulse is the wave of blood driven by the contraction of the heart through the arteries, and recognized anywhere by gentle compression against a resisting background. The beat does not interpret the forward movement of the blood so much as it does the wave-like impulse, the undulation, the propagated motion from the heart, recognizable through the plasticity of the arterial walls. There are numerous accessi-

Pulse

ble pulses, but the one ordinarily used is where the artery is gently compressed against the radius, on the thumb side of the wrist. An unskilled person who attempts to feel the pulse in accident or sudden illness, to determine whether the heart still beats, is sometimes deceived by the vessel lying too deep for easy recognition. Therefore failure to find the pulse at the wrist is not a surely fatal sign. There are accessible pulses in the neck, over the temple, at the angle of the jaw, in the groin, in the inner part of the arm and of the thigh, and under the inner ankle, any of which may be used to determine the action of the heart or to control adjacent bleeding. The normal pulse-rate, that is the heart-beat, for an adult man in repose is 72 a minute. This is increased by muscular exertion, sometimes to more than 200 a minute for a short time, which involves tremendous strain of the heart; and it may vary between recumbency, sitting, and standing by eight to ten beats a minute. It also responds quickly to emotion. A pulse persistently much slower or much faster than normal usually, not always, is a sign of ill health. An excitable and rapid pulse, in a youth otherwise well, generally means an irritable heart from the abuse of tobacco or from vice. In women the pulse is normally slightly faster than in men, in children it is much, and in youths it is moderately, faster than in adults. In the old it is apt to be somewhat slower.

Pulse-rate

Veins are much softer and more collapsible than arteries, and the most of them have pocket-like valves in the walls to support the column of blood.

Veins

Neither arteries nor veins contribute directly to vital action. But between the smallest arteries and the smallest veins are interposed the capillaries, distinct from both the others, by means of which all the vital action in which the blood takes part is carried on. They are, therefore, of the utmost physiological importance, but their significance is popularly overlooked.

Capillaries

The capillaries, which are infinitesimally short as well as slender, are of the practically uniform diameter of about a five-thousandth of an inch, and the blood carries on its peculiar work while traversing them. The blood transports nutriment to all parts of the body; it carries to the various tissues the oxygen so necessary to their life, which it absorbed while in the lungs; and it bears the waste products from the tissues and disposes of them in various ways. These somewhat elastic, very minute, vessels have walls so thin and with a structure so simple that through them in the lungs the carbon dioxide passes in one direction and oxygen in the other; in such organs as the liver they supply material for secretion; in the intestines they take up the digested food; in the excretory organs, as the kidneys, they emit the waste; and always and everywhere there is going on that interchange upon which depends the life of the body. Speaking generally, this action is one of osmosis, and the capillary walls are osmotic membranes. Nutrition and waste are accomplished not only by means of the capillaries, but

Province of the blood

Osmotic action of the capillaries

directly through their walls, as the juice of crushed fruit oozes through a linen bag without rupture of the texture, and these minute elastic tubes are in some respects the most important of the physical agencies.

Blushing

They are also capable of dilatation, as seen in blushing when nervous control is temporarily lost through emotion, and in the permanent flush of a drunkard's face and the congestion of his interior economy.

The arteries, the capillaries, and the veins, each a distinct class, are all continuous and designed to convey the blood about the body. But it is through the capillaries that the blood itself carries out its physiological purpose. The blood, for whose circulation this

Nature of blood

complicated network is arranged, is a watery fluid, or plasma, in which float innumerable small corpuscular bodies. The plasma is a mixed solution of nutritive material and waste. The most of the floating corpuscles individually are a dirty yellow, and in mass they are red. About one in three hundred is white. The white corpuscles are important, but their functions do not concern us in this connection. The blood that returns to the heart through the veins, from the body, is a dark-red or purple, because of the carbon dioxide it holds in solu-

Carbon dioxide

tion. Complex tissues have broken down and carbon dioxide has diffused into the blood in the capillaries on its way to the veins. This dark-red blood is driven by the right heart into those other capillaries that lie in the great multiple membranes

that we call the lungs, and the carbon dioxide escapes by osmotic action through the capillary walls into the aerial tide which flows around the pulmonary alveoli, and thence by expiration into the general atmosphere. Should the carbon dioxide not escape, the animal is made ill by self-poisoning and ultimately dies. Simultaneously oxygen from the fresh air that has been drawn into the lungs passes through the capillary walls and is absorbed by the red corpuscles, changing their color to scarlet. The red corpuscles are essentially oxygen-carriers, and when the freshened blood passes from the heart into the capillaries of the body they yield the oxygen, which escapes through the walls and the carbon dioxide in turn is taken up. The student must not suppose that these are in the arteries and veins in gaseous form, but remember that they are held in solution in the blood ready to escape as gases under proper conditions.

Oxygen

The adaptation to life of the atmospheric ocean at whose bottom we live is remarkable. In general terms we breathe a mixture, not a union, of oxygen and nitrogen, containing also minute quantities of other gases which, as far as we now understand them, are negligible. The oxygen and nitrogen are not united to make a third, but for convenience we give the mixture a new name and call it air. Chemically the gases are unaltered and we are able to breathe the air because the oxygen is free, is in companionship, not in union, with the nitrogen. A disadvantage is that the mixture may, and sometimes does,

Atmosphere

receive contaminating gases, as from factories and sewers, from combustion and from respiration itself, when their products are not properly removed; that is, when there is not the adequate ventilation which intelligence and energy may always provide. It must not be forgotten that the character of our blood, and hence our inherent vitality, depends more upon the air we breathe than upon the food we eat. Certainly impure air means impoverished blood; and, equally, insufficient air means inadequate blood. It cannot be too clearly remembered and acted upon that respiration is a vital process, and that the gases which enter the lungs are taken up by the blood for good or for evil. If the air is pure, the blood is renewed; if it is breathed-over air, the blood is contaminated; if it is poisonous air, from a sewer or a cigarette, the blood is poisoned. These conditions apply to daily life, particularly to residence within doors, and to the watches of the night as well. Many a man who opens his windows by day closes them at night. There is no better reason why he should suffocate himself in any degree by night than by day. If the domestic ventilation is sufficiently inadequate to require such air-channels at one time, it would also at another, especially as the occupation is more continuous and the incidental currents from doors and passageways are less. He is apt to plead fear of the night air. At that season the night air is all the air there is, and there is no good reason to exclude it

Contaminating gases

Air makes blood

Night air

merely because of the time of day. Noxious insects, more prevalent at night, should be guarded against; dampness, due to the absence of the sun's warmth, should be antagonized; but it is hurtful to exclude the fresh atmosphere because of non-essential incidents which may be neutralized. Some gases quickly destroy life, others slowly undermine health. The latter are generally of our own making, and both should be avoided.

The normal quantity of blood in the body is estimated at about $\frac{1}{13}$, or 7.7 per cent., of the gross weight. Thus, a man weighing 140 lbs. would have about $10\frac{3}{4}$ lbs., or 11 pints, of blood. Any particular portion of blood is supposed to make the circuit of the body in about 23 seconds. A man may lose at one time nearly 3 per cent. of his own weight, or about $4\frac{1}{4}$ pints in volume, of blood without necessarily fatal results. Accidental bleeding to any extent is to be deprecated, but the amount lost is easily overestimated, especially if it is caught in a vessel where there already is water. A little blood will color a relatively large quantity of water and deceive the unaccustomed eye.

Amount of blood

It would be beside our purpose to describe the capillary service in other great internal organs. The entire interior of the body is traversed by numerous enclosed channels through which the blood courses to and from the heart, and all the interspaces are filled with a vast network of microscopical vessels. From all of these capillaries fluid is constantly oozing, not as blood but as its constituent

Capillaries elsewhere

parts; and into them waste material is entering, not as organized waste but as worn matter for later disposition. That one can scarcely intrude the point of a needle into the flesh without drawing blood, means that a needle's point is too coarse to pass between the meshes.

V

The Nervous System

AS Watson long ago remarked, the nervous system is the third leg of the tripod upon which animal life rests. The other two are respiration and the circulation. Through the nervous system man himself, not merely his physical envelope, is brought into relation with the outer world and the conditions of time and space. The nerve-cell, which corresponds physiologically to the molecule of the chemist, is the elementary unit and, in its various combinations, makes up the brain, spinal cord, nerves, and ganglia, which are the working apparatus of the nervous system. The nerve-cell originates and conveys nervous impulses. It responds, without recognizable change, to stimulation. Muscle changes form when it displays energy; bone does not respond to stimulus; but a nerve receives, originates, or transmits a stimulus without appreciable alteration of form. A nervous impulse once started may arouse a similar impulse over considerable distances, and a nervous current is particularly prone to sweep repeatedly over the same course and thus affect our daily life.

Brain, Spinal cord, Nerves, Ganglia

Nervous matter is gray or white. Nervous force appears to originate in the gray and to be transmitted along the white matter. The brain is an ovoid white mass lying within the skull, in which are embedded numerous gray foci or islands, and over it is a convoluted (folded) gray surface. All the gray parts are connected by white fibres, and the gray brain is also thus connected with the gray of the spinal cord. The brain consists of two lateral halves united near the centre and subdivided into lobes, of which an English walnut with the shell removed is a rough model. (O. W. Holmes.) The interesting, but probably erroneous, doctrine of the Duality of the Mind rests upon this duplication. Nervous manifestations really arise from distinct gray centres. Every brain has a general resemblance to every other brain, but may differ from it in the number and depth of the gray folds. Upon this difference and probably upon the inherent quality of the gray matter depends the capacity of the mind, which is physically dependent upon the brain for its operation. In infants and idiots these folds are meagre and shallow, in intellectual men they are conspicuous and deep. But as their number and quality cannot be determined, mere inspection fails to show natural capacity. Nevertheless in general terms the size of the skull implies the weight of the brain, and in dealing with considerable numbers we find the large-brained men to be the superior as a class, although the factor of quality may disturb the finding in any particular case. At all events narrow foreheads and narrow

Brain

minds seem closely associated. The pseudo-science of phrenology appears to have no scientific basis, but there is a higher phrenological doctrine * which is plausible. This associates the pre-frontal lobes with intellection, those just below and behind them (tempero-sphenoidal) as connected with the propensities common to man and the lower animals, the emotions with the parietal and the hinder parts of the frontal lobes, and places the domestic and social affections in the occiput. Although not demonstrated, this is at least credible. The standard weight of the adult white male brain is 49.5–50 ounces; the female brain about 44 ounces. The brain increases rapidly in weight until the seventh year, more slowly until between 16 and 20, still more slowly until its maximum at 40, and after 50 it slowly loses about one ounce in every ten years. The spinal cord, enclosed and protected by the spinal canal, is continuous with the brain, but in it the white matter is superficial and the gray is central. Death promptly follows whenever the cord is severed high up, whether pierced by the garrote, torn on the gallows, or crushed by breaking the neck in shallow water or elsewhere. Interrupted lower down, by disease or by violence, sensation and voluntary motion are abolished below that point. This continuous nervous mass communicates with the organism at large by the nerves which escape through openings between the vertebræ.

Spinal cord

* Mental Functions of the Brain. (B. Hollander.)

The brain as the seat of the mind induces the voluntary movements of the body. Automatic action inspired by portions of the cord may be modified by the brain, but when not thus controlled the cord itself superintends complicated movements, as walking or dancing, without the intervention of thought. The lower cord contains centres that respond equally to emotion and sensation, and, when stimulated act reciprocally; but these may also be controlled in their operations by the active brain.

Nerves

Nerves are slender whitish cords running from the nervous centres to all parts of the body. Alike in structure, those from the brain and the cord are sensory (afferent) or motor (efferent). Both lie indistinguishably together, the sensory being those which convey impressions from without to the nervous centres, whence the outward impulses are borne by the motor nerves. Some of the cranial nerves are those of special sense. There is also a system chiefly within the trunk, the sympathetic (or organic) nerves, arising from ganglia and distributed to the viscera and the blood-vessels and connected with the brain and the cord. Ganglia are enlargements of nerve substances, spinal (general) and sympathetic (organic) connected with other ganglia and with the centra system. The sympathetic nerves chiefly go to organs involuntary in action and obtuse in sensibility whose functions are subconscious and automatic. These nerves are affected not merely by drugs such

Sympathetic nerve

as may act on the other nerves as well, but by bad habits and indeed by emotions which may induce bad habits as well as by those springing from them.

In health we have no direct knowledge of possessing a liver, kidneys, intestines, or other internal organs. When subjectively conscious of any organ or appendage of the body, something is wrong. The heart and the lungs, for instance, do their daily work under control of the sympathetic without supervision and without discomfort. But the sympathetic system is also associated with other nerves. Thus through this medium the pupil responds to emotion as well as it does to light. A part of the service of the sympathetic is to regulate the tension of the arteries and the capillaries, by distributing to them the filaments there known as the vaso-motor nerves. This control of the calibre of capillaries (alcohol dilating, nicotine contracting, for example), is particularly important in affecting the local supply of blood. The pallor or flush of the countenance is a visible example of its operation under emotion.

Reflex action is the simplest form of nervous activity. This may or may not involve the sympathetic. An appropriate stimulus applied to a sensory nerve excites a motor response without the intervention of consciousness. Thus when light falls upon the open eye the muscle regulating the pupil contracts. The will has nothing to do with it. Under a bright light the pupil contracts, we say spontaneously. A sleeper will involuntarily with-

Reflex action

draw his foot when it is tickled, owing to the play of a reflex centre in the spinal cord. If the cord should be severed above that centre, the legs will move in response to the tickling without the knowledge of the subject except as he may see their motion. So food entering the upper intestine induces an unconscious flow of bile. Other elements may add to the complexity of the operation, when the gray matter of the brain becomes involved and action is delayed or uncertain. For instance, in the East a suspected thief may be detected through his inability to moisten with saliva raw rice held in his mouth, when accused with the offence and this impotence predicted. The emotion of guilt inhibits the salivary flow through reflex force. Much reflex action is too common to attract attention until we stop and analyze it. We more easily observe examples in disease, because they are less familiar and are apt to be marked by suffering; as headache from a disordered stomach, or pain in the knee when the hip is affected. However, not all pathological reflexes are painful. Frequently a sensory impulse occasions a dream whose numerous incidents depend, in a not necessarily logical sequence, upon the first nervous irritation. Thus, a man aroused by the slamming of a door from a short sleep dreamed that he had enlisted in the army, had joined a distant regiment, deserted, was captured, had been tried by court martial, was sentenced to be shot, was led out to execution and awoke at the sound of the volley. Here the whole

chain of events, involving an imaginary enlistment and the violation of his oath, was called before his mind by his ear being startled at a sharp and sudden noise. Not all dreams are reflex, but some, like that, clearly illustrate that phenomenon.

Reflex action has a practical relation for students in its connection with eye-strain. The unconscious effort of an astigmatic eye to neutralize its defects sets up disturbance, elsewhere. Astigmatism is rarely appreciated as early as simple near-sightedness, and when not corrected by glasses it occasions pain, not necessarily in the eyes, generally somewhere in the head or the back of the neck, frowning, nausea, dizziness, or even dyspepsia. Sleeplessness and vertigo, sometimes nightmare, may be attributable to the forced use of astigmatic eyes. Deep perpendicular lines in the forehead of the young usually have eye-strain behind them. The habit of leaning the head toward one shoulder in reading or writing pretty surely indicates mechanical trouble in the eye, with the risk of some reflex being established. Pain, at intervals which usually grow shorter, after reading or writing is a sign of such disability; and in some the strain of gazing in a brilliant theatre, or that of looking up at a high pulpit, renders this defect active. It has been plausibly maintained * that the notorious intermittent ill-

Astigmatism arousing reflex action

* Biographic Clinics, by George M. Gould.

health of such well-known men as Carlyle and Darwin was determined by unrecognized astigmatism.

Cardiac and solar plexuses

The cardiac and solar plexuses are large sympathetic networks which are also connected with the spinal nerves and lie behind the heart and the stomach respectively. The solar plexus is distributed to the stomach and the adjacent organs, as the cardiac plexus is to the heart; and our daily life is maintained in great part by the nervous force they furnish. Severe blows over the heart may be followed by faintness, sometimes unconsciousness, occasionally death, from the shock of the impact to the nervous system. The ribs protect the heart and the nerves from direct injury, but the jar is transmitted to the plexus. A blow over the stomach is even more dangerous than one over the heart, because the solar plexus is larger and is less protected from violence. The padded guards of the base-ball catcher are a tribute to the vulnerability of these localities. The mental lassitude that follows a heavy meal depends upon the draft of nervous force, as well as the diversion of the blood-supply required by digestion. Too vigorous exercise of the brain while the stomach is active is liable to interfere with the efficiency of one or the other.

Revival after prostration from violence

The heart's action is best revived in a person unconscious or prostrated from violence, by dry heat over the heart through hot-water bags or bottles, hot sand-bags, cloths, or a heated plate. If able to swallow, strong coffee, diluted aromatic ammonia, or a very little spirits,

preferably in hot water, may be given. Alcohol in excess depresses.

Depressing as well as exciting emotions act on the sympathetic, and death has followed threatened beheading after a mock trial. Hence the danger as well as the folly in frightening children and others of nervous susceptibility, who sometimes lose health and occasionally reason by severe nervous shocks. **Fear**

The complicated act of walking excellently illustrates correlated and partly automatic nervous action. The brain wills walking to begin and the cord maintains it without conscious effort. The brain may at any time interfere and regulate the pace or change the direction, but until that interference occurs the unconscious spinal cord controls the exercise. Skilful dancing still better illustrates such automatic service. **Automatic spinal action**

Different nervous manifestations have distinct sources; that is, localized brain-centres control particular actions. The whole brain does not conduct the act of writing or of speaking, certainly not the movement of an arm, probably not the play of an emotion. Within narrower limits this is true of the spinal cord where reflex centres may come into independent operation without reference to the conscious mind, as illustrated by the feet that move when tickled although communication with the brain may be entirely cut off. Sensation resides in the brain, but motion may originate automatically en route. **Centres of action**

Usually reflex centres coordinate and rearrange received impulses, producing an advantageous result. Thus the presence of food, rather than the mere motion of the jaws, excites the flow of saliva. Some centres are distinctly automatic, as that which controls respiration. Breathing may be affected by the will only within very narrow limits. So with the heart, whose perpetual pumping exertion or emotion may modify but the will cannot control.

Automatic centres

A nervous impulse is transmitted in cold-blooded animals about 92 feet a second; in the warm-blooded a trifle more rapi ly. The natural difference between each other in ability to perceive and to act upon our percepts is the personal equation. This is best observed in a primary function, as making and recording a simple observation. Originally connected with noting the passage of a star across the meridian, it now has a much wider application. Within certain limits the speed and accuracy of both observation and action may be increased. Much of the advantage of out-door games is the training of "the eye," which besides speed of vision means rapidity of judgment and the swiftness and precision with which motor impulses call successive muscles into action, and the close adaptation of mind and body alike to the situation. Such benefits extend beyond the game to the general advantage of the individual. Acquired skill means judgment, promptness and agility, and depends primarily upon a cultivated nervous system

Rate of impulse

Personal equation

Acquired skill.

which also promotes efficiency in the classroom, the laboratory, and over the drawing-board. But field achievements should be tributary to intellectual progress, not in place of it. The Gymkharna should be an ally, not a rival, of the College.

Two practical lessons should be learned about the nervous system: (1) nerve-cells undergo constant change; (2) nervous action tends to repeat itself.

We may infer constant change in the nerve-cells from the abundant blood-supply of their vicinity. Moreover, the microscope demonstrates that nerve material is expended and renewed during respective periods of activity and rest. During prolonged exertion the essential centres (nuclei) of nerve-cells shrivel and the whole cells diminish compared with those at rest. In old age they are habitually small and distorted, hence nervous exhibitions of high grade and especially of prolonged energy are rare in the aged. These changes are most conspicuous, and probably most common, in the gray matter. The gray cells break down and must be renewed. The white matter, whose function is limited to transmitting a form of molecular motion, shows no such palpable changes. We are not to conclude that nervous waste does not occur because it is not as apparent as that of muscle or fat; nor may a stimulant be substituted for nourishment and rest. As well overcome fatigue in a tired horse by whip and spur, rather than by oats and repose. Nervous tissue expended by work, study, or worry must

Change in nerve-cells

be restored by rest and nourishment and by these alone.

The second lesson to remember is the inherent tendency of nervous action to repeat itself. We are liable to overlook habit as an essential attribute of all phases of the nervous system. The facility with which complicated muscular movements, as swimming or the use of musical instruments, are resumed after years of inaction illustrates one aspect. Excepting as barred by the weakness or stiffness incidental to disease or age, the muscles respond, perhaps not as vigorously but, as perfectly as formerly; for the nervous messages flow as readily as in boyhood. So there are tricks of physical expression, peculiarities of gait or of speech that we truly say have grown upon one. They begi in early life, continue as a habit, develop into a characteristic. Among these may be eccentricities or provincialisms of language which, carefully guarded against ordinarily, reappear under excitement in the grammatical errors or local idioms of an illiterate youth. That is, the old nervous paths once worn are not barred, much less destroyed. New ones may have been laid out, but the old ones remain ready for the nervous flow to follow the familiar channels. Paths of conduction become, through frequent use, particularly adapted for the passage of emotions and thoughts as well as of mechanical and simpler habits. It is especially to be remembered that there is not merely a facility but a tendency for individual thoughts and for groups and

Nervous action repeats itself

classes of thoughts to repeat themselves and to generate others like them. "As a man thinketh, so he is," is a solid and fundamental fact, and Personal Hygiene, while chiefly concerned with the body, also touches the mind whose servant the body is. The late Professor Martin, of Johns Hopkins, felicitously said:* "The higher nerve-centres are eminently plastic; it is that which marks them out for a far higher utility and greater adaptation to the varying experiences of individual life than the more fixed and mechanical lower centres." But he adds: "Every thought leaves in [those centres of intellection and emotion] its trace for good or ill; and the moral truism that . . . the more often an evil solicitation . . . has resulted in a wrong act . . . has its parallel (and we can hardly doubt its physical antecedent) in the marking out of a path of easier conduction from perception to volitional emotion in the brain." "On the other hand every right action helps to establish 'a path of least resistance' and makes its subsequent performance easier." Thoughts, whether high intellectual concepts or based on appeals of passion, follow each other over the old paths with increasing facility. That is true of morals and mind alike. Perhaps not literally, but certainly in effect, "runways" are easily established in the brain, over which our mental processes race along in preference to breaking out untrodden routes. New paths are formed under compulsion; old ones invite by their familiarity.

* The Human Body, by H. N. Martin, p. 631, *et. seq.*

Cerebral action is accompanied by cerebral change, for nerve-cells break down in operation. Without doubt intellectual and emotional operations follow laws like those that govern motor functions. As the practised nerves of an acrobat convey at once the necessary directions to his muscles, which execute with comparative ease a new feat in which a novice would fail disastrously, so the skilled mathematician solves an unfamiliar problem more readily than a man of equal but untrained mind. Equally a roué commits without self-reproach sins from which a neophyte would shrink in dismay. *Obsta principiis* applies as well to ethics as to mechanics, to modes of living as to a leak in a dike. To quote Martin again: "Association of movements . . . finds an interesting parallel in . . . the association of ideas; and all education is largely based on the fact that the more often the brain regions have acted together the more readily, until finally almost indissolubly, do they so act." The plasticity of the brain, like the flexibility of the muscles, may be preserved by practice, but disused thought-centres lose both pliancy and force. Nevertheless, whatever exercise may be given the brain, the time will come when habitual thoughts of former years will recur and the brain be haunted by the echoes, if not by the renewed calls, of those earlier familiar ideas. If they are exalted, the later years will be, if not exhilarated, at least serene. If they are narrow or unhallowed, the prospect will be one of limitation and regret. The importance of

cultivating clear strains and broad views in mental operations cannot be exaggerated. However attractive football may be, it is not the *summum bonum;* and the men who achieve success in logical debate are at least as likely to be eminent in the world as those who acquire their numerals on the track. To quote finally from Martin: "The brain like the muscles is improved and strengthened by exercise and injured by overwork and idleness; and just as a man may specially develop one set of muscles and neglect the rest until they degenerate, so he may do with his brain, developing one set of intellectual faculties and leaving the rest lie fallow until, at last, he almost loses the power of using them at all." It is a part of merely honest mental hygiene to cultivate the mind and accumulate mental resources outside of a selected career. The narrowest specialty, the most technical study, rests best upon a broad base; nor should the habit of looking at a subject from every angle be neglected. Neither should one wander so far into so-called general reading that nothing is thoroughly learned and the end is illogical thinking and mental slovenliness.

VI

The Contents of the Abdomen

THE organs below the diaphragm are those engaged in digestion, the transformation of food into the living body or assimilation, and the elimination of waste. This general region is the abdomen or belly.

Abdomen

Its best recognized content is the stomach, which in common speech gives its name to the whole. This is illustrated in the popular sacrifice of accuracy to imaginary elegance of expression in such a phrase as "stomach-ache," for an entirely different condition. The stomach proper is a hollow, extensible, muscular organ lying directly under and touching the diaphragm. Its fibres run in various directions, assuring a complicated motion by their successive contraction. As food, the stomach of the lower animals is known as tripe. When moderately full the adult human stomach has a capacity of about three pints, but under gormandizing or disease it may be much dilated. Digestion is the process of preparing food for assimilation, and the digestive apparatus begins with the mouth. From the mouth the food passes down the gullet (œsophagus)

Stomach

into this sack, the stomach. Beyond the stomach the digestive tube is continued by the small intestine and is completed in the large intestine. The small intestine, so called from its calibre, varies from twenty to twenty-five feet in length and lies coiled in the middle of the abdomen. The large intestine, also named from its calibre, is several times the diameter of the former but is only about five feet long. It lies in a single large coil on the outer border of the assembled small intestine. Its greater length is the colon, along the upper and left border, the seat of the colic. The last eight or ten inches, comparatively straight, is the rectum, which terminates at the anus. The two extremities of the digestive canal, the mouth and the anus, are sphincters—purse-like muscles not directly attached to bone. At the junction of the large and small intestines is a bulge or enlargement, the cœcum, about three inches in length, from which the well-named vermiform appendix proceeds. The appendix, closed at the lower end, is from three to five inches in length and about as large around as the stem of a clay pipe. Its wall, like that of the rest of the intestine, is not much thicker than fairly stout paper. The appendix is conspicuously known from its condition in disease rather than in health, due to accuracy in diagnosis and the wonderful possibilities of aseptic surgery. Appendicitis was formerly lost in the general designation of inflammation of the bowels, a condition that almost invariably proceeded unchecked to a fatal end;

Intestines

Vermiform appendix

for operations which now are done successfully every day, not many years ago would have been homicidal. The appendix * is not a catch-all for the collection of grape-seeds, cherry-stones and the like, with consequent inflammation. Although it occasionally occurs, the detention of foreign bodies there is so rare as to be negligible. It is not yet practicable to assign a general cause for appendicitis, but although not demonstrable at this time, it seems probable that habitual constipation with bacterial action depending thereupon may induce the condition. Practically if the bowels are kept fairly regular, it is not worth while to anticipate the introduction of a foreign body or the spontaneous development of inflammation.

Liver

Directly below the diaphragm on the right side and in front, extending from the fifth to the tenth rib, is the liver, the largest single organ in the body. Its weight is a trifle over three pounds. It consists of innumerable lobules the size of a pin's head (one-twelfth inch), themselves composed of cells completely enveloped in capillaries. This organ has a special and important circulation of its own, not necessary to be described here; but any organ so large and so full of blood, whether, as formerly supposed, the seat of sentiment or not, is necessarily of conse-

* Some authorities regard the appendix as a purely superfluous relic, an evolutionary sign-post of the past. Others look upon it as a lymphoid organ, of positive although secondary importance. It is found only in the higher apes, the curious marsupial the wombat, a few rodents, and man, and its genealogy is not well made out.

quence, and whatever may disturb its work must damage the system at large. All the blood in the body passes through the hepatic (liver) circulation and is modified thereby just as certainly, although not with the same immediate influence upon life, as in the pulmonary (lung) circulation. Various secretions that affect the digestion of food, of which the best known is the bile, form in the liver. In the intervals of digestion the newly-formed bile collects in the gall-bladder, a small reservoir that peeps out under the front edge of the liver.

Pancreas

To the left of the middle line and below the stomach is the pancreas, which in food-animals is sweetbread. This secretes a digestive fluid.

Spleen

Farther to the left is the spleen, connected with the disintegration of the blood-corpuscles and not at all with digestion. The residents of malarious districts know it, when enlarged and hardened in such disease, as ague-cake. An earlier generation seated here a form of ill temper.

Kidneys

On each side of the spine, near the level of the last rib, is a reddish-brown, "kidney-shaped," body. Each of these is about $4\frac{3}{4} \times 2\frac{3}{4} \times 1\frac{1}{4}$ inches in size and about 4 or $4\frac{1}{2}$ ounces in weight. These are the kidneys, and in their small compass are packed half a million capsules and fifteen miles of delicate tubing, All the blood passes through the kidneys sooner or later, and from it they excrete from two and a half to five pints of urine daily.

Within the pelvis and well to the front in the middle line is the bladder, capable normally of holding rather more than a pint, although in disease it is sometimes distended much more. The urine, constantly formed but irregular in amount, reaches the bladder through a tube from each kidney called the ureter.

Urinary bladder

In the male attached to the lower part of the bladder are two small very irregularly-shaped reservoirs, the seminal vesicles, which receive the semen secreted by the testicles, and hold it preparatory to evacuation. Like the urine, the semen is constantly forming (during the virile period) and, also like the urine, at very irregular rates. In the female the uterus, or womb, lies behind the bladder, and after conception the child developed therein passes out at the proper time between the bones of the floor of the pelvis. Because of its relation to that phenomenon the normal female pelvis is broad and roomy.

All the organs of the abdomen have now been roughly accounted for.

VII

Digestion and the Care of the Digestive Apparatus

DIGESTION, the preparation of food for assimilation, like all vital acts requires blood and nervous force. Consequently neither severe physical labor nor marked mental activity should be attempted simultaneously with the digestion of a heavy meal. But in a vigorous person neither mental nor bodily activity should interfere with the digestion of a temperate meal. It is in part because of its demand for blood and nervous force that modern life has unconsciously placed the heaviest meal at the close of the day, when serious drafts upon the system are not likely to be made. But where the early night is devoted to study, care should be taken that the last meal is not unduly heavy. Enough food should be eaten, but it should be digestible in quality and not excessive in amount.

Digestion

Digestion begins in the mouth, and the mechanical subdivision of the food by the teeth is always serviceable. With some classes of food this subdivision determines between the fact and the failure of digestion. Cheese is a conspicuous illustra-

Mastication

tion of this. Some persons to whom cheese carelessly eaten is entirely indigestible, assimilate it perfectly when it has been finely subdivided by the teeth. As digestion depends upon the action of fluids upon solids, it follows that the more extensive the surface of any particular quantity of food with which the digestive fluids come in contact, the more readily is it accomplished; and obviously the superficial area increases rapidly as the fragment is divided. A reasonable recommendation has been made (Dewey) to chew solid food while any taste can be recognized. Ordinarily this requires each portion to be acted upon from twenty to forty times. Besides prolonging the gustatory pleasure and bringing the food into the best possible condition for digestion, such careful treatment satisfies the appetite more readily and diminishes the amount consumed. When food is abundant we all are apt habitually to eat too much. Three consequences follow compete mastication. Sapidity, or at least the recognition of sapidity, is increased; swallowing is facilitated; and one variety of food is partly digested.

Saliva

Flavor is recognized only when the part of the food next to the nerves of taste is moist. A little sugar or salt laid upon the tongue when wiped perfectly dry will yield no taste. As embarrassment in speaking, to use a minor illustration, may inhibit oral moisture and render the mouth dry and stiff, so the act of swallowing is aided by a copious flow of fluid. But saliva, besides having these

mechanical advantages, is a digestive fluid which turns starch into a form of sugar as a prerequisite to further digestion. Starch is a considerable component of flour, potatoes, and many other vegetables, but is digested with difficulty, if at all, in that form. To use a borrowed illustration: Starch mixed with cold water will not dissolve, but ultimately settles as wet starch. Starch boiled in water will partly dissolve, but when such a mixture is placed in a bag of several thicknesses of fine muslin, the water will leak out and the most of the starch will remain. But sugar (or salt) will thoroughly dissolve in hot or cold water and the sugar (or salt) in solution will pass through the muslin walls as freely as the water itself. Now something very like this occurs in the alimentary canal, the walls of whose capillaries will not absorb starch suspended in water but will readily take up sugar in solution.

It is insufficient, therefore, for the starch merely to pass through the mouth; it must be thoroughly mixed with the saliva in order that advantage may be taken of its sugar-making quality. When starchy food is bolted, as with ill-bred or over-driven people, nature happily provides a supplementary agent in the upper part of the small intestine to complete, or to replace, the service begun, or indeed omitted, in the mouth. But it puts a strain on those glands when they are called upon to transform the starches that have passed through the stomach practically as so much

foreign matter. There is intestinal indigestion quite as truly as gastric indigestion, and one form of it is where too much starchy food for the small intestine to treat has reached the bowel unacted upon.

Malted food

Various malted and otherwise predigested foods are advertised to assist nature presumed to be delicate. Malted foods have had at least a part of their starch artificially transformed into sugar. Their design is to lighten the work of the digestive fluids, because these are either inefficient in character or inadequate in amount from sickness or undevelopment. Or else they are open aids to laziness in eating, artificial props, proxies, or substitutes, that enable a man to slight his physiological work. They may remind students of contraband ponies on which to trot swiftly over classical highways, instead of depending upon honest toil on foot with the pilgrim's sandals and staff of grammar and lexicon, makeshifts to shame vigorous men—although both may lift invalids over serious difficulties. The repulsive habit of chewing tobacco, fortunately rapidly waning, wasted large amounts of saliva, besides having other disadvantages. Its inane successor, the chewing of gum, observable in a certain class, is also happily going out of vogue. These people are not apt to be aggressively offensive, like the dischargers of tobacco-juice, but besides the repulsive working of their jaws they waste saliva; for saliva is wasted when swallowed without food, and taken in excess on an empty stomach it is supposed to cause irritation.

The ordinary moisture of the mouth depends less upon the saliva than on the watery secretion from the numerous glands which stud its surface, saliva flowing in addition when food is present. The sensation ordinarily confused with thirst is a superficial dryness of the fauces. This false thirst, the dryness of the throat, is best relieved by holding in the mouth a bit of wood, a pebble, or other inedible substance. On the track gum is commonly used to induce moisture, but gum is undesirable for prolonged work. In a long excursion, a march, or even an extended walk, all the advantage of drinking water will be secured by keeping the mouth moist in just that way. An experienced soldier on the march will keep a pebble in his mouth, but will drink nothing after the morning meal until he approaches camp. As soon as one begins to drink on a long walk, the temptation is almost irresistible to repeat the indulgence, often at great inconvenience. The exception is that of extreme exertion under tropical conditions, when there is risk that excessive perspiration may dangerously increase the density of the blood. For of course the perspiration, like the choleraic discharges, is ultimately derived from the blood itself. Such loss of fluid causes true thirst, and when the loss is excessive it must be replaced. True thirst therefore depends upon the loss of the watery part of the blood, usually by perspiration, sometimes from intestinal discharge (from ordinary diarrhœa to cholera), occasionally by hæmorrhage. This can only be relieved by drinking

Thirst

more water, and the overpowering thirst of a bleeding man depends upon that drain. To supply water to a man who has lost much blood not only relieves his most obvious symptom, the distressing thirst, but it partly qualifies the vital fluid to pursue its course more easily. It is always proper to give water to a man who has lost much blood. Alcohol may start the bleeding afresh, water ordinarily will not.

Water taken into an empty stomach is not absorbed directly through the walls, but is spirted in small successive jets into the upper part of the small intestine. Obviously it is unwise to flood the empty stomach with water, especially with ice-water, that escapes slowly. On the other hand when water is mixed with food, so that a nutritious solution is formed, it is absorbed directly and rapidly into the walls of the stomach, that is into the capillaries that throng them. As a rule, to which there may be exceptions, there is little risk of diluting the gastric juices, as is popularly taught, by drinking freely with meals when natural desire prompts. In this instance the natural impulse may safely be followed. Curiously, the various alcoholic beverages are absorbed directly and rapidly by the stomach itself.

Swallowing

Food enters the stomach from the mouth through the œsophagus (gullet), down which it is not shot as along a chute nor dropped as a pile-driver. It is passed, in a small quantity and a little way at a time, by the action of involuntary muscles. This is clearly seen in a horse drinking, where the

successive gulps may be observed moving along the exposed œsophagus, usually against the action of gravity. When one drinks directly from a spring he knows that position neither retards nor assists the process. The effort to transfer a morsel of food somewhat larger than the tube conveniently accommodates makes one conscious of the muscular effort. Conversely, the real difficulty occasionally found in swallowing a pill is not that it is too large but that it is too small to be grasped readily by those muscles; and the remedy is, to increase its bulk either by a wrapper, or by associating it with a swallow of water or a bolus of food.

Gastric digestion

In the presence of food the inner surface of the stomach changes from a grayish tint to a bright red, because of the increased flow of blood in the capillaries; and a thin, colorless, acid fluid, the gastric juice, begins to trickle from the glands with which the lining of the stomach is thickly studded. The function of the gastric juice is to act on the proteid parts of food, as represented by lean meat, white of egg, cheese, the gluten of bread, etc., and prepare them for absorption into the blood as nutriment. Obviously it is reasonable and desirable to leave moderate, sometimes long, intervals between meals so that the gastric glands may recover their activity before being again drawn upon. One of the evils of civilization and the abundant food that belongs with it is too frequent eating. Many indispositions, some quite grave, are recovered from when the meals are limited to two a day, sometimes to one,

with an occasional fast. Persons in good health are not rare who eat little or nothing between a noonday meal and breakfast the next day, or who omit breakfast entirely. But active children may properly enough eat small quantities of nutritious food between the arbitrary hours for stated meals, and youth still undergoing development should not starve themselves either in emulation of ascetic saints or from false notions of manly limitations.

Our knowledge of the physiology of gastric digestion dates from, and to a remarkable degree still rests upon, the observations and experiments between 1825 and 1833 of Dr. William Beaumont, of the United States Army, upon Alexis St. Martin, where advantage was taken of an artificial opening in the stomach following gunshot. Too much credit cannot be awarded Beaumont for the intelligent use that he made of a unique situation in the isolation and dulness of a remote post. He is a great man who recognizes and utilizes an important opportunity, and this is Beaumont's warrant to scientific fame.

Beaumont and St. Martin

As the food gradually becomes digested, it passes as chyme into the intestines. The stomach is usually emptied in from two and a half to three and a half hours. The small intestine is lined with innumerable small glands, devoted to the digestion of that part of the food not acted upon by the stomach. Immediately on its entering the small intestine the bile and the pancreatic juice

Intestinal digestion

together act on the chyme. One of the services of the bile is to reduce the fats and oils, as country house-wives use ox-gall to remove grease-stains, and the pancreatic juice completes the action of the saliva in changing starch into sugar. It also supplements the gastric juice in dissolving albuminous material, and it acts even more powerfully than the bile itself in promoting the absorption of fats. Digestion is popularly regarded as a function of the stomach alone; but practically the action of the small intestine upon food is quite as valuable as that of the larger organ. The completion of the intestinal digestion leaves a highly nutritious creamy fluid, known as chyle. This is directly taken up by capillary vessels in the bowel and ultimately enters the main column of the blood.

Office of the large intestine

So much of the transformed food as is not absorbed in its slow progress through the small intestine passes on into the large intestine, where the absorption is completed and the refuse is brought together more compactly. This refuse consists of indigestible matter, as ligament from animal and cellulose from vegetable tissue; undigested material, as fragments of flesh, starch, and fat which have simply escaped digestion; products of bacterial decomposition; and various forms of body waste, whose names are not important here.

If for any reason the intestinal contents are swept too hastily through the body, proper absorption of nutritive matter cannot occur; if they are too much

delayed, an absorption of undesirable products may happen. In their fresh state the fæces are harmless, however offensive to the sense of smell; but when retained they undergo gradual change, a part of their offensiveness is absorbed, and their general repulsiveness increases. It has been explained how readily the capillaries absorb gases, as in the lungs, and liquids, as in the stomach and upper bowels. Now when organic matter undergoes decomposition in immediate contact with the capillaries, the very law of their being requires them to take up some of the products. Fæcal matter passed daily is not apt to be dry, but after several days' delay the evacuations are hard and compact. The normal moisture has been reabsorbed as a consequence of the constipation.

Fæces

The longer such waste is retained within the body, the more easily this absorption occurs; and auto-intoxication or self-poisoning is the necessary consequence of retaining in the blood material rejected by nature. One form of auto-intoxication is where the excretory organs fail in their full work, and the other and more common is the reabsorption of that already prepared for expulsion. This is an ordinary consequence of packing the lower bowel with successive instalments of intestinal waste. In this way constipation leads to greater or less physical depression which sometimes induces mild feverishness, dulness of thought, commonly headache, frequently loss of appetite and general

Auto-intoxication

Constipation

languor, and occasionally positive illness from the system becoming loaded with emanations that, worse than useless, are positively harmful. Well-defined differences in appetite, in clearness of thought, and in activity of body are easily recognized as coinciding with what is commonly called the state of the bowels. In extreme cases the absorption of these gases gives a perceptible odor both to the breath and the perspiration. Fortunately all foul breath is not due to this cause, although it is not unusual in the young. Sedentary people are apt to neglect these functions, and youth whose attention has not been directed to their importance often act as though regular habits were matters of no consequence compared with mere temporary inconvenience. They should reflect upon what such procrastination really implies.

Rectum

The relatively straight lower portion of the bowel, the rectum, is not designed as a carrier, although frequently transformed into such, but merely as a discharger of waste. Normally the rectum is empty until just before evacuation. Properly the waste gradually passes along the large intestine to a curved portion within the pelvis. In health this is passed at stated intervals into the rectum, where desire for relief immediately occurs and, unless it is antagonized by the will, this will be effected by reflex action. When the desire is effectually resisted, the contents lie there packed more and more tightly with every accession, so that in extreme cases the damming

leads to an accumulation far up within the colon. Under such conditions the rectum becomes diverted from its function as a temporary reservoir into that of one of more or less permanence, a condition for which there is no excuse. Although with the body as with the mind bad habits form more readily than good ones, care easily determines our physical usages, especially in youth. To visit the closet at a fixed hour regardless of immediate inclination soon leads to periodical desire. To press or knead the abdomen along the line of the colon, from right to left, aids. Corn bread, chocolate, dates, prunes, figs, and, generally speaking, fresh fruit, assist in overcoming the habit of costiveness. Medicine should be reserved until advised professionally, and reliance upon physiology is better than upon pills. Indeed the use of proprietary preparations is a prolific ultimate cause of the evil they are taken to avoid. However, a few leaves of senna chewed thoroughly from time to time are frequently useful. Morning is better than night as the season to attend to this function, but whenever felt the reflex impulse should not be restrained, although the habit may be gradually regulated. For physiological reasons a loaded rectum should be evacuated at night in preference to further delay.

Piles

Besides leading to general depression, habitual constipation is the efficient cause of the distressing local complaint of piles, or hæmorrhoids, whose essence is the engorgement and partial rupture of rectal veins. These veins have no valves

to check the tendency of the blood to stagnate near the bottom, so that when the flow toward the body is impeded it is liable to congest near the anus. As the venous flow is progressively interfered with one or more small veins are choked, the inner coat tears, the outer coat stretches, and a grape-like enlargement, the pile, occurs. Piles give rise to a sense of weight and heat, they are prone to protrude, and usually they are very sensitive. Sometimes by further rupture they bleed freely. When inflamed they are exquisitely tender and quite disqualify for active work, and even when not inflamed they cause constant discomfort. Contributing causes in youth are a sedentary life, the use of soft cushions, highly spiced food, which has a peculiar tendency to lead these veins to fulness, and in later years congestion of the liver affects the rectum through a peculiarity of the local circulation. Life in the saddle, the very opposite of the sedentary life, especially when combined with constipation, also tends to piles; but, although ever threatening the cavalryman, it is essentially a disease of the careless student.

Fissure

Fissure is a very painful crack or tearing in one of the many folds of the anus. It is usually traceable to the expulsion of large hard masses created by constipation, is particularly sensitive, and is very difficult to heal. As with piles, it is much more easily avoided than cured, and the old injunction *Obsta principiis* applies to no physical error more directly than to these.

As previously suggested, it seems probable, although not proven, that habitual constipation predisposes to appendicitis. Not that the large intestine is so loaded with unexpelled waste that it finally directly excites inflammation there; but it seems probable that the retention of refuse so congests the capillary and other circulation of the bowel as by degrees to cause a puffiness or engorgement of the small-calibre appendix, and so open the way for the local attack. The general lesson certainly is, by attention to this function of relief to keep both the brain and the lower viscera free from fulness of sensation and sluggishness of action.

Appendicitis

The teeth, at the actual beginning of the alimentary canal, are the only parts of the human organism which, when broken, nature makes no attempt to restore and whose decay is always progressive. When damaged, they must be repaired or replaced by art. But decay, practically always due to bacteria, is preventable. Bacteria are microscopical vegetable organisms upon whose action many vital processes depend and against which antiseptics are directed. They are always present in the mouth and thrive particularly in that ropy saliva which clings tenaciously to the teeth, especially in those who sleep with the mouth open. They are more abundant when the brush is neglected. They abound where the remains of food, especially starchy food, stick to the teeth. Their mischief is done by the formation of an acid which eats away the enamel and

Teeth

then leads to interior decay. Careful brushing and washing the mouth with plain water will rid it of 92% of the bacteria, which will then increase very slowly until food is taken again. But two hours after eating a piece of fresh bread or a cracker ,the mouth will swarm with them, and in four hours the normally alkaline reaction of the saliva will be acid from their multiplication where food has lodged. Cracking the enamel in the abuse of the teeth by biting hard substances opens the way for bacteria, and wounds of the gum by toothpicks and bristles sometimes give them access. When they are in undisturbed possession, the teeth are pretty sure to decay. It is probably true that the local use of tobacco by chewing sterilizes the mouth and thus conserves the teeth, but the abuse of tobacco is believed to harm the teeth. It is not probable that gases from the fermentation of imperfectly digested food have any material direct action upon the teeth, for there is no constantly open channel from the stomach to the mouth. It is doubtful whether eating a reasonable amount of sugar tends to decay the teeth, as vulgarly believed. Sugar in excess diminishes the appetite for the time, but certainly in cake, so far as the teeth are concerned, the flour is much worse than the sugar, and candy cannot be compared for mischief to the remains of bread in an uncleansed mouth. Those who eat food difficult of mastication, as most savage nations, usually have sound teeth from the inevitable polishing they undergo. The advance in modern dentistry is doubtless due to the necessity

imposed by dental deterioration. The interdependence of the entire organism upon the normal condition of all its parts is illustrated by the fact that children with sound well-cared-for teeth are not only heavier than children of the same age whose teeth are diseased, but mentally they are at least half a year in advance of them. However, this may merely mean that the care of the teeth is an index of genuine cultivation. With those who have reached years of discretion uncleansed teeth are a fair sign of a polluted person, of one unacceptable socially or physically.

Care of the teeth

To maintain the teeth in good condition requires the careful use of a soft pick, if they are irregular; passing floss-silk between them so as not to cut the gum, several times a week; the careful use of a soft brush, which should be discarded when the bristles loosen, after each meal and on rising and retiring. The most useful powder is probably prepared chalk or simply baking-soda (sodium bicarbonate). Teeth are best, but not most easily, brushed toward the crown, not transversely. When not readily kept in good condition they should be polished, not filed nor scraped, by a competent dentist every two or three months.*

The care of the teeth has more than an æsthetic, or indeed a simply digestive, value. Through reflex action decayed teeth sometimes disastrously affect or-

* For much of the section on the teeth credit is due to Dr. S. A. Hopkins's very excellent essay on The Care of the Teeth.

gans of special sense. Deafness has been traced to disturbance of the auditory nerve through other nerves connected with damaged teeth, and complete loss of vision has followed the unsuspected and painless reflex action from decayed roots, sight returning on their removal. Such conditions are very infrequent, but they warrant careful search for this possible disturbing element when all the usual causes of functional disability have been rejected.

Reflex action from decayed teeth

VIII

The Development and Care of the Body

THE preservation and development of the normal physical vigor which in varying degrees is the heritage of youth, and not the athletic distinction that in the nature of the case can be attained by few, should be the chief object of physical culture by those in pursuit of intellectual superiority. The primary object of all exercise is to secure or maintain physical and mental health; not to acquire strength, which in a reasonable degree follows incidentally. Excessive strength is undesirable, except as means to some special end; and such end is not among those which an institution of learning has in view or which its graduates will require in their vocations. Abnormal strength is frequently accompanied by physical limitations, for masses of muscle impede freedom of movement. There is liability for over-developed muscle to take on partial fatty degeneration when allowed to return to the normal too suddenly, on which account even

Exercise vs. strength

legitimate training, if severe, should not be abruptly "broken." Universal experience confirms the adage that a healthy mind depends on a healthy body, and to maintain the health of the body requires the free and frequent exertion of all its parts. Vigor cannot be secured merely by systematic exercise to the neglect of other physical duties, but neither may exercise be neglected by those who would reach reasonable development and maintain fair health. An admirable discussion of this special subject is contained in Benson and Miles's "Daily Training," a little volume from which much of this section is adapted with frank acknowledgment. The training best adapted for students are exercises which lead to skill, to endurance, perhaps to speed, and only incidentally to strength. They most efficiently educate the nerves and develop promptitude and quickness of apprehension as well as of motion. They are better practised in the form of games, or at least in company, and should call into play the whole body; for these encourage, along with the physical qualities, the moral ones of courage and perseverance which come from confidence, and of self-control and courtesy, the attributes of a gentleman. Such ends are quite worthy of steadfast effort, independently of the pleasure of the games themselves. Exercises of quickness, or even of endurance, do not necessarily add to the bulk of a muscle. Each effort may require only very slight exertion of the individual muscle, but the sum of the whole may exceed the force involved

Object of exercise

in great feats of strength. Besides, it is quite possible that a muscle of fine quality may excel a coarse one of greater bulk. Doubtless the essential power of a muscle is improved by training, but we also find that a trained man can use all the appropriate muscles, when the untrained man depends upon a few. Thus a powerful man without skill will go down before a trained lightweight. The light but agile man strikes with all his disposable force at the exact point required. It is neither expedient nor possible to attempt training all the muscles equally, and if it were possible endurance would suffer. The most practical rule is to select a game for which there is aptitude, or at least predilection, and steadily practise it and supplementary exercises. To maintain efficient health under the conditions of college life requires about two hours' active exercise daily. This is represented by a brisk walk of six or seven miles, or by its physical equivalent. Such exercises are much better taken in company, for ignoring that it is exercise adds to the efficacy. That is a reason why games are more effective for health than solitary walks or than merely routine work, as with dumb-bells or clubs—although these are much better than none.

Methods of exercise

Games in this sense are not those great contests that degenerate into a spectacle, participated in only by small select teams. Football, for example, is only of service for the elect, the qualified few whose growth, weight, and force fit them for the arena.

There is no saving grace in assisting at football, or baseball, by holding down the bleachers. The lungs may be occasionally expanded, but one should not be deluded into fancying that to be exercise. The older and better football, for the greater good of the greater number, as played before the Rugby importation, involves the lining up on opposing sides, with a captain for each, of an indefinite number of players who run and kick the ball as opportunity permits, but who are penalized for touching it otherwise than by the foot.* Opportunity is given to the many. The guarantee against contingent roughness lies in the breeding and self-control of the players. It is not a game for roughs, but it is fit for students—and other gentlemen. Even under the temptations of the Rugby game, no college with traditions of manly honor can afford to violate with intention the Golden Rule, one of the bases of good breeding, or to condone errors invited by the impetuosity of the contest.

Football

An admirable game, better known under its modification into the team-game of hockey, is shinny. It may be played on any moderately level, unobstructed, field by a few men or a hundred. It gives full play to arms and legs, lungs and back. Like other games of multitude it may be made rough and dangerous, but it is not essentially such.

Shinny

---

* Association Ball is a modification of this.

Golf

Except that it consumes more time with less profit than the average student can spare, and incidentally it may be costly, golf is a wholesome game that must be played out of doors. The essential advantage of golf is that the skill required tempts to gentle and prolonged exercise in the open air persons, usually not well adapted to strenuous contests, who might otherwise be indisposed to leave their studies—or their clubs. It gives to a long walk an immediate interest, with occasional exercise of the upper extremities and some cultivation of the eye and control of audible emotion. But, like whist, it is best suited for men to whom excitement and acute energy are past pleasures. Women who will not walk for the sake of walking may better substitute the tee of the links for that of the drawing-room, but in the hands of vigorous young men the golf-club is no equivalent for the saddle, the racket, the bat, or a dozen other agents for the exhibition of vital activity and strength.

Cricket

Cricket, an exotic that has never taken wide root on our soil, lacks many of the qualities of a good game, chiefly because of the long waits before going to the bat and the limited number actively engaged.

Fencing, etc.

Fencing, single-stick, the broadsword, and sparring, when the latter is not carried to extremes, are admirable. For many reasons every man should be qualified to defend himself with the equipment of nature, wherein skill in boxing

transcends the mere question of exercise. Active practice with a punching-bag beautifully develops agility and, within limits, chest expansion and the general strength.

La Crosse

La Crosse, although limited to teams and liable to abuse, does not require weight and is free from the roughness so nearly associated with the English football. It is graceful and vigorous, deserving much greater vogue as a game for the open than it has acquired south of the Canadian border.

Basket-ball

Basket-ball, played by gentlemen, is a fine gymnasium game, again with the disadvantage of drifting into one only for expert teams.

Tennis

Tennis is the queen of games. It may be played gently or vigorously, it exercises all the muscles except possibly those of the left upper extremity, it cultivates the group of qualities known as "eye"—that is, accuracy, promptness, and agility—and it should encourage good temper and courtesy.

Boating

Boating not carried to an extreme is valuable exercise for the arms, the legs, the back, the lungs, and the heart. But that means neither racing nor any approach to it. Racing or severe training may hurt the lungs and is almost sure to damage the immature heart. Physiologically it is more than unwise; it is wrong. A college crew is an expensive luxury

Swimming has a double value, and every man owes it to himself to learn to swim and to keep in practice,

Swimming

although fortunately once acquired swimming never becomes a lost art. Occasional practice when completely dressed is valuable, less for hygienic purposes than to qualify for rescue.

Exercise

Exercise may be defined as movements of the muscles sufficient to contract them energetically. Its usual effects are increase in the size and power of the voluntary muscles and of the functional capacity of the involuntary muscles involved, and health and general vigor are promoted by its increasing respiration and quickening the circulation. After attaining their full size muscles cease to grow, but exercise cultivates their higher functions. It should never be forgotten that walking for exercise, as an example, to be effectual must be brisk, not mere sauntering. For instance, in walking four miles an hour the lungs inhale five times as much air and of course five times as much oxgyen as in repose. That oxygen taken up in the blood goes to the removal of tissues and compels the carbon dioxide, formed by their disintegration, to make way for it. Thus following the quickened circulation exercise hastens repair by the more rapid interchange of the primary cells through waste and assimilation.

Advantages of exercise

The physiological advantages of exercise as observed and summed up by Dr. Beyer, U. S. Navy, are these: An immediate subjective feeling of general well-being. While the supply of those substances in which energy is stored equals the demand and before breathlessness limits it, there is

exhilaration. We sleep better and think more clearly and move quickly; our senses are more acute; the skin and the kidneys, the special excretory agents, act better; digestion and assimilation are improved; the lungs expand better, and the heart contracts more strongly from the increase of blood pressure, and all the muscles contract more quickly and effectively. The "warming up" of animals and men on the race-track and in the athletic field is taking practical, although possibly empirical, advantage of this better state. The common condition and the primary cause of all this is the increased supply of oxygen in the capillaries, and a more abundant outflow of the products of wear and tear than when at rest. The importance of the capillaries appears in this. From two to seven times as much oxygen unites with the cells as in repose, and the products of its consumption leave them as rapidly. To attain the best results of exercise the work must be systematic and, if in the gymnasium, it should be in classes or groups carefully arranged with reference to the individual requirements. Irregular and desultory exercise is rarely helpful, and where regular exercise is not obligatory a large proportion of those who require it the most use it the least.

Growth affected by exercise

Besides leading to desirable control of the body and to reasonable health, systematic exercise within the growing age increases the length of the bones as well as the bulk and serviceability of the muscles. Even where growth ap-

pears attained, the shoulders may be broadened and while still within the period of development the chest may be expanded. This is shown by observations covering two considerable terms of years upon cadets of the Naval Academy, who were lads of similar age, similar original selection, and were living under otherwise identical conditions. The groups were large enough for minor errors to be disregarded. During both periods their compulsory drills and general duties gave them more exercise and more time in the open air than other students as a class enjoy. The only difference between the groups was that one underwent systematic bodily training in addition to the drills and the other did not. Comparison with the stature of the untrained men, which might be taken as a standard, showed that between the ages of 16 and 21 there was a gain in height of rather more than one inch (26.6 mm.), that is, the men of the trained battalion averaged a full inch taller than the others. In individuals this increase may have been considerably more. Weight increases with height, and while the normal increase between 16 and 21 was about 21 lbs. (10 kilos), that actually attained was 77 lbs. (35 kilos). However, weight depends upon too many conditions for it to be a constant quantity. But the most important gain was that in lung capacity, which is reported as increasing five pints as against one and four-tenths pints. Such increase of lung capacity implies a greatly enlarged chest and presumably a stronger heart. There can be no better demonstration of the advantage of sys-

tematic exercise than the results thus acquired by picked youth, results that are open to others who will make the effort. But no serious exercise should be undertaken inconsiderately. It should be selected for appropriateness, be approached gradually, and be increased only with increasing strength. Irregular and excessive exertion yields ill effects. On the other hand the neglect of exercise leads to want of appetite, to loss of vigor and of animal warmth, and to imperfect sleep.

Effect of exercise upon the lungs

Good breathing-capacity implies endurance, the key to success; and it is more important than mere muscular strength. Regulated, deep-breathing exercises strengthen and normally develop the breathing apparatus. But shallow and careless breathing may lay a foundation for disease. Therefore the chest should be free from the restraint of either tight clothing or position, and formal exercise should be carried on out of doors or in a room free from dust and overcrowding. Dust and rebreathed air are obviously harmful, and a dusty, ill-ventilated gymnasium may more than neutralize the advantages its facilities present. On the other hand over-exertion causes pulmonary congestion; the blood cannot pass rapidly enough through the lungs. Hurried and rougher breathing indicates this. Suddenly to "break training," especially that for running or boating, invites, or runs a risk of inviting, tuberculous disease, as explained elsewhere. In such prolonged exertion as serious training implies, the extreme upper

part of the lung is unusually expanded. Sudden suspension of the exertion leads those margins partly to collapse, and, no longer washed out by the recurrent aerial tides, they afford a nidus, a nest, for the omnipresent bacillus or germ of tuberculosis. It constantly happens that athletes and prize-winners fall early victims to consumption. It is to be expected that such men will die, but on the face of it one should suppose that consumption would spare them. It is not normal exercise, it is the excessive strain that leads to this mischief.

Effect of exercise upon the heart

Exercise influences the heart, so that palpitation may follow when it is either excessive or insufficient. Overwork may lead to overgrowth (hypertrophy); strain, that is some unusual effort, especially in the young, leads to dilatation. A dilated heart is a stretched heart. There is serious risk of this accident where great volumes of blood are forced through the heart, especially the growing heart, within a narrow limit of time, as in some of the great contests. Following convalescence from a prolonged fever, as typhoid, the heart usually remains particularly weak very much longer than the rest of the system; so that there is great danger from strain then, even after the other muscles have fairly recovered their tone. Racing on the wheel or on foot, or heavy lifting and other great effort, may lead first to strain, then to dilatation. A dilated heart is not one stretched like a balloon, for a very small change disturbs the relative state of the parts. Too much blood forced

into any of the four chambers is liable to distort the flexible doors, the valves, so that they will leak backward. Happily a single such strain properly managed is usually recovered from in the young, if recognized and cared for in time. But it is better not to incur the risk. Excessive or badly regulated exercise leads first to dilatation and then, usually, to overgrowth; although hypertrophy (overgrowth) may be, and often is, induced by continuous overworking of the heart without intermediate dilatation. All the conditions leading up to these disabilities are beyond the legitimate field of general exercise.

Sighing

Sighing generally means insufficient oxygen. Either the blood passes so rapidly through the lungs that it cannot take up an adequate supply, or an insufficient amount of blood goes through them, or the air itself is limited in amount or quality. In either case the cells of the body are sending an inarticulate message for more oxygen. Under great exertion there is gasping, a modification of sighing; and when the chest is mechanically constrained (as with corsets), or there is great loss of blood (as in hæmorrhage), true sighing occurs. The involuntary sighing sometimes noticed is a modification of one or the other of these conditions. In later life involuntary sighing may mean a leaking valve.

The foundation of all physical vigor lies in the proper development of the chest, which implies habitually full inspiration through the proper channels. The mouth, frequently used for breathing, is not a

proper channel. The offices of the mouth are the mastication and transmission of food and articulation. We eat and talk by means of the mouth, but we should not breathe through it. The air should pass, in both directions, through the nose, the multiple folds of whose lining membrane are lubricated by its own secretion. In health there should be no discharge from that organ, and the handkerchief in its common application should be a sheer superfluity. The lining membrane, rich in blood, warms and moistens the incoming air, and minute hair-like attachments (cilia) waving to and fro intercept and gradually expel the suspended dust. This secretion is also supposed to neutralize at least some of the accompanying bacteria. The mouth that habitually hangs open means either a carelessness closely approaching inferior intelligence—idiots have that habit—or disease. Sometimes the minor morals of polite usage have been so neglected in childhood that an untrained youth may, from sheer indifference, sit with a dropped jaw and a vacant expression. But usually it means that the passages are clogged by a congested lining or by a painless and unrecognized growth (known as the third tonsil) at the rear opening of the nasal canal. Other possible states, to be noted presently, gradually assert themselves. Unconscious habits, or states, become so nearly second nature that frequently the victim is unaware that he differs from his fellows and fails to appreciate that such observations as these have a personal application. If directly

Normal breathing

asked, he may reply that he "has a little cold"; but should he reflect he may find that the little cold, interfering with his own comfort and with the pleasure of his associates, is a frequent if not a constant condition, and that the accidental want of a handkerchief seriously embarrasses him. We can hardly be too critical of ourselves, and when any defect is under discussion every one may properly ask himself, Is that mine? He may be surprised at the answer. In mouth-breathing children, not those who carelessly acquire the habit when older but in whom it is congenital, notwithstanding the outer nostrils may be unobstructed the inner passage is apt to be found clogged in some way, so that the true nose fails to develop as an organ for breathing. In such cases the infantile arch of the upper jaw persists, the upper teeth are apt to protrude, and the voice is liable to be modified. (Another cause of the contracted arch and protruding teeth is supposed to be the infantile habit of thumb-sucking, which modifies the soft upper jaw by mere pressure.) Where the air is cut off from its proper course, the condition inconsistently known as speaking through the nose results. Rather curiously, members of one's own family are not apt to recognize these defects, probably because of the familiarity which breeds indifference. Or, if recognized, they are liable to be regarded as incurable infirmities to be patiently endured. It is never too late to remove the third tonsil and thus open a freer route, although should this be deferred until the bones of the face are set the appear-

ance will not be changed. Adults and children alike have numerous other painless but remediable conditions, including innocent but space-filling growths within the nose. A common obstacle is a deviation of the median partition, which is not so easily rectified. Whenever one channel is blocked, wherever in its course, a greater liability to catarrh seems to depend upon the effort to force a larger volume of air through the remaining channel. As already intimated, it is probable that some disease-bearing germs enter the lungs much more freely when the mouth is the main air-channel.

Nasal twang

The misnamed nasal twang with which some Americans are justly charged is due, partly to chronic catarrh blocking the nasal passages, and partly to that curious and unconscious imitation by which in youth we acquire the tones most commonly heard. Unfortunately as a people all our voices are too sharp and rasping, chiefly from the want of a fair standard for comparison and imitation. We are so accustomed to strident voices that we fail to recognize their inherent infirmity. The one defect of our charming women is that their edged words are apt to cut the air too keenly, and, except that they are somewhat less shrill, the tones of our men offend in much the same way. One advantage of university residence should be serious and systematic effort to acquire a tone more serene and persuasive, even if less penetrating and far-reaching.

When runners get their "second wind" it means

that under the stronger action of the heart the elastic blood-vessels gradually dilate so that the circulation becomes freer and the blood flows more easily. Normal children when unrestrained run freely and easily, in preference to walking sedately. This is because their vessels, besides being equally elastic, are of greater relative calibre to the size of the heart and the quantity of blood than are those of adults. The heart has so much less resistance to overcome that children are not restrained by its oppression. With youth, and with some others before old age sets in, the blood-vessels gradually expand under exercise and thus relieve the tension in the lungs that would follow from forcing too much blood through them hastily. Horsemen recognize as a fact, although perhaps not always understanding the reason, that a prerequisite for fleetness in a horse, and especially in a long-distance horse, is large veins which under the requirements of speed swell with blood and relieve the heart. The preparatory "warming up" of both animals and men is partly to supple the muscles and partly, unconsciously, to expand these channels. Another factor in acquiring second wind is the unconscious temporary increase of chest capacity by the expansion of the walls through the flexibility of the ribs, and the depression of the diaphragm in the very effort to introduce more air. Very soon, then, the respirations become longer and deeper and both blood and air are pumped more freely. As long as this condition is maintained there is no trouble. It is when the further demand exceeds the

Second wind

supply that the respiration becomes quicker and more shallow and there is distress. With advancing years the arteries grow more rigid, and they fail to yield (except by breaking) either to the strong impulses of the heart under sudden strain or to the more gradual effort of the track.

Breathlessness

Breathlessness in its last analysis is not absolute lack of air, but its relative insufficiency. So much blood is driven through the lungs in response to the requirements of the system under muscular exertion that the carbon dioxide cannot be eliminated nor the oxygen be absorbed with sufficient rapidity to keep it pure. The same consequence from different conditions occurs in certain forms of heart-disease. The victim pants not because the air does not freely enter the lungs, but because of the difficulty in sufficiently aerating the blood.

Chest

A barrel-shaped chest is the most serviceable, and a broad chest is one of strength. As already pointed out, the essential factor is less the gross circumference than the difference between inspiration and expiration. The ribs, especially in youth, are very elastic, and much of the development of the lungs depends upon their flexibility. Practice increases this acquirement, and very happily will carry this qualification of youth into advanced years; but neglect will encumber its victim with rigid and unyielding walls. The professional strong men, the weight-lifters, are frequently inelastic in the chest and are valueless in daily life. Even although the chest

may be loaded down with muscle, this immobility remains. Still more objectionable, except that taken in time it may be modified, is the contracted chest which fails to expand properly. Here the muscles are weak, the back is rounded, usually the ribs may easily be counted, and frequently the subject is badly nourished.

Defective chests, besides the two immobile classes just noted, are those marked by abnormalities unconsciously acquired and ignorantly maintained. The common errors, so common that in many they fail even to attract the eye, much less to offend the observer, are one shoulder lower than the other, a transverse (lateral) curvature of the spine, or a bending forward, particularly at the shoulders. The lowered shoulder, possibly concealed by a little padding, is usually accompanied by flattening of the upper chest on the same side. Some persons, not commonly reckoned as deformed, have the breast-bone thrust forward like the prow of a ship. They are pigeon-breasted. In all of the foregoing capacity, that is breathing space, is lessened. Usually these defects depend upon ignorance or carelessness; a few are due to unwise handling in infancy; more to improper attitudes at the desk, especially in writing. To carry weights, whether school-books in a strap or the burdens of severer labor, over one shoulder or by one arm, tends to depress the opposite shoulder (in the effort to preserve the line of gravity) and to flatten that side. Where shoulders slope effeminately it is sometimes charged that the effort to keep suspenders from slipping off is respon-

Defective chests

sible for a similar irregularity. A frequent occasion for such obliquity is the weakness of rapid growth, where mere erectness becomes a strain upon the supporting spinal muscles, and parents and guardians shirk their duty. But sheer carelessness is the chief cause for both unequal shoulders and a flexed spine. The average citizen upon the street, the frequent student on the campus, are daily illustrations. Unfortunately the eye is so accustomed to the lounging gait and the distorted figure that, because they are not unusual, to most they do not seem unnatural. This carelessness is so great and anterior curvature of the upper spine, round shoulders, is so common as to be formally recognized in the great factories of ready-made clothing where the coats are habitually cut to accommodate the artificial hump which, more and more, is marking the untrained man. A man with the erect back that nature gives will find such a coat lie in folds across his shoulder-blades. This is not merely a question of looks, it is one of utility. Every deviation from nature is not merely an offence to the trained eye, but is a practical blemish in the physical life of the subject. It puts him to disadvantage as well as disfigures him. There is no physiological reason for a shambling gait more than for a trembling hand; nor should the rounded shoulder and the hanging head be glorified as the scholar's stoop, while a similar impress on the cobbler over his last, or the tailor at his board, is a trade-mark to be avoided. In each case it means diminished lung capacity, lessened

Physical carriage

physical vigor, weakened muscles, and an unnatural flexion passing into permanent deformity. All this is absolutely unnecessary. Young and healthy children are usually erect and graceful. Square shoulders, an erect head, and a natural spine, the perpetuation of what so many have lost, are perfectly available for every healthy young man. It should be a laudable ambition for every liberal student to bear himself so that his very carriage will make him an example in physical life, as his intellectual attainments should make him a leader in the civic world.

IX

Physical-culture Exercises

THE following are rules * for maintaining a normal posture, as has been advised:

A line perpendicular to the floor should pass through the shoulder, hip, and ankle.

The neck is to be erect and the shoulders held up.

A perpendicular plane touching the buttocks passes just in rear of the shoulder-blades and about twice as far behind the heels.

A perpendicular plane in front should just touch the lips, chin, chest, and toes when the feet are at an angle of 60°.

The chest should be thrown forward by expansion, and the abdomen be moderately retracted.

These rules yield a correct standing position and hence a point of departure for walking and other exercises. This position is not to be maintained by contracting any muscle into stiffness, nor by holding the body rigid, but by encouraging the frame to support itself naturally.

* These are abstracted bodily from a writer whose name has been mislaid.

The commoner incorrect positions are: The back held flat in constraint (normally the spine curves forward below the shoulder-blades); the forward stoop and rounded shoulders; the narrow chest, intensified by lateral curvature. Such deformities, besides being offensive to the eye, diminish the breathing capacity and decrease the stature, the barrel-like contour of the chest is destroyed, and the height lessened from one-fourth to one and a half inches. When the pelvis is tilted or a shoulder drops, lateral curvature of the spine follows. The pelvis acquires an angle in standing carelessly, as is so common, on one leg. To counteract this there is at once a compensating lateral curvature, which becomes fixed if the habit is maintained. Sitting with a tilted pelvis leads to the same results. When the head turns sideways or the neck bends toward the shoulder (usually from defective vision), as in reading or writing, or from any cause the body inclines to one side, there is a compensating curve to the other side. Such deformities may commonly be corrected before maturity sets in, or the body may be fortified against them. To correct irregularities of carriage or to promote flexibility, balance exercises are important. Keeping one's balance depends upon retaining within a certain base the centre of gravity, which necessarily shifts with the movement of the body or the imposition of burdens. A perpendicular passing through the centre of gravity must fall within the base upon which we rest. Standing on both feet,

Incorrect positions

Balance exercises

the perpendicular readily falls within the space inclosed by their outline. Standing on one foot, the base is by that much diminished. To stand on the toes diminishes it still more. Hence to stand on one foot, or on part of it, and to move the other through space increases both suppleness and agility. To walk a tight-rope only a few inches above the floor, which relieves the exercise of danger, is admirable balance practice; so is skating; so is bicycling, where the counteracting evil is cramping the chest in racing. An exercise, not practicable in ordinary clothing, to increase balance and flexibility is: Stand erect with the arms at the sides; draw the arms backward until the hands are about eighteen inches from the vertical; drop the body quickly by bending the knees until the thighs and the legs are in contact, the body itself remaining upright; then at once spring up on the toes, swinging the arms forward. As the buttocks touch the heels there is a natural tendency to rebound, and this may be repeated from three or four to a dozen times. Another exercise, useful to the whole body as well, is that of skipping the rope without using a rope. Swinging the arms in circles adds to its value. The movement should be repeated indefinitely, stopping short of breathlessness. During this, and in all physical exercises, the breathing should be deep and slow with the mouth closed. However, as the exercise proceeds, especially when it is unfamiliar, the heart moves faster and respiration is necessarily hastened. The art of dancing, which adds to the general control

of all the muscles, their agility, and their coördinate action, should be acquired by every young person; and the more difficult it is to learn, the more important is it that it should be learned. The very confidence in physical carriage and the unconscious grace that it bestows, in themselves approach very closely to inherent hygienic value.

Certain general exercises may be practised in the privacy of an apartment quite as well as in a gymnasium. To increase the power of the shoulders: Stand in the correct position; lift the shoulders as high as possible, and bring them forward and throw them backward as far as they will go. Such simple movements mobilize the collar-bones and shoulder-blades and at once strengthen and make more flexible the overlying muscles. To broaden the shoulders and to develop the muscles of the upper back: Stand erect at right angles to a vertical surface just far enough away for the tips of the extended fingers to touch it easily. Move away an inch and again touch the surface without changing the feet or bending. Move another inch and it is not so easily done. Repeat, changing the position only a trifle each time, until the surface cannot be touched while the perpendicular is maintained, and then begin with the other side. Persisted in for a few months, broadened and symmetrical shoulders will be acquired.

General exercises

To secure some flexibility of the pelvis: Stand erect and alternately drop the hips by bending the corresponding knee. This increases the flexibility and

vigor of the muscles and ligaments involved, and it adds to elasticity and endurance in walking. Begin slowly, keep it up for a minute or two, and ultimately increase the rapidity of action and prolong the time. The common act of stooping to pick something from the floor may easily be made profitable. Do not squat, but first bend the knee, then the hip-joint, then move the shoulder forward and extend the arm so as to bring the hand to the ground without twisting the spine. It is a fundamental rule in stooping to contract, not to relax, the abdomen. At table throw forward the shoulders and if necessary bend at the hips, but do not twist the spine if it can be avoided.

But although it is undesirable to bend the spine in stooping, its flexibility should be maintained. An effective exercise is: Stand correctly, extend the arms in line with each other at the level of the shoulders, and then swing the arms and shoulders together in the same horizontal plane until they are as nearly as possible at right angles to their original position, the hips not moving, and then back again through 180°. To support the arms with a light rod makes it easier. Do this twenty times a minute until the shoulders tire. Each vertebra turns a little and after some practice the aggregate is considerable. This is as useful in developing the muscles of the back and the sides of the chest as in promoting flexibility. An excellent variation is to turn slightly the hips and pelvis, bend one knee a little, and with the extended arms directly opposed to each other turn the body

on its axis and bring first one and then the other hand between the feet. Properly these movements should be at the rate of fifteen a minute. At their best the face should always be directed toward the front so as to strengthen the neck, but the double twist is difficult. Persevered in, such movements will strengthen the back and will relieve the painful weakness of those who grow rapidly. They are much better done in undress. To develop the neck-muscles and prevent headaches from muscular weakness, stand against a wall and move the head from side to side, keeping the face vertical. This is very difficult to do without rolling the head, but the ultimate result justifies the effort.

Exercises in breathing

The act of breathing is either costal or abdominal in preponderance, not exclusively. The lungs expand laterally through the elasticity of the ribs, or perpendicularly by depressing the diaphragm and raising the apex of the chest. The essential feature in all breathing exercises is to inflate the lungs upward instead of downward, as though trying to lift the body off the ground by the inspired air. As a preliminary exercise, the chest being unconstricted, first fill the lungs with a deep breath without straining, hold the breath a few seconds, allow it to escape slowly. This strengthens and makes elastic the chest-walls and increases the lung capacity, and it should be done whenever it is remembered; at first once or twice a day, afterward once or twice an hour, finally habitually. Once acquired, this habit

betokens dignity and repose of manner and, more important, enduring strength. Shallow-breathing and quick-breathing persons are necessarily devoid of endurance.

The principle just described is at the foundation of competent breathing, but there are valuable special exercises which combine respiratory and muscular exertion and are particularly adapted to enlarge and strengthen small-chested men, those deficient in measurement and mobility. The simplest, of which all the others are variants, is to stand erect, lock the thumbs in front of the body, draw in a long breath, and at the same time slowly raise the hands above the head, keeping the arms straight and the hands extended. Then slowly lower the arms, keeping the head erect, and exhale as they descend. Such movements are exhilarating by introducing more fresh air, and they tend to develop both the lungs and the chest-walls. They should be practised night and morning, not oftener than ten times a minute. Another is to raise the elbows to the level of the shoulders, the hands together and on the same plane, extend the arms as in swimming, and simultaneously fill the lungs with air. Then bring the arms around on the outer circle to points on a level with the shoulders, and slowly empty the lungs as the hands fall to the side. An excellent way to attain the same result is to face the angle of a room with both hands extended against the walls. Lean forward on the toes until the head enters the angle, and support the body by allowing the extended

arms to glide along the walls so as to stretch the chest mechanically. Resume the upright position by drawing the body back with the arms. Careful practice with any of these movements should develop strong chests.

The heart, the other chief occupant of the chest, is closely associated with the lungs in complementary function as well as in position. A sedentary life interferes with its full action because the blood fails to circulate with normal force and frequency, so that in enforced general inactivity there should be co responding exercises to maintain the balance. The poverty of the blood known as anæmia (literally bloodlessness) is generally due to insufficient diet, but may depend upon the sluggishness of the circulation—the blood failing to move rapidly enough to undergo proper nutritive change. This is particularly true of children within the school age, and some who do not suffer from insufficiency of food may long feel the effects of inadequate exercise. For the very young, exercise of the heart is of prime importance, and it is better attained by natural unrestrained running and out-door play than by the artificial methods of the gymnasium. With every one, but especially with young children, the object should be to avoid heart-strain, and to encourage exercises which do not require a maximum effort within a limited time. That is because in the very young the heart is small and is limited in strength, but the arteries are relatively large and the circulation goes on readily. This

The heart

is the natural reason why children, if not too hard pressed at any one time, can run in the course of a day for periods that would completely exhaust an adult. With children waste and repair go on very rapidly, and their ultimate reason for moderation and rest is that prolonged exercise uses up tissue and fills the blood with disintegration-products. Along with the heavy demands for repair are the requirements of new growth, so that a growing child often requires for its daily wants as much food as an adult—certainly as an adult not carrying on severe labor. But about puberty the heart suddenly enlarges out of all proportion to the calibre of the arteries, and it pumps then with more force. The relatively smaller arteries therefore afford more friction and more resistance, so that to accomplish equal results the heart drives the blood under greater pressure. That difference in relation persists, and after the age of twenty-five exercises of speed affect a person much more than during the period of development. The foundation for the mechanical straining of the valves is laid about the age of twenty and subsequently, when the blood cannot get away fast enough from the heart. With advancing years the arteries lose much of their remaining elasticity and grow more and more brittle, with increasing risk of that snapping of their coats which causes apoplexy.

Note.—The most of the exercises described in this section are from text-books whose references unfortunately have been lost.

X

Fatigue

THE condition of fatigue and recovery therefrom is common experience. We all know experimentally what it is to be tired, and when, no longer tired, we say we have rested we express one of the agencies in the recovery of strength. The human organism is in perpetual unrest and it is the wearing away of its particles that causes weariness, and their renewal is the revival of vigor. Every physical movement, exercise of the will, stirring of emotion, causes the disintegration and death of animal substance. The various parts wear away under labor, and in health they are renewed in the manner about to be outlined.

The blood-bearing capillaries interlace everywhere through microscopic areas so close together that the prick of the finest needle draws blood. But between the cells which make up, each group after its kind, the various structures there are also innumerable chinks and crannies called lymph-spaces, into which oozes from the capillary blood nutrient material and from the tissues themselves

Lymph-spaces

waste in solution. Thus the cells are constantly bathed in a mixture of their peculiar food and of their own worn-out matter. If it were possible to make a section of flesh from which no blood would escape, nevertheless to the hand it would feel soft and damp, as the moist and pliable fresh meat at the butcher's imperfectly illustrates. If it were devoid of all liquid except the blood itself, it would be stiff and relatively hard. Much of the flexibility of the soft parts during life depends upon their saturation with the animal fluids.

Blood

The condition is substantially this: Osmosis is constantly occurring through the simple walls of the blood-bearing capillaries. Blood is a watery fluid, or plasma, holding in solution or suspension nutritive materials derived from the food, and also heavily charged with floating particles. These particles are the red and white corpuscles, in the proportion of 300 red to one white, and in every $\frac{1}{25}$ cubic inch of blood there are about 5,000,000 red corpuscles which give it its color. These "are so many little packages in which oxygen is stored away." The chief province of these corpuscles is to absorb oxgyen from the air, which they readily do as they pass along the capillaries in the lungs, and to carry it to the inmost recesses of the body where on demand it is relinquished to the primary cell-combinations that make up the ultimate structures. In health the red corpuscles themselves do not escape through the capillary walls, but under varying degrees of pressure

they yield a part of the oxygen they are carrying to the liquid itself, the plasma, where it is held in solution and from which it escapes to build up cells when the plasma passes by osmosis out of the vessels.

The nutritive part of the plasma that thus reaches the spaces outside of the capillaries is called lymph, and the spaces into which it thus leaks are the lymph-spaces. By further osmosis into the cells the lymph gives up to them a part of its constructive material, and it receives from them broken-down material of which a part thus gathered returns by a further osmotic process to the capillaries, whence it flows on as a part of the blood into the veins. Hence by means of these minute vessels the moving column of blood constantly loses nutritive material and as constantly takes up that which has been worn out in the service of the body. Moreover, the capillaries near the digestive apparatus directly absorb the nutritive material as it becomes fit. Then, as the blood passes through the kidneys and the sweat-glands, it parts with a great deal of water, much of which, especially that going out by the kidneys, is charged with waste. As explained elsewhere, the whole character of the blood changes in the lungs by the elimination of carbon dioxide into, and the absorption of oxygen from, the air, both through the agency of the capillaries. Hence at varying points in its progress the blood differs from the theoretical standard. Upon the whole, because of the greater pressure within the vessels, the plasma loses more liquid to the lymph than

Lymph

it receives from the lymph-spaces. The excess ultimately rejoins the column of blood in ways of no practical importance for consideration here.

Fatigue

When there is much exertion, physical or mental, and in some forms of illness, breaking-down goes on faster than building-up, so that there is in the blood an excess of disintegrated material. When that occurs we say we are fatigued. Now fatigue is both a condition and a sensation. It is a condition, in that it represents loss of strength due to exertion. It is a sensation, in that it expresses in terms of nervous action the consequences of that loss. The normal sensation (not the condition) of an excess of body waste in the blood may be masked by certain drugs, notably alcohol, so as to disguise the fact and make a false record upon the nervous system, and the subject may temporarily fail to recognize that he is fatigued. Pure emotional excitement may lead to extra exertion. In the lower animals, and indeed in man, the stimulus of the whip may induce fresh exertion when genuine fatigue demands rest. All of these, corporal punishment, high emotion, or alcohol, are false helps in that they do not remove the fatigue itself. Either they apply for the time a stronger stimulus, or, as is notably true of alcohol, they derange the nervous conducting power, so that false messages are transmitted. Alcohol, moreover, does other mischief, to be noted elsewhere.

An interesting demonstration of the nature of fatigue is this: A certain quantity of blood was taken

from the veins of a dog that had undergone no exertion, and an equal quantity drawn from another dog of the same breed, age, weight, and general style that also had been at rest was substituted. There was no change in the behavior of the dog thus operated upon, which showed that the substitution of normal blood was a perfectly regular procedure so far as consequences were concerned. In connection with the experiment that followed this was what is technically known as a control experiment. That is, the conditions were identical excepting as to the special feature under investigation. Then on another day the experiment was varied by substituting in a dog that had undergone no exertion blood taken from one completely tired out. The dog that had taken no exercise and that should not have been tired, but which received blood from the overworked dog, immediately showed all the signs of fatigue and crept away into a place of repose and slept. The fair inference is that muscular work creates fatigue-products which enter the blood. These probably represent an excess of broken-down muscle- and nerve-cells and perhaps their more than usual disintegration, so that the lymph and hence the blood is temporarily poisoned by these products of exertion and the nervous system in contact therewith carries that message to the brain. One's working power is diminished when he is tired, because a part of his working apparatus, of his capital, has been ex-

Demonstration of fatigue

Nature of control experiment

Demonstration continued

pended. More than that, he feels less inclined to work because his brain thus interprets the sensation conveyed to it by the nerves in contact with the disintegration-products. He is also less capable of working for the same reason, because voluntary labor requires adequate nervous stimulus. The warnings of fatigue should therefore be respected. But it is not necessary to be too cautious in this matter of work. All work need not cease at the first suggestion of fatigue, for strength and especially endurance (a different quality from strength) may be acquired by practice which passes the limits of ease. That is, a distinction should be drawn between disability and disinclination. It is profitable to remember that "what man calls lassitude the fox calls laziness," and not to confuse languor and laziness with the premonitions of fatigue and incapacity. We may fairly infer from the foregoing that severe intellectual labor, leading to the expenditure of nerve-cells, acts in the same way. It is not so easily proved, but doubtless all such effort throws into the lymph-spaces, and so into the blood, broken-down nerve-cells in excess of the ordinary wear and tear. But after all worry is more responsible than work for nervous breakdown, and the abuse of tobacco and other nervous depressants is a close second in the causation of neurasthenia or nervous prostration, so called.

Nervous prostration

It follows, and it is confirmed by common experience, that vigor returns after rest and food. This is because during simple rest not only the special draft

ceases, but the blood, unless impoverished by starvation or disease, sends into the lymph-spaces more lymph than that neutralized by the current vitiation. Moreover, the waste matter already in the blood is constantly being lessened. It is not the elimination of waste from the blood, it is its passing into the blood, that makes trouble; just as, for example, it is not the sewage filtered out of a water-supply, but that which is discharged into it, which damages the public health. Mere rest, the negative factor of simple abstention from exertion, thus helps to equalize outgo and income. When we add to the foregoing the positive element of new material derived from nutritious food, we see how fatigue is overcome. Both are necessary. Food is essential, but we know very well that we cannot continue working indefinitely as a consequence of merely eating. Rest must help to restore the equilibrium. Nor is simple rest, abstinence from labor, alone sufficient. Sleep, sleep at night in a thoroughly ventilated apartment is of prime importance. Breathing, which is a modified form of nutrition, constantly carries oxygen to the blood, and it is as important that it should be pure at night as that it should be uncontaminated by day. Every man should sleep consecutively for eight hours, and for many ten is not too much if appropriate work has been carried on in the day. The younger and the more industrious over books and field sports are the subjects, the more

Recovery from fatigue

Food

Sleep

imperative is the need for sleep. And as the sleep before midnight is the beauty sleep for those to whom beauty is an attribute, so is one hour's sleep before midnight worth two after it for growing youths engaged in mental work. It must never be forgotten that a stimulant, whether coffee (or its analogue, tea), tobacco, alcohol, or any of the myriad nerve excitants, is not a substitute for food and repose. Sometimes these temporarily suppress or modify the message sent to the brain so as to falsify the actual condition, but they add no strength, restore no waste, and in the end the most of them create a special mischief of their own.

Stimulants

XI

The Elimination of Waste

THE perpetual renewal of the human frame is necessarily accompanied by the elimination of worn-out material. A small quantity of such tissue-waste escapes with the solid discharge of the bowels, but that discharge is chiefly the direct remains of food, and its consideration need not detain us. But much of the fluid sometimes passed from the bowels does come from the person, not from the drink. As such diarrhœas represent departures from health, they concern us here only as something to be avoided. It is sufficient that many diarrhœas are due to antecedent irritation and represent nature's effort to expel unassimilable material, some are symptoms of constitutional disease, some follow a disturbance of local temperature. These last, with which alone hygiene is properly occupied, occur when the surface of the abdomen, sometimes the surface of the entire body, becomes chilled, so that blood driven from that surface is thrown in excess into the intestinal capillary circulation, from which much of the watery part exudes into the course of the bowel.

Diarrhœas

This is nature's method to relieve a local surplus. It is always good policy, not only negatively, to avoid chilling the abdomen, which is most likely to occur at night, but positively, to keep it warm. There may also be a diarrhœa of constipation, where retained fæces sometimes act as an irritant, leading to watery flow in the effort to get rid of them. The general lesson is to avoid unduly cooling the surface, and to take competent advice as to persistent diarrhœa. Uninstructed persons sometimes say dysentery for diarrhœa, as more elegant. The conditions are entirely distinct, and it is as absurd to say dysentery when diarrhœa is meant, as it is to speak of a common cold as an influenza.

Lungs

From half a pint to a pint (330–526 gms.) of carbon escapes invisibly from the lungs daily in the form of carbon dioxide. This is easily demonstrated by passing the breath through lime-water, when a white cloud appears. Watery vapor also escapes freely from the lungs. On a frosty day much of this is visible in the exhaled breath, but there is none the less when it is not sufficiently condensed to be observed.

Kidneys

The kidneys separate from the blood waste held in watery solution. The half-million capsules and fifteen miles of tubing there assembled assert the importance of these organs, through which sooner or later all the blood in the body passes, and from which the perpetual current of urine is excreted. The amount of urine formed in any par-

ticular period varies with that of the perspiration to which it is complementary, and the rate may be influenced by nervous conditions. As rapidly as it is formed it passes through one long slender tube from each kidney to the bladder, which easily holds from one-half to three-fourths of a pint or more. The total amount made by the adult in the twenty-four hours varies between two and a half and five pints. About forty parts in one thousand of average urine are solid, chiefly representing broken-down flesh. It is this which must be expelled, not the water, which is merely the vehicle. This waste is formed in the liver and there is thrown into the blood to be eliminated by the kidneys. When they are damaged so that a part of this waste is retained, the body suffers in proportion; and when they entirely cease to act death quickly follows. An excess of flesh food, that is more than the system requires to repair waste and in the young to form new tissue, puts a serious strain on both the kidney and the liver, requiring of them extra work. When the bladder is irritable, so that water is passed more frequently than usual, it is often supposed that an unnatural amount is actually excreted; and when there is pain or stiffness in the loins many think the kidneys are diseased. These are two popular errors that often occasion much unnecessary anxiety. Important as they are, the kidneys are rarely attacked acutely and more rarely with direct and severe pain. The constant, even if not excessive, drinking of alcohol is apt finally to disorganize them, but local disease

is usually a complication of other diseases. Thus it is a frequent and dangerous consequence of scarlet fever, and the lighter the attack appears to be, especially in a cold climate, the more liable are the kidneys to be involved. In convalescence from scarlet fever, preëminently a disease of youth, extra work is thrown upon the kidneys owing to the inactivity of the skin, and the subsequent dropsy that frequently happens is due to the inability of the kidneys to dispose of all the water. The most scrupulous heed should be paid lest the imperfectly-working skin and the overworking kidneys are chilled, or are clogged by unwise diet. Acute inflammation of the kidneys (not incidental to other disease), a very serious state, most commonly depends upon exposure to wet cold, either directly over the loins or general and prolonged. It is neither a sign nor a test of manhood to submit to avoidable trials of that kind, and forewarned should be forearmed by the operation of intelligent prudence.

Skin

The skin is a general envelope of two strata. The outer one (epidermis) is insensitive and consists of flattened cells whose dead superficial layers are constantly pushed off by those under them, as illustrated by the rolls peeled off after a warm bath. It is without blood-vessels and is nourished by simple absorption from beneath. The lower layer or true skin (dermis) is extremely sensitive through the terminal filaments of its multitude of nerves, by pressure upon which, through the loose upper stratum, we literally keep in touch with the outer world.

Complexion depends upon the color of the deeper cells, blonds having little and the dark races much pigment. Blushing follows an increase of blood in the superficial capillaries, and its occurrence upon slight provocation indicates extreme, sometimes abnormal, nervous sensibility. The pallor of some disease, as well as that of persons not otherwise appreciably ill, shows an insufficient amount, or an impaired quality, of blood. Continuous exposure to the sun and wind coarsens the skin as well as darkens it, as seen in the face and neck of farm-laborers and sailors. A sun-and-wind-roughened skin probably never recovers its pristine delicacy. Freckles are changes induced by the sun in the pigment of delicate skins. A yellow veil should protect against them.

Complexion

This lower stratum, the dermis, is closely-woven fibrous tissue which becomes areolar toward the body. In the young of both sexes and in women these meshes hold numerous fat-cells, which round the contour and are non-conductors of heat.

Areolar tissue

Under the epidermis are minute elevations of the dermis called papillæ, some of which contain an artery and two small veins, and others tactile nerves. On the palm these lie in rows which form delicate ridges as the epidermis dips between. On the finger-tips they run in whorls which are never duplicated, and the impress of the thumb, the oldest of all seals of authentication, is the best possible identification.

Papillæ

Hairs arise from follicles, or special papillæ, at the bottom of depressions, and slender unstriped muscular fibres run, usually obliquely, from the true skin to the side of the follicles. When these fibres shorten under the reflex action of anger or fear the hair becomes relatively erect. Hair does not grow in the ordinary way, that is at the outer extremity. It is protruded, pushed out from beneath. Its color depends upon the pigment in the cortex, and it becomes gray as the central air-cells increase and better reflect the incident light. But it is not clear why they increase. Probably air replaces the shrunken cells. It certainly indicates either general or local physical deterioration, and the influence of the nervous system is constant and well marked. There are historical instances of the hair turning gray in one night, and premature grayness from sorrow or anxiety is not very uncommon. The falling of the hair depends on many causes, not all of which are recognized. Heredity and certain diseases play a part, the essence being degradation of the follicle. Baldness is also one of the signs of the atrophy, the general wasting, of advancing age; although the hirsuteness of other parts, as the chin, the breast, the axillæ, the pubes, is not diminished. Probably the most general condition leading to premature baldness is confinement of the hair by a close-fitting, ill-ventilated covering, or by constriction of the blood-supply by a tight circumscribing ring. Certainly savages and women, who are least troubled with tight hats, preserve

Hair

their hair much longer than the average white man. Notwithstanding a substantial head-covering may interfere with the quantity of hair, the greater should not be mistaken for the less and the head be allowed to suffer for the sake of its appendage.

Sweat-glands

In the connective tissue just beneath the true skin lie an enormous number of minute glands, each with a spiral duct that opens upon the surface. These microscopical mouths are popularly known as the pores of the skin, and the common impression seems to be that they play the part of a colander whose orifices open and close automatically. As a matter of fact around each of these little glands is entwined a very close capillary network, which always implies an active function. They are about 2,500,000 in number, and they extract from that capillary blood the colorless fluid we call perspiration or sweat. The quantity made every twenty-four hours varies from one and a half to nearly four and a half pints. When, as is generally the case, this evaporates as rapidly as it reaches the surface it is known as insensible perspiration. Visible perspiration forms only when the secretion is so very profuse, or the air is so charged with moisture, that more moisture is taken up with difficulty or not at all. The combination of heat and atmospheric humidity is sultriness, and on a sultry day perspiration clings to the skin. Humidity is an element of climate, and its oppressiveness is directly proportioned to the atmospheric moisture which interferes with evapo-

ration from the body and it marks one of the differences between Philadelphia and Denver, for example, in the summer. The odor of perspiration, lying in the excreted solids, varies with the race and with the individual, and in different parts of the same person. It is probable that by such variation, unrecognized by our duller sense of smell, the lower animals, especially dogs, differentiate the trails of individual men; and that by the general residuum of the perspiration the scent of game is formed. The insensible perspiration goes on by night as well as by day, and of course is absorbed by the bedclothes as well as the underclothing. When for any reason the body appreciably perspires, there is so much the more to be taken up. Underclothing that is to be worn the next day should therefore be freely exposed to the air when it is taken off; and the proper course on arising is distinctly not to draw the bedding back in place for the sake of appearance, but carefully to expose it to the light and air over the foot of the bedstead or on chairs. Bedclothing hung out of a window is not attractive to the passer-by, but it is a sign of hygienic housekeeping. The more frequently underclothing can be changed, the more comfortable and the healthier will be the wearer.

Perspiration disposes of water next after urine, and sometimes it discharges much more. Its chief function, however, is not to establish an equilibrium of fluids, but to regulate animal temperature. The action of the sweat-glands depends entirely upon the nervous

system, and neither directly upon the heat of the body nor upon the quantity of blood near the surface. A profuse perspiration may break out on a cold pallid skin, and in a fever with the superficial vessels full of blood the skin itself may be parched and dry. Ordinarily we perspire more when the weather is warm because external heat increases the nervous irritability of the sweat-glands. We perspire after labor because the heat generated by muscular work acts as an irritant, and the swifter circulation sends more blood through those capillaries in a given time. But pain or fear by reflex action may cover the body with moisture, and the drenching colliquative sweats of wasting diseases follow relaxation of nervous tension.

The philosophy of cooling by perspiration is simple. Evaporation, the changing of a fluid to a more rarefied state, reduces the temperature of the surface acted upon, as illustrated by the sensation that follows the volatilization of a little ether or alcohol from the palm. So bathing the body with water, whether poured on from without or exuded from within, cools it. Although the perspiration is of the body-temperature, its evaporation holds that temperature in check.

Normally the skin discharges a trifling amount of solids in solution, as recognizable in the saltiness of perspiration. But when the kidneys are inactive through disease this special excretion, urea, of which ordinarily there is but a trace in the sweat, is greatly increased therein. The impression that water may be absorbed as well as given out by the skin seems to

depend on the popular and erroneous colander doctrine. The orifices of the sweat-ducts are outlets, not intakes.

Besides the sweat-glands are oil-glands (sebaceous glands) yielding a greasy semi-fluid secretion which becomes cheesy after exposure to the air. These are generally associated with the hair-follicles, but they are also found in hairless regions. When near a hair-follicle the discharge escapes upon the hair as it passes through the skin. This physiological protection to the skin should not be removed too completely. Cleanliness is desirable, but not too much daily scrubbing. It is not always necessary to be scraped in order to be clean. The oily film on the surface should be removed occasionally, not continually. This does not militate against a daily bath; it is merely a caution against too much subsequent friction.

Oil-glands sebaceous glands

An obvious illustration of sebaceous secretion in excess is the so-called flesh-worm or blackhead of the face and back, especially in dark- and coarse-skinned adolescents. A blackhead is the secretion of an enlarged and stimulated sebaceous gland whose canal has been partly blocked. The black points are not dust as commonly supposed (except occasionally with the very careless), but are pigment granules. Annoying as they are to the eye, they are painless and perfectly harmless, and usually disappear at maturity. The secretion is most easily emptied by pressing the barrel of a watch-key over the canal.

Black-heads

Frequently mingled with the blackheads in the adolescent age are the pimples known as acne. To squeeze or handle these irritates them. Pressing out the contents is not curative. The bowels, apt to be sluggish, should be attended to, and frequent gentle bathing with hot water and good soap is helpful. Permanent relief is found through patience and the lapse of time.

Acne

Warts are simply overgrown papillæ whose density depends upon the amount of the epidermal layer. Their cause is not clear, but usually they may be removed by a mild caustic systematically and not too vigorously applied. They often disappear spontaneously and there is no ground for the superstition that they are communicable.

Warts

Corns begin with an overgrowth of the papillæ, but when the corneous layer becomes predominant the papilla is forced down, the true skin wastes, the fat is absorbed, and sometimes a pouch is formed below. Corns are entirely due to pressure and friction, generally from tight shoes, although occasionally from chafing by those too large. Long-continued pressure may set up an inflammation, sometimes leading to suppuration. They are ordinarily on the more prominent parts of the foot, but the so-called soft corn occurs on the inner side of the toes where there is free perspiration. The prevention of corns is in the avoidance of pressure. They frequently arise in childhood before it can be intelligently explained where the shoe pinches, but quite as often

Corns

they are created or intensified by vanity and ignorance forcing a growing or full-grown foot into an insufficient shoe. Their treatment does not belong to this subject, but where there has been no pressure there will be none to treat. A callosity or modified corn develops on various parts of the person from mechanical occupations, and it sometimes points out the trade of a suspect.

Callosity

A bunion, much more formidable than a corn, is a change in the joint of the great toe next the foot. The toe having been turned inward by a shoe too short or too tight, the end of the bone enlarges from the irritation, the face of the joint turns outward from pressure, and a sac (bursa) forms on the joint surface. When inflamed this is very painful. The efficient use of the foot requires the weight in walking to be thrown on the ball rather than on the heel, which cannot be done if this important joint is crippled. The least deviation from the line of nature tends to increase, and the changes range from a slight enlargement at the joint to a complete change of direction carrying the toe across the others. Pressure always aggravates it, and freedom from compression keeps it at the minimum. Corns and bunions, especially if liable to inflammation, should be protected within a roomy shoe by a ring of soft felt to take up the pressure.

Bunions

Blisters of the foot, usually at the heel, are due to friction by a rough shoe or a wrinkled stocking. The fluid should be allowed to escape through a minute hole, made by the point of a needle,

Blisters

at the most dependent point and the skin be left in place. To avoid blisters on a long tramp, the shoes should be well-fitting and not too coarse, and the stockings quite smooth. Sprinkling the inside of the stocking with a foot-powder whose base is French chalk and salicylic acid is a good preventive. At the end of the walk the feet should not be soaked in water, but be wiped carefully with a damp towel. To grease tender feet overnight is a relief.

XII

Catching Cold, Swimming, Bathing

IN common speech we catch cold when the open pores are exposed to a draught, or to general low temperature. These "open pores" are the active perspiratory glands which popular opinion seems to regard as apertures in the skin having varying degrees of patulousness. Catching cold is in effect a disturbance of capillary equilibrium, so that the blood passes in excess from the capillaries of the skin to those of the lining membranes, sometimes of the intestines but usually of the respiratory organs. Popularly that disturbance means the substitution of cold for heat; either general, as when exertion is suspended in the presence of cold or one passes from a warm room into cold air, or local, when by a current of air or otherwise a part of the body is cooled more than the remainder. That is frequently the case, but quite as many common colds are contracted by entering an overheated apartment from biting out-door air. The ordinary condition

Catching cold

seems to be that a disturbance of the capillary circulation of the skin sets up a counter-disturbance in the lining membrane of the nose or throat. In substituting general cold for heat the capillaries about the sweat-glands are suddenly contracted by the reflex action of the cold and perspiration is checked, but the capillaries of the membranes remain, or become, engorged, and leakage of serum soon ensues because the other capillaries are not prepared to maintain their share of the work. Where the cold is locally applied, as to the feet or the back of the neck, there appears to be a reflex disturbance of some regulating centre so that the membrane of the nose, for instance, receives more blood than usual. When one comes from the outer cold, with all the superficial capillaries contracted, into an overheated apartment, it is generally after out-door exercise has rendered the circulation specially active. There is prompt removal of the capillary tension, but the capillaries of the skin do not respond to the change as quickly as those of the membranes, which thus become engorged and "a cold" results. The explanation of the cause, however, is of less importance here than a recognition of the condition and its avoidance. Entering a hot room one should accommodate himself to the situation by taking off his wraps slowly and by degrees. Submission to such temporary inconvenience will usually result in escaping a probable cold.

The most usual illustration of unequal bodily temperature leading to colds is wet feet. The mistake

there is in confusing conditions. When any part of the body at rest becomes wet and there is a local reduction of temperature in consequence, harm is apt to follow. But exercise usually counteracts the mischief, as common observation of hunters, fishermen, and all kinds of day-laborers shows. The real danger from wet clothing in general is that the evaporation from large surfaces materially lowers the bodily temperature, so that reaction from the depression is difficult. This is less a question of catching cold than of serious illness. A cold wind increases the danger from wet clothing. Experienced frontiersmen accidentally immersed in severe weather will strip and dry themselves and their garments by an extemporized fire, regardless of the temperature of the air, in preference to wearing wet clothes. If the temperature is not very low one may trust to exercise; but when it is really cold, strip and dry.

Wet clothing

Adaptability, however, is such that men gradually inured may march all day in the wet and sleep under the stars in moderate weather, merely being uncomfortable. But the sensible rule for ordinary life is to substitute dry clothes for wet ones when exertion ceases. That those whose general health is reduced do not suffer from living constantly in the outer air regardless of the weather, is shown in the very successful treatment of those consumptives who are kept, warmly clad, always out-of-doors. It is a singular and not entirely explicable fact that well persons who spend night and day out of doors not only

Sleeping outdoors

are much less liable to colds while thus exposed, but the first night spent in a house is almost certainly followed by a cold.

The liability to these disagreeable ailments seems to be proportionate to the sensitiveness (not the delicacy) of the skin, and every cold makes the way easier for its successor. They are best avoided, not by senseless effort at "hardening" through insufficient clothing, but by keeping the body comfortably, not excessively, warm, by living at night as well as by day in well-ventilated, not draughty, apartments, and by gradually diminishing the sensibility of the skin through the systematic use of cool baths. It is imperative that the bowels should not become constipated.

Avoidance of colds

There is another class of colds, not distinguishable in symptoms, clearly communicable by infection. That is, it is liable to be contracted through mere association with a person already affected. Such a cold is liable to run through a family or an associated group, independently of exposure to wet or draughts. It probably depends on a yet unidentified bacillus.

Infectious colds

Connected herewith is the mischievous every-day advice not to go in swimming while warm or perspiring. Under its influence boys rush to the waterside and, dressed or undressed, sit still, hot and perspiring, to cool as rapidly as possible, a course naturally productive of colds or worse. The proper course is to strip quickly, plunge in,

Swimming

and swim. To swim is necessary. Merely to bathe or to paddle in the shallows when hot is hazardous. Swimming is good active exercise well calculated to keep the blood moving rapidly and to counteract the chill of any water at all fit to swim in. It is of no consequence whether one is perspiring or not on going into deep water, provided one swims vigorously at once. But it is a very different and it may be a very serious affair to remove one's clothes when hot and passively stand or sit in the water. No one when cold should go into water for swimming or bathing —unless it be hot water—nor remain in the water after the faintest sign of chilliness. There is frequent temptation to do so, but always at serious risk. To remain in the water, whether in a tub or in the sea, long enough to feel cold is wrong. Blue lips and chattering teeth are a challenge to congestion and a defiance of Providence. Powers of resistance differ so much that it is impossible to lay down rules as to the time of immersion. The limit of endurance in this respect for a dozen men is no more identical than would be their strength for lifting weights, or their speed upon the track, and in rivalry there may be danger. Women, especially young women, who swim frequently can remain in the water longer than men because of their non-conducting fat; and it is folly for a man to risk illness through false pride in competition with them. A man of any age who begins to feel cold should leave the water without delay, and if it is desirable should frankly give the reason.

Younger persons whenever in the water should be carefully watched by those responsible for them, and be sent out promptly on the slightest sign of chilliness.

Surf-bathing, being knocked about by the breakers, is much more exhausting than it seems to those exhilarated by its novelty, and novices should husband their endurance. The chief sanitary advantage of sea-bathing is this concussion by the surf, being smitten and showered upon by a hundred points of spray with the body wrought up physically in withstanding the waves. The salt is a stimulant chiefly in increasing the density of the water driven against one, and the hygienic value of "sea-salt," advertised for the tub, is nothing.

Sea-bathing

Delightful as swimming is as an accomplishment and valuable as it is as an art, the ears may be readily damaged by deep diving, by swimming too far under water, or by exposing them to the force of the surf. The delicacy of hearing is very readily disturbed and the organ itself may easily be hurt. Whoever is much under water should carefully guard his ears by using unwashed wool. Wool from which the oil has not been removed retains its elasticity and is much better, under all circumstances, for use in the ear than cotton, which packs whenever it is damp. Those conscious that their ears are delicate or unsound should take this precaution before entering the water at all.

Care of the ears

Swimming is not undertaken primarily for the sake

of cleanliness. That is one of the functions of the bath. Cold water alone is not particularly cleansing. Poured over an oily skin it flows off uncontaminated. But to most persons cold water, especially in the form of a shower when the atmosphere is temperate, is a delightful stimulant. But neither the very young, the aged, nor the truly delicate can endure the shock of immersion in cold water. Such persons can secure the most of the benefit of a cold bath by standing with the feet in tepid water and pouring cold water from a large sponge over the body. The extremities remain warm while the stimulant effect of the cold is obtained. The interior temperature of the human body is 100° F., and the conventional temperatures of the various baths are as follows: cold, below 65°; cool, 65°–80°; tepid, 80°–90°; warm, 90°–99°; hot, above 99° F. The immediate effect of a cold bath is to contract the superficial capillaries and to drive the blood inward. Breathing is deepened, at first quickened and then slowed; the circulation is slightly retarded; the temperature very slightly lowered. The nervous system and especially the mental faculties are immediately and powerfully stimulated, probably by the influx of blood unaccompanied by any morbid condition. Reaction should occur immediately upon leaving the bath, when the capillaries and the small arteries dilate, the skin flushes, and there is a general sense of warmth and well-being. Such reaction is the test of whether the bath is well borne. It may be aided by brisk rubbing down

Baths

Cold bath

with a coarse towel. Apart from this agreeable reaction, there is almost complete immunity against catching cold in those who take such a bath daily.

Hot bath

The hot bath also is stimulating at first. The superficial capillaries dilate promptly. The circulation is quickened; perspiration is excited; the skin easily parts with its worn-out layers; the stiffened and wearied muscles are relaxed; the joints become more flexible; the sense of fatigue yields to one of satisfaction; and for the time the brain is more alert. This is soon followed by a happy sense of languor and drowsiness, and if maintained longer sleep is apt to follow. There is no single agent that gives such complete relief after fatigue, or that mechanically removes so well the effects of labor. It does not take the place of food or sleep in overcoming fatigue, but it is an admirable prelude to each. When followed by a cold bath there is a marked revival of energy. The hot bath is often used for its secondary relaxing effect in some forms of sickness, especially with children. This is referred to here only to impress the caution that the cold faucet should always be opened first, and that in testing the temperature, in the absence of a thermometer, the elbow and not the hand should be used. The hand is too insensitive to judge for the more delicate skin of the body.

Washing

To wash properly, in distinction from bathing, tepid or warm water and soap, but not too much soap, are required. Soap by uniting with the natural or acquired grease on the skin makes it

soluble. When in excess it removes too much, for unless it is replaced very rapidly a little of the protecting oil should remain. Good soap, soft water, and a fairly coarse towel carry off the worn-out surface-skin in rolls.

The simpler soaps are the best, the type being castile. Highly scented cheap soaps are always to be avoided, for the perfume is liable to conceal rancid fats. This does not apply to the delicately perfumed high-grade soaps, which on the other hand are too costly for common bathroom use. For irritable skins much pains should be taken to select a soap with no free alkali, usually best determined by experiment. The so-called medicated soaps are of little value, for the soap does not remain long enough in contact with the skin for any remedy to be effective.

Soap

For purposes of cleansing a quart of water properly applied is as useful, although not as convenient, as a tubful; and a hot bath is a luxury rather than a necessity. If an entire bath cannot be taken, the feet should be carefully washed daily, preferably before retiring, and prodigality would better expend itself in stockings than in neckties.

When the bath is neglected the body slowly acquires a musty odor and the clothes become offensive. This proceeds so gradually that the subject himself is not always aware of it, and his own senses may be quite unconscious of his offensiveness to his neighbor. Such a caution can be required by only one, if any, of a multitude newly gathered from heterogeneous

homes with scholarship as the only common standard. To avoid being that one too much care cannot be taken to not transgress against the straitest rule of bodily purity. It is a physical quite as much as a moral rule that it is the first deviation from the right way which opens the undesirable course.

Reference has previously been made to the occasional affliction of fœtid feet. There the sweat-glands are abnormal and secrete a horribly offensive perspiration. Those people are not unclean. Usually they are scrupulously stainless in their persons, but the secretion is tainted at the fountain. They change their stockings with great frequency and also change and ventilate their shoes; but they suffer from a disease, not a condition to be remedied at will, and it may be alleviated, if at all, only by medical advice of the first quality.

Hidriosis

XIII

Clothing

CLOTHING is primarily designed to promote health and comfort by protection against wet, by conserving bodily heat in low temperatures, and by shielding against solar heat. As worn during exercise, it should minimize the heat thus generated. Its secondary objects are decency and attractiveness. Warmth is not an intrinsic quality of clothing. If two blocks of inanimate matter are dressed, under the same atmospheric conditions and out of the sun's rays, one in woolen or fur and the other in muslin or paper, and their sensible temperature is measured after a definite period, there will be found no change in it due to the clothing. The temperature of both objects will closely correspond to that of the surrounding air. When clothing adds to the heat of the body, it is by absorption directly from the sun's rays. But although neither warm nor cool intrinsically, clothing conserves animal heat or allows it to escape freely by radiation. Clothing is only warm in the sense that it retains, not creates, caloric. That is a quality of the

Object

Warmth

Temperation as depending upon clothing

material and is not influenced by the solar rays. But independently of material, when in those rays color causes a marked difference in their absorption. Thus, in the sun black takes up the most, blue the next, and so down the scale to white, which absorbs the least. The difference between white and black in the sun may be ten degrees. A thin white cotton tissue over a black coat has reduced the temperature in fierce rays of the sun, as compared with a coat not thus covered, by 12°.6 F. This may be demonstrated by exposing to the sun upon a bank of snow equal surfaces of identical cloth colored differently (Franklin). The relative sinking of these in the snow shows their comparative absorption of the solar heat. It is felt, if not seen, by those who wear black instead of white hats or coats in the sun. White clothes are therefore worn logically in the tropics or during our own summers. Color also determines the conspicuousness of clothing, background being a contributing factor. The order in which colors are observed over a neutral ground is red, white, black or dark blue, butternut, dust-gray, olive-drab. Surveyors' flags and railroad signals are chosen on this principle. Clothing absorbs odors partly on account of its color and partly from its hygroscopic quality. Black takes up the most, blue the next, and white the least. A material is hygroscopic as it absorbs moisture within its fibre. Exact experiments to show the relative absorption of odors by different materials of the same color are wanting. Where

Conspicuousness

Odors

texture is identical the absorption-order is black, blue, red, green, yellow, white. Hence black is the worst and white is the best color to be worn where odors abound. Probably morbific emanations are taken up more readily by the black and moisture-absorbing dresses of amateurs, and least by the light-colored and non-absorbent gowns of professional nurses.

The ordinary materials for clothing are cotton, linen, woolen, silk, leather, and, for occasion, india-rubber. The ultimate fibres of cotton and linen are very hard and durable, very slightly hygroscopic, and are very good conductors of heat. Hygienically they are of equal quality. The body generates heat in proportion to its exertion; but in health the temperature to be maintained should not exceed 98°.4 F. near the surface, or 100° F. within. Hence the warmer the external temperature the less of this self-generated heat should be retained; but the cooler the air, the less rapidly it should be dissipated. Nature's cooling process is by the evaporation of perspiration, which continues after the exercise which induced it has ceased. Both cotton and linen easily become wet, but they are only slightly hygroscopic, and so do not well take up the water. That is, it passes through them and evaporates. This evaporation would readily chill a person at rest. Besides, both cotton and linen, even when dry, allow the heat of the body to radiate rapidly; that is, they are good conductors. Consequently they are not suited as the only clothing, either when there may

Cotton and linen

be perspiration or when mere exposure to dry cold is probable. The wearers of mere cotton or linen risk their health according to the degree of perspiration, to the temperature of the air, and to their personal power of resistance. This power of physical resistance represents the distinction between individuals. Usually it is overestimated, which leads to serious risk; and inappropriate clothing should not add to the chance of harm.

Wool

Wool conducts heat badly and absorbs water freely: (1) by absorption within its fibres (hygroscopic water); and (2) as it lies between them (water of interposition). The water between the fibres gives the sense of dampness, and the most of this can be removed by pressure. But the water that enters the fibres themselves (hygroscopic water) gives no sense of dampness, and little of it can be expelled by wringing. Wool absorbs water twice in proportion to its weight and four times in proportion to its surface, as compared with cotton or linen. By taking up its moisture it counteracts the evaporation from consecutive perspiration. As the vapor from the body is condensed by dry woolen clothing, the heat that would become latent when the perspiration passes off insensibly is released. This creates the sense of comfort felt when a woolen garment is put on while the body is cooling rapidly after sharp exercise, because the further evaporation from the cloth proceeds slowly and there is not the chilling effect of the clinging vegetable tissues. This is the philosophy of the

sweater. That all laborers, even enginemen, wear flannel shirts shows that experience and theory agree. Wool is neither easily penetrated by cold winds nor readily conducts heat from the body; so that while it is comfortable in cold, it is oppressive in warm, climates. When, as rarely happens, woolen clothing becomes saturated with perspiration, the water of interposition may be wrung out, so that it will serve anew for condensation and absorption. A full suit of woolen underwear, neither too closely clinging nor too coarse, is the most comfortable and safest dress in the so-called temperate zone for nine months in the year, and light wool is better worn over the chest and abdomen the whole year round and the wide world over. The shrinkage of wool in washing is best avoided by mixing with it about thirty per cent. cotton. The trade name of this is merino. Flannel is a loosely woven woolen, chiefly used for undergarments. "Flannelette" and "sanitary flannel" are practically cotton. "Canton" flannel ("cotton flannel") is cotton, not woolen, with a long soft nap on one or both sides. Serge and worsted are light woolens easily permeable by air, and have the good qualities of the lesser woolens. Any closely woven cloth takes up dust less readily and parts with it more easily than that of loose structure. Shoddy is old, used and worked-over wool and cloth. Blankets and garments made from it tear easily and wear badly. Mixed with fresh wool it is a common fraudulent ingredient in contract goods and low-grade ready-

Flannel, etc.

made clothes. Silk, of animal origin, sometimes used for shirts and pajamas, is not common for men's wear because of its cost. It is highly hygroscopic and a poor conductor of heat. Rather curiously it is subject to complete substitution, as well as to adulteration. Pure silk is practically noiseless, and when it rustles, as often represented in fiction, cotton has been added. Leather, besides being a good covering for the feet, is an admirable emergency dress in dry, cold, and windy climates. Tanned with the fur or wool on, which assists in turning water, no material can compare with it in resisting cold. Leather is not air-tight and it permits the insensible perspiration to transpire, but as a bad conductor it retains the heat of the body. Patent leather is so varnished as to be air-tight and water-tight, and hence is inappropriate for prolonged wearing. India-rubber has a temporary but invaluable use against rain, but it retains the heat and perspiration of the body so effectually that it should not be worn persistently. Neither should any water-proof clothing be worn constantly. In outdoor life india-rubber has very great value as a protective against ground-moisture.

Silk

Leather

India-rubber

Poisonous dyes are occasionally absorbed with serious results from wet clothes, when these come in contact with the skin. Aniline dyes, black as well as bright, may be absorbed from both shoes and stockings when worn on hot and moist feet. Aniline black destroys the oxygen-carrying

Dyes

capacity of the red corpuscles, an evil that requires no commentary. The brilliant colors, fixed by irritant minerals, as arsenic, may disturb the skin, and deaths from their absorption through abrasions are not unknown. Low-grade white collars and some hat sweat-bands occasionally irritate from a contained chemical, in which case they should be discarded. Paper collars may contain arsenic. Celluloid, as used in collars and cuffs, is highly inflammable and also may explode under great heat. Red flannel acts on some skins as a mild irritant, and hence has acquired a reputation against the stiffness and pain commonly called muscular rheumatism.

Celluloid

Paper conserves heat so excellently that it is valuable as an extra sole within the shoe, as an additional blanket stitched to ordinary ones, or as a cuirass outside the undershirt.

Paper

In moderate climates to dispense with a covering for the head probably conduces to the vigorous growth of the hair and to general health. But extremes of heat and cold must be protected against. All exposure, even when not extreme, coarsens the skin and hair; and a certificate of tan as to summer absence from town ultimately reduces a delicate complexion to a rough brown coat. To go hatless in a sunny climate further disfigures either sex by a scowl acquired in protecting the eye from glare. No hat should be tight enough to interfere with the full supply of blood to the scalp. The head should not remain covered within doors, because it

Hats

would be kept too warm and the hair be ill-ventilated. Appropriately made and used, the silk hat has the advantage of being light, of having abundant air-space, and in this country of being worn only by those not much exposed. Its usual color and the possible danger of constricting the scalp are its chief disadvantages, and it should not be worn under our midsummer sun. The derby is so full of sanitary defects as to be properly tolerable only for those whose hair is beyond redemption and their skulls resistant to ill usage. Every stiff hat should be moulded to the head before it is worn, and under hot sun it should not be black. A soft hat of light color, to be in summer of light flexible straw, in cold weather of wool or fur, is more comfortable and more sanitary.

Collars are comfortable agents of cleanliness, which should never be tight nor interfere with the downward flow of blood through the veins. The heavy woolen muffler bathes the neck in perspiration and makes it sensitive, so that after irregular and partial contact with the air, colds follow. There is no objection to a light temporary wrap across the chest when an open coat replaces a close one in severe weather, nor to a heavy kerchief for strictly temporary use, but habitually to swathe the neck in wool is pernicious.

Neck-wear

A chamois or buckskin chest-protector, perforated, may be worn by the delicate in severe weather, and the back of the chest should not be neglected as it frequently is. All clothing over the body should be so loose as not to

Protection for the chest

present to the chest-walls the least constriction. Even the light pressure of suspenders tends to make the shoulders round and the chest contracted, and for the young they are undesirable. In a normal youth with normal hips the trousers should be sustained by a broad, moderately tight belt above those bones. But it is better to depend on suspenders than to wear a really tight belt, for the abdomen should not be constricted. Trousers, and particularly drawers, should not bind across the seat nor in the joints. Socks or stockings should be suited to the season, and if not sufficiently elastic to remain in place should be suspended. There should be no excuse to tie anything around the leg, for fear of interference with the circulation. Woolen stockings are not suited for those who perspire freely. In such cases the feet become damp and grow chilly when exercise ceases. Although uncomfortable, wet feet are rarely hurtful to a man in good health who is taking active exercise, excepting under excessive cold. In extreme low temperature, for the body to be wet at all is hurtful; and the greater the surface that is wetted the more serious the risk. A poor shoe inevitably cripples the foot, either for the time or permanently. Every shoe should be large enough for the foot in walking to expand one-tenth in length and more in breadth. But when too large, blisters and chafes follow; and corns, bunions, and serious displacements of the toes are due to ill-fitting shoes.

Suspenders and belts

Trousers

Stockings

Wet feet

Shoes

To have room over the toes for expansion in both directions is particularly important. High heels disturb the level and may distort the symmetry of the pelvis, and are specially harmful to the young. To go barefoot in a suitable climate assures normal feet for children.

The abdominal protector is a valuable addition to ordinary clothing, not only for torrid climates but under either extreme of heat or cold in the temperate zones. It is an apron of two thicknesses of soft flannel, worn next the skin, suspended from a tape tied around the waist. In that form it lies smooth and is comfortable. As a belt, as frequently supplied, it rolls up and is uncomfortable. Its purpose is to equalize the intestinal circulation, which is liable to derangement with consequent sickness, in either very hot or very cold weather. The protector should be worn by night and by day, and its constant use shields against that form of diarrhœa which follows exposure to prolonged heat, especially when the nights are relatively cool.

Abdominal protector

XIV

Food

FOOD repairs the body's ordinary wear and tear and supplies material for tissue in those still growing. "Force manifested in the living body must be the correlative expression of force previously latent in the food eaten or in the tissue formed." That is, food provides for growth and repair and enables work to be accomplished and heat to be generated. Normal appetite and hunger are to be gratified and allayed in the interest of health. There should be an interval of four or, better, six hours between meals, for the recuperation of energy expended in digestion. The better practice is three meals in the twenty-four hours, although for a few mature persons two seem sufficient. Exhaustion from over-work or prolonged fasting manifests itself in the digestive apparatus, so that indigestion follows the failure of the proper fluids to be secreted. Food taken by force of will when one is "too tired to eat" generally leads to nausea or dyspepsia, and a necessary caution in those reduced by starvation is to supply the most digestible food in

Meals

Fatigue or fasting

the smallest quantities. The use of alcohol, whether disguised as vegetable bitters or taken more openly, before meals by men whose stomachs are jaded by overwork or who are run down by daily nervous strain, to stir the enervated stomach into action, induces an ultimate condition worse than that for which its aid was invoked. A hearty meal should not be eaten within two hours before bedtime; but this does not forbid a glass of milk and a few biscuits, or even a little well-masticated cheese. A little digestible food may be taken by light sleepers with advantage in an interval of wakefulness.

Bitters

Sleep

Food supplies material, energy, and animal heat, partly directly and partly by restoring expended material. It is divided roughly into proteids and albuminoids, grouped as nitrogenous; the carbohydrates and fats, non-nitrogenous; the inorganic mineral salts, and water. Practically nearly every food contains more or less of various classes, whose preponderance alone places it in one group or the other. The construction of tissue is carried on by the proteids, the mineral substances, and water alone; all the organic constituents (that is, the non-mineral) evolve energy; and cell life produces heat. The proteid foods are casein of milk, myosin of muscle, gluten of flour, legumin of beans, peas, and other pulses. In other words, flesh, milk, bread, and leguminous plants are chiefly, but not wholly, proteids. Albuminoid food,

Classes of foods

Proteids

as a descriptive class, is limited to the non-nutritious gelatines, although retained by some writers as a synonym of proteid. Besides the proteids, the energy-makers (the heat and work producers) are the albuminoids, sugars and starches (carbohydrates), and fats. Of these the proteids alone supply both tissue and energy and, witness the South American Indians, lean meat and water are adequate for the support of an active life. The various proteids are similar, not identical, and have in common nitrogen and a little sulphur as their characteristics. When the nitrogen is cut off, the various functions gradually languish as the reserve in store becomes exhausted.

Albuminoids

Energy and strength are not identical. Energy belongs to the nervous system, strength to the muscles (Hutchison). In that sense nitrogen is essential to energy, and intellectual capacity and bodily vigor are only found among those using an essentially nitrogenous diet. Starches and sugars are found in varying proportions in all vegetables. Before transformation into animal tissues the starch and cane-sugar are changed partly by cookery, partly by digestion, into grape-sugar. A part of this is still further converted into animal starch (glycogen) and stored as a reserve. The surplus of this sugar makes fat, and that sweets in excess are fattening is notorious.

Energy

Starch and sugar

Glycogen

The fats and oils of food are of both animal and vegetable origin. As stored in the body, fat is de-

rived chiefly from the starches and sugars; and, curiously, there is no positive evidence that fat eaten is stored as fat. It is absorbed after disintegration in the intestines, but its ultimate destination is obscure. As diet, fat is particularly necessary where growth is going on, although in the form of simple fat it often is objectionable to the healthy stomach. In cold climates much animal fat is consumed, and in the warmer regions the vegetable oils are drawn upon. Our ordinary diet supplies fat in butter, milk, and cheese, and fat is a part of the meat-supply. It is digested in the intestines and not in the stomach, and when in excess of the digestive powers it is prone to decomposition. The common inorganic salts are small in amount but important in character, and are furnished integrally with the food. The lime salts enter bone, and those of potassium blood and muscle. Common salt, which is a part of nearly every tissue in the body, must be supplied artificially. Wild animals instinctively travel long distances to salt-licks, and the staring coats of domestic live-stock soon betray its need. It probably aids digestion, and also assists in the passage of fluids into the tissues by changing their specific gravity so as to facilitate osmosis. An extreme punishment formerly in vogue in Holland was to feed a condemned prisoner with only unsalted bread. Besides the inorganic salts, certain vegetable acids and their salts, insignificant in amount, are absolutely essential for health.

Fats and oils

Inorganic salts

Vegetable acids and salts

When lacking, as formerly at sea, occasionally with armies, and frequently with arctic explorers, the very serious and distressing disease of scurvy is induced. Men cannot live in health on salted food alone. Salted food is typically represented by beef or pork preserved by common salt and similar agents.* The vegetable acids from which the organic salts are formed are the preventives of scurvy, and must be supplied to maintain health. These are best found as lemon or lime juice, raw potatoes, tomatoes, onions, cabbage, and vinegar, and it is imperative that some of them should be used where fresh vegetables are wanting.

Scurvy

All the general classes of food must be represented in a wholesome diet as necessary for substantial health, although so simple a combination as lean meat and water contains the requisites. The essential dietary problem is to secure the proper proportion of each class of food at a practicable cost, and to make use of it without undue strain upon the animal economy. Thus one might live on bread alone and secure enough nitrogen, but in doing that he would overload himself with carbon. Or, confined to a meat diet he must digest four times as much nitrogen as necessary before getting enough carbon. That is, a man would require $6\frac{1}{2}$ lbs. of flesh, $4\frac{1}{2}$ lbs. of bread, or 15 lbs. of potatoes a day in the attempt

Limited diet

* Common salt has no connection with the organic salts of vegetable origin, and should not be confused with them, as is sometimes done by younger students.

to live on any one of them, and even supposing that he could digest the whole he would run risk of disease from the surplus. In starvation the non-nitrogenous substances go first. Thus, 97 per cent. of fat disappears against 30 per cent. of muscle and none of the brain and cord. For instance again, a bear in hibernation will lose all his fat, but his muscular system will be unimpaired. On the other hand, when a well-fed animal is given a very rich nitrogenous diet, all the nitrogen in the food reappears in the urine; that is, it is excreted even while fat may be accumulating. As the elimination of nitrogen in excess means extra labor for the organs concerned, it is very unwise to indulge in rich meat diets when the body is not using up its nitrogen by exercise. For the proteids sometimes go to waste easier than the fats. When built into the tissues they are much protected from oxidation, that is from being burned; but before being taken up, they are easily oxidized. They very readily go to waste, but only by the operation of some bodily organ. Should that organ be damaged by overwork, one or both of two results may follow. The organ—liver, kidneys, or what not—may be disabled; that is, we become ill with some disease of that organ. Or else the waste that should pass out of the body is retained and circulates within the system. For instance, much of the waste of the proteids, whether from the breaking down of our flesh in the ordinary course of life, or from the

Expenditure of elements

Elimination of nitrogen

Urea

direct decomposition of their excess in food, takes the form of urea, which is discharged through the kidneys but is nearly all formed in the liver. But if the liver is so disordered that it cannot make the urea, or the kidney so disabled that it cannot rid the blood of it, we are poisoned, either rapidly or slowly, as the disability may chance to be. The lesson for us is that even in health the function of the liver has a limit beyond which we should not trespass. We do more than merely waste food when we eat in excess of our requirements. Intemperance in eating does not affect the nervous system, like alcoholic intemperance, but it is not the simple condition of mere overflow, as so often assumed. The liver may be and often is damaged in its attempt to dispose of the surplus. An extreme example of what a good diet improperly used may cause is the artificially diseased goose-liver which appears on the table as *pâté de foie gras*. In man an alcoholic debauch develops an acute fatty liver. The alcohol, more readily oxidized than the natural fats, is burned in their place and a carbonaceous excess accumulates. All alcohol consumed in health beyond a very narrow limit has the same tendency; and when its consumption is habitual the internal organs suffer in increasing degrees.

Food intemperance

Alcoholic excess

The physiological value of food is measured in calories. The calorie is the standard of heat-production, and, as heat and work are convertible terms, a calorie expresses the complete

Calorie

combustion of a given amount of food, which thus develops energy. It is the amount of heat required to raise the temperature of one gramme of water one degree centigrade. The great or kilo calorie is the heat required to raise one kilo, or litre, of water one degree centigrade, or practically one pound of water four degrees Fahrenheit.

Without attempting to describe in detail even the ordinary articles of diet, emphasis is laid on this generalization: Strength may be developed by the sugars, starches, and fats, and the proteids assist in maintaining the bulk of muscle (which is the agent for the development of work); nervous energy involves the assimilation of nitrogen, which is found in the proteids; and a reasonably mixed diet furnishes both forms of food. Thus bread has a value of 1128 calories per pound, while beef has only 623, and eggs 739; so, weight for weight but not bulk for bulk, bread is a very valuable food. But the proportion of proteids to carbohydrates (starch and sugar) is too low to warrant relying on bread as a sole diet. Ideally the proportion should be 1 to 4.2; really it is 1 to 8.5, which, as already explained, would require four pounds of bread to be eaten daily, overloading the digestion with twice as much carbon and hydrogen as required.

Mixed diets

Bread is so important as to be worth individual discussion. It is the only article of diet in which there is no waste, and which never palls upon the appetite when one is accustomed

Bread

to its use. Its essential constituent is flour. Dough is flour mixed with salt and water, and bread is dough distended throughout its particles with carbon dioxide and cooked. Flour is the crushed kernel of wheat with the two outer husks, the bran, removed. Theoretically bran is very nutritious, because it contains 15 per cent. nitrogen, 3.5 fat, and 5.7 salts. But practically bran is indigestible. Its valuable material is not in a form that can be absorbed, and moreover it mechanically irritates the intestines and induces diarrhœa. Consequently the "whole flour" recommended by theorists is an unfit food. As a matter of fact the whole flour sometimes advertised rarely contains more than a moderate portion of the outer part. On the other hand the highest commercial grade of flour, the very fine and white flour from which all the husk has been discarded, is not as valuable as the grade technically known as "straight flour," which is the entire product of the wheat, less the refuse. That is, one should habitually eat neither very fine nor very coarse flour.

Heavy and hot bread

Two practical questions immediately arise. What is heavy bread, and why is it indigestible? And is or is not hot, or fresh, bread, including rolls and breakfast cakes, to be classed with it? First, what is bread? As just stated, bread is dough distended with carbon dioxide and cooked. Careful kneading of the flour with water surrounds each particle with an aqueous film. If baked in that condition, these particles would be cemented into a

hard and tough inedible mass. But when the dough is moderately heated, not only is the albumen in the gluten coagulated, but a part of the starch is transformed into dextrin, and carbon dioxide is generated from it and from the yeast or similar agent that has been added. This gas, the carbon dioxide, forces its way between the particles and separates them so that their digestibility is facilitated and the taste is improved. Bread is heavy when the gas does not sufficiently permeate it and it is imperfectly aerated. It is then a sticky mass to whose surface alone the digestive fluids have access and within which they cannot act. From its density it is literally as well as figuratively heavy. Conversely, bulk for bulk, properly aerated bread is light. Fresh or hot bread is not necessarily, but it is apt to be, heavy. Its mere temperature is immaterial, the objection to it being that in that state imperfect baking may conceal its degree of aeration.

As already said, bread alone is not an ideal diet, but it is a good "proteid-carrier," as it has been expressed, and except by the very poor its deficiency may be remedied by adding meat, cheese, or milk. Bread and skim-milk is a very nutritious combination, especially for growing youth. Stale bread is more nutritious, weight for weight, than fresh bread, because a part of the water has been evaporated. Toast is still more digestible; more water has been driven off and more of the starch has been converted into the soluble dextrin. Biscuit, from the pilot-bread of the sea to the crackers of the shop, is unfermented dough thor-

oughly kneaded, and baked completely but not burned. Bulk for bulk the hard bread of the camp, which is a variety of biscuit, is more nutritious than soft bread, but men do not thrive on it as well continuously. Corn-meal is, in this country, next most common to flour as a sort of bread. It contains as much nitrogen as flour and four times as much fat (6–7 per cent.) and is very nutritious. But it must be thoroughly cooked and cannot be forced upon persons unaccustomed to its use.

Potatoes

Potatoes are little but starch and water and consequently have narrow limitations. The starch is nutritious, but where potatoes constitute the sole food, as has been the case in Ireland, the best that can be said of them is that they are better than nothing. That is, besides a little cellulose, indigestible material which one might call vegetable gristle, in a thousand parts of potatoes 13 are proteids, 154 are starch, and the rest is water. The vigor of men fed on starchy food alone is trifling compared with those which absorb nitrogen abundantly, as is especially manifest in tropical countries where nature supplies it in abundance with an equal indisposition to severe labor.

Oatmeal

As has been suggested, the proteids are to be regarded as nervous food. Exhibitions of energy depend upon the nitrogen, which is contained in them alone. Such diet "makes for intellectual capacity and bodily energy" (Hutchison), and is found most concentrated in the flesh foods,

but not in them alone. Oatmeal is very nutritious when properly cooked. It develops, weight for weight, 130 foot-tons of potential energy against 87.5 for bread. This is due to the contained nitrogen, the same element that makes it stimulating for horses. Oatmeal gruel is extensively and profitably used by laborers on hard work, and should be serviceable for men under athletic training.

The value of beans and pease also lies in the contained nitrogen. Beans contain several times as much nitrogen as bread, but unless properly cooked they are indigestible and anything indigestible not only does no good but is harmful after it enters the stomach.

Legumes

Eggs contain very little useless matter and are particularly nutritious. Both the white and the yolk contain proteids of different quality, fats, and a considerable quantity of phosphorus, which has a special relation to the nervous system. It is a delusion that fish are peculiarly food for the brain. As others have pointed out: Fish contains phosphorus; the brain contains phosphorus; but no such syllogism can be constructed from those two premises. Milk contains nearly all the elements of food and is the one article of diet upon which alone life can be sustained. It is not a perfect food, and is better adapted for the very young than for adults, but skim-milk is a good source of proteids, and its deficiency in the carbohydrates is readily supplied by bread. It is a food quite as much as a beverage.

Eggs, fish, milk, cheese

A half-pound of cheese contains as much nitrogen as a pound of lean meat, and a third of a pound contains as much fat.

Sugar

Sugar has long been known as fattening, but popularly it has been considered undesirable, especially for the young. However, its value as a producer of muscle and energy is practically recognized in the habitual supply of molasses to New England farm-hands, and molasses is a staple for lumbermen in the northern camps. In fact the desire for sugar by men doing very hard work and by those imperfectly nourished often amounts to a craving. This has been illustrated on a large scale in the prodigious consumption of candy by armies in the field in South Africa and the Philippines, and on a small scale, but very effectively, by lads in training who were victors over non-consumers.* Herein practice has, until very recently, outrun theory. Now sugar is formally recognized as a source of energy, and this is confirmed by scientific experiment. An eminent student of the subject suggests that small cups of highly sweetened black coffee administered to the teams between the halves would probably be rewarded by greater endurance in the second half of match games. The writer has advocated considerable indulgence in sugar at the training-table, especially after weight begins to be lost. As a part of daily diet sugar is theoretically underrated. Children's instinctive desire

* In the Philippines the stout little native horses are regularly served with a ration of molasses.

and young women's admitted fondness for it have stigmatized its use by grown or growing men as childish, or at least effeminate, whereas it is but the gratification of a natural appetite. Where the taste has not been vitiated, in a degree by tobacco but chiefly by alcohol, sugar is as acceptable to the normal civilized man as it is to savages, and his disposition toward candy is no bad test of one's drinking habits.

Bodily heat

A secondary but important use of food is the generation of heat from its oxidation within the body, and the changes in cell life which its presence facilitates. When more heat is required, more food must be eaten; and as the fats break down the easiest, we instinctively eat more of them when it is cold. The mere act of living creates bodily heat, and we adjust our personal temperature to the surrounding air by the amount of heat lost by radiation. Thus, in the tropics we not only spontaneously alter the character of our diet rather than its amount, but we reduce our temperature still further by providing for its more rapid radiation by wearing thinner clothes, or none at all.

Water

It is impracticable in this connection to discuss all the details of diet; but its fluid elements should be considered. The so-called solid food carries with it much water in composition. This yields about one-third of what we actually require, so that besides that which we neither see nor think of as water we should take daily from three to five pints of it either directly or in the ordi-

nary table drinks of milk, tea, coffee, and the like. In scientific strictness water is not a food, in that "it undergoes no change, no chemical alteration in the body, and hence is not susceptible of liberating force. But it contributes to chemical changes by supplying a necessary condition for its occurrence in other bodies." It makes that solution of the food which is necessary for digestion; the tissues are bathed in fluid; and our secretions and excretions in great part escape in water. It carries the solid infinitesimal tissue-making particles all through the body, and it bears away much excrementitious matter. One dies of thirst much sooner than of hunger, and a bleeding man requires water more imperatively than any other non-surgical service. A man cannot live without water more than ten days, but he may go without food several weeks. As a rule we drink too little fluid, and many drink entirely too little at meals; but in this latter particular every one must develop his own equation. What is too much or too little for some is not enough for others. The limitation of water common at the training-table is designed to remove superfluous water from the muscles and thus to increase energetic quality. Enough water should always be taken to satisfy actual, not factitious, thirst. The common fear that water taken at meal-times interferes with digestion by diluting the gastric juice is unfounded. Experiment has shown that the presence of a pint of water has no retarding influence; on the other hand it materially assists in softening or dis-

solving some forms of food into a pulp for easier digestion. Simple water escapes from the stomach by gushes, at the rate of almost one pint every three-quarters of an hour; but hot water passes out more rapidly, and it also stimulates the movements of the walls of the stomach. Much of the water that holds food in solution, as soup, for example, is directly absorbed by the capillaries of the stomach. It is an error to take our drink too cold. The fashion of ice-water is purely a fashion, easily abandoned when ice is difficult to obtain. To flood the empty stomach with ice-water is not wise, for in real excess it may delay digestion a little. Distilled waters, which *a priori* would seem the very best, lie under the suspicion of irritating the lining membrane of the stomach when drunk habitually (Hutchison). Usually the domestic water-supply of an intelligent family is better than that to be found in promiscuous wells.

Tea and coffee

Much of the fluid we drink is an infusion of tea, and more is a decoction of coffee. It is their contained active principles that make what we drink at table more important than the question of their quantity. Both tea and coffee, besides their agreeable warmth and pleasant flavor, are gentle nervous stimulants with practically no reaction. The active principles of both are so nearly alike that caffeine may be taken as their representative; and this has been supposed to retard tissue-waste, but the latest experiments show that it tends to increase it. Tea and coffee are simple exciters of the nerve-centres,

accelerating, and at first strengthening, the heart's action and also the respiration, and increasing the secretion of the skin and the kidneys. In some persons coffee increases the action of the bowels, but in more strong tea, from its tannin, constipates. In excess both induce sleeplessness, headache, palpitation, tremor of the muscles, and impaired digestion. They are so active in their effects, and these are so mischievous, that they should not be taken on an empty stomach. Unless so weak as merely to flavor the water, it is impossible to drink enough of either beverage, day by day, to supply the requirement for fluid. When drunk at breakfast, coffee should be largely diluted, preferably with milk. For most, a small cup of black coffee after the evening meal assists digestion and also acts as a gentle nervous stimulant. But to drink, as sometimes undergraduates thoughtlessly do, large quantities of strong coffee for the express purpose of impelling the brain to wakefulness and study, is harmful and therefore wrong. Coffee does not create organic tissue-changes, as alcohol does; nor, like alcohol, does it lead to reaction; but, abused, it jars the nervous system into profound irritability, and in a few persons it acts as a cumulative poison. That coffee is the strongest known antidote to the lethal effect of opium is the most conspicuous evidence of its action on the nerves. "Because caffeine increases the heart's action and has a distinct medical value for such use, is the very reason why it should be taken with caution and moder-

ation where the cardiac action is already too vigorous."* Its great remedial value is the resistance it affords to the depressing effects of fatigue and of exposure to cold, where it is far and away in advance of any good that alcohol bestows. Water sipped as hot as it can be borne is effective to stimulate the brain for purposes of study. The local effect of the heat is to increase the cerebral circulation and hence the flow of thought.

Summary

To epitomize the subject of diet: An intelligent dietary is a mixed one, and contains a due proportion of nitrogen to furnish energy and of starch, sugar, and oils to furnish muscle for work and fat for protection, and, by its more rapid oxidation, to generate heat. Although meat is instinctively accepted as the typical nitrogenous food, there need be none if we are sure of plenty of beans, of fish, of cheese, of eggs, of bread from reasonably coarse flour, of nuts,—not all of these together, but some of them. Flesh is usually the most convenient form in which to secure the nitrogen, but it is by no means indispensable. A purely vegetable diet is more bulky, it tends to the increase of fat, and the energy it furnishes appears not to be as promptly available. The disadvantage of meat in excess is the heavy burden it throws upon the liver and the kidneys in disintegrating and disposing of its waste. As a rule we all eat too much, especially when not exercising vigor-

* Hygiene and Sanitation, p. 244. By S. Egbert.

ously. For those yet growing, milk most nearly approaches an ideal single diet. Bread and milk, or milk and oatmeal, cannot be excelled, excepting that as maturity is reached milk disagrees with some persons. It is an error to suppose that skim milk is poor milk. It has lost much of its fat by the removal of the cream, but the other valuable qualities remain.

Table

The table with congenial companions, sufficient time, and fair service should be one of the most attractive centres. It is a mistake from the point of hygiene as well as of good manners to sacrifice any one of these features. There should be opportunity for conversation and to eat at leisure. As previously pointed out, prolonged mastication means better digestion, less risk of excess, less immediate demand upon the blood and nervous force, and pleasant social surroundings facilitate the flow of the digestive fluids. Food should not be stinted. To eat enough and to have it of good quality is most important, especially while growth is in progress. However plain, food should be abundant, wholesome, and well cooked. The stomach is the last object on which to economize. Dollars saved at a table below the standard are dollars wasted. If retrenchment is necessary, it should take some other form of self-denial.

XV

Tobacco

TOBACCO has been so extravagantly praised and so fiercely denounced that prejudice for or against it is very common. This must be set aside, in whatever direction it may run, if the subject is to be studied on its merits. The active principle of tobacco is the alkaloid nicotine. In its pure state this is an exceedingly poisonous, volatile liquid, very soluble in water even as absorbed from the air, colorless, but rapidly turning brown on exposure, when a part is transformed into an allied substance, pyridine. Practically the effects of pyridine are identical with those of nicotine, so that the whole may be considered under the latter head. When nicotine is administered in increasing doses its more prominent symptoms are giddiness, nausea, vomiting, diarrhœa, prostration, trembling, convulsions, paralysis of the motor nerves, and death. Ordinarily, however, nicotine is not administered as nicotine, and the body receives it as incidental to the use of tobacco, in which it exists in varying degrees according to the quality of the leaf. Its range runs from one to nine

Nicotine and pyridine

per cent. The physiological influence of tobacco upon man is that of the nicotine, a powerful nervous depressant, usually taken in small individual doses. But it has occasionally been used by prisoners and others to induce vomiting, purging, and prostration, so as to feign serious illness and thus lead to transfer to a hospital and hence to escape from confinement after recovery from the acute poisoning. This is a hazardous ruse. Before anæsthesia, tobacco was sometimes used, as it yet may be when ether is not available, to induce the relaxation of faintness as an aid in reducing a dislocation.

Physiological effects

In other ways and in smaller amounts multitudes of people have used tobacco by smoking or chewing it, or as snuff, and with some this consumption has extended over many years and to a great extent without noticeable influence upon health. The establishment of toleration is one of the peculiarities of the nervous system, examples of which are found in the habitual use by some of enormous quantities of opium, of arsenic, and of alcohol, such as would overcome beginners. But freedom from observed results does not mean immunity from actual consequences. The nervous system is able gradually to resist increasing doses of many poisons, so that a particular effect only follows the use of multiple quantities. Usually this is at the expense of delicacy. Repeated shocks, especially when pleasurable, or repetitions of mere exaltation or depression, decrease susceptibility. More than that, habit creates a demand,

Toleration

a positive want, and this craving often becomes imperative and renders the victim miserable until it is gratified. Such gratification must be habitually renewed. The use of tobacco is a typical illustration of toleration and of craving. In the beginning there is distress, then endurance, then desire. Further, it is a fact that, with many, when the habit has been acquired tobacco smoked in moderation after meals stimulates secretion and aids digestion. Many also recognize that it soothes, promotes revery, favors mental and physical calm, and counteracts nervousness. In a limited degree it conserves strength where food is scanty, by diminishing the retrograde metamorphosis of tissue. In the face of its wide-spread use, practically over the inhabited world, it is absurd to say that tobacco is only a poison or that it is always morally wrong or physically hurtful. Like certain medicines, it surely has a place when the physical system is not equal to the demands upon it; but, unlike ordinary medicines, it cannot be administered without preparatory adaptation of the system to its deranging action. We may go further and say that, unlike medicines which build up, it creates its own special demands and thus must have a classification of its own; for even alcohol and opium may be taken in appropriate quantities without exciting repulsion at the very first. It has a tolerated, not a necessary, place among the auxiliary agents of daily life, over a very wide geographical range and among diverse multitudes.

Advantages

This is all that may legitimately be said in favor of its ordinary consumption, excepting that tobacco has a decided bactericidal action, so that when chewed it frequently stops the superficial decay of teeth, a condition depending upon the action of bacteria. Between the occasional aching of a tooth and the habitual chewing of tobacco, it is a choice of evils. As just remarked, it has exerted a wide sway over many peoples since it was found in America about three hundred and fifty years ago; but it is equally true that "individuals and nations have attained the highest intellectual and physical development without its use in any form, and that it is in nowise essential to the progress of the race." "It is positively injurious to the young, to those with certain diseases, to those with a marked susceptibility against it or who are highly nervous by disposition, to those unable to restrict its use within proper limits, to all who use it in great excess" (W. G. Thompson).

Toothache

The ways in which tobacco is harmful are these: The lining of the mouth becomes congested and feels dry, notwithstanding the copious secretion of saliva. The tongue may be coated, or be dry, red, and burning from the ammonia given off, not from the heat. In some cases the irritation goes on to actual ulceration. This ulceration, or any fissure, opens a way for the introduction of the virus of constitutional disease by any contaminated pipe or utensil. It is not alleged that smoking predisposes to such disease; that would be absurd. The asser-

Modes of harm

tion is that the frequent sores among smokers are channels for possible infection from numerous sources. There is no scientific reason to suppose that the irritation of smoking produces cancer of the mouth. But when from causes not yet understood there is predisposition to this malignant disease, it does appear to be focussed at the seat of such irritation. The mouth and throat are injured by smoking far more than by chewing. The volatilized products of combustion are more acrid and penetrating than are the juices merely pressed out by the action of the jaws, although probably the long-continued presence of a quid may act as a local irritant. The upper part of the throat (the pharynx) is habitually congested in heavy smokers, catarrh and hoarseness characterize smokers' sore throat, and a general disturbance of the upper air-passages is common and obstinate. Tobacco affects the action of the salivary glands, so that much water is lost, for many spit a great deal while smoking, and all do in chewing. Apparent, and sometimes real, thirst is increased, and what is more serious, the digestive quality of the saliva is impaired. It is easily understood how the excessive flow may weaken the quality. When smoke is inhaled, a part of it is absorbed by the lining membrane of the mouth and pharnyx, and also by that of the nose when passed through that organ, as well as by the lungs. The lungs themselves are not apt to be directly affected by tobacco-smoke, but persons with liability

Cancer

Smokers' throat

Inhaled smoke

to consumption have special need of pure air and normal heart action. Of course so far as the products of combustion displace the purer atmosphere they are negatively harmful, just as any other substitution of impure for pure air would be. As presently to be shown, the introduction of tobacco-smoke into the lungs favors its action upon the heart and nervous system.

In a sense the foregoing may be regarded as the superficial or mechanical effects of tobacco, the consequences of contact. But there are far more serious consequences, which depend upon the absorption of the hurtful principles, particularly of the nicotine. Osmosis leads not only substances in actual solution but also aerial mixtures, gases pure or combined, to pass through capillary membranes. If a part of the nicotine is dissolved in the fluids of the mouth, we may expect a little of it to be absorbed through that mucous membrane. It must be remembered that nicotine is exceedingly volatile as well as very poisonous, and that heat easily disengages it from the tobacco, so that along with other products of combustion it is a component of the smoke. Of its presence there the nausea of unaccustomed persons breathing an atmosphere clouded with tobacco-smoke is physiological evidence, for the fumes of ordinary burning vegetation have no such effect. Ocular evidence of the disengagement of nicotine is to be had from the stem of any cigar-holder, the bowl of any meerschaum pipe, the fingers of any cigarette-smoker. The brown stain is cer-

Nicotine absorbed

Evidence of nicotine

tainly not that of simple smoke. It represents nicotine driven off by heat, condensed and made visible by the absorption of moisture from the air. If all the nicotine were expelled into the outer air, it would be of no consequence where it might be condensed later. But in too many instances when smoke laden with nicotine enters the mouth it is also drawn into the lungs. Some smokers regard it as an accomplishment "to swallow the smoke," as it is called. It is a dangerous feat. The smoke is not really swallowed, it is inhaled, drawn into the lungs where it replaces an equal quantity of pure air. In this way a good proportion of volatilized nicotine enters, or may enter, the lungs. Were it not so, did all the nicotine remain outside the body, the visible stains would merely be an outward sign of one way of spending money. But while it is thus volatilized within the lungs a part of the alkaloid is taken up by osmosis into the blood through the delicate walls of the capillaries with which it comes in contact. For "the blood always absorbs such ingredients with great rapidity, and distributes them so as to produce their effects speedily." The nicotine as a vapor enters the blood through the capillary walls with perfect facility. Besides, a certain proportion of carbon monoxide, very different and far more poisonous than carbon dioxide, which acts directly and actively upon the blood as a disintegrator—it is the death-producing agent in poisoning from illuminating-gas—is also disengaged from the tobacco and absorbed. The special

Nicotine inhaled

Carbon monoxide

action of the carbon monoxide is to destroy the oxygen-carrying capacity of the red corpuscles of the blood. But although this gas is dangerous, the quantity of it disengaged is small. Much more important as an active disturbing agent is the nicotine itself. One of its effects is upon the vaso-motor nerves which control the calibre of the blood-vessels. The tendency of alcohol is to cause the capillaries to dilate, that of tobacco is to cause them to contract. "When a smoker drinks wine or spirits, he has been described as inducing a balance in the tension of his arterial circuit" (Richardson). That is, the effect of tobacco is to contract and of alcohol to expand the fine elastic blood-vessels, so that when nicely adjusted one would counterbalance the other. Such a balance is impracticable, and "in the end the nutrition of the organic parts, which are under the influence of the same nervous regulation, is sure to suffer and in many organizations rapidly and fatally" (Richardson). Besides this specific action of contracting the calibre of the blood-vessels, there are well-established general physiological functions attributable to tobacco, all operating through the nervous system, to be carefully remembered.

Nicotine and vaso-motors

Tobacco does not directly affect the brain, but its active principle does impair first the conductivity of the motor nerves and then that of the motor paths in the spinal cord. When under the influence of the alkaloid the nerves fail to excite muscular contraction, there follow weakness, inability to

Motor nerves

stand, depression of the respiratory movements, and finally death from failure of the respiratory muscles. Breathing ceases because the chest-walls no longer respond to the vital requirements. A person who smoked in one day fourteen cigars and forty cigarettes had paralysis of both legs and a copious discharge, probably from sheer want of tone, from the larger bronchial tubes (Axon). By causing irregularity of the nerve-supply it degrades the tissues generally, and it predisposes to neuralgia, vertigo, indigestion, and other disturbances of the nervous, circulatory, and digestive systems. That tobacco causes wasting of the great nerve that presides over sight is not true; or if at any time it might seem so, the condition is so infrequent as to be negligible. But very frequently its working power is interfered with, for tobacco is liable to render vision weak and uncertain, causing objects to appear nebulous, or it creates the sensation of floating spots and of similar subjective phenomena (Stillé). In numerous instances amaurosis—a defect in vision without change of structure—is induced, and sometimes buzzing, ringing in the ears, and hallucinations occur. One distinguished oculist reported thirty-five cases of amaurosis due to the continued irritation of the optic nerve by tobacco; and another asserts that when the sight fails with smokers and no appreciable change of structure can be found, tobacco-poisoning may be assumed. This reaches certainty when appropriate remedies fail

Irregularity

Optic nerve

Amaurosis

during continuance of the habit, and recovery follows the abandonment of tobacco (McSherry). Candidates for the Naval Academy rejected for defective vision have admitted the premature use of tobacco, and the Professor of Drawing at that institution has found that the smokers have an impaired muscular control which retards progress and efficiency, and he believes that he can invariably recognize the use of tobacco in a naval cadet by his tremulous hand in manipulating the pencil, and by his "absolute inability to draw a clean straight line" (Gihon).

Drawing

Decaigne asserts that it often induces an intermittent pulse, and that 21 out of 81 smokers showed such a pulse without there being any change in the structure of the heart to account for it. With the abandonment of the habit the intermittence disappeared.

Heart

Annually candidates for the Naval Academy have been rejected for cardiac disturbance, who afterward admitted using tobacco. When its use was allowed there, the annual physical examinations showed tobacco-hearts among those previously free. Stillé and Maisch, eminent American students of the general action of drugs, discussing the subject scientifically and without prejudice, wrote long ago: "Often there is a feeling of rush of blood to the head with vertigo and impairment of attention, so as to prevent continuous mental effort; the mind is also apt to be filled with crude and groundless fancies, leading to distrust and melancholy. The sleep is frequently restless and disturbed by dis-

General action

tressing dreams. It impairs muscular power and coordination by interfering with nutrition and by exhausting nervous force, and it usually keeps down the growth of muscle and the deposit of fat. . . . To the greater number the habitual use is more injurious than useful, and it acts upon a certain number in almost all doses as a poison." The abuse of tobacco does not cause all these disabilities in every case. But in a tobacco-consuming group every subject may have one or another of them.

Tissue-waste

Tobacco probably assists in arresting molecular waste of tissue, and on that account may be used by many adults, not only with apparent impunity but, under certain circumstances, with positive benefit—as, for instance, by soldiers on hard marches with limited food, and by underfed laborers generally. But that very action, the arrest of waste and the failure to utilize fresh material, is detrimental to the young by retarding the progressive changes upon which the advanced development of the body depends.

Mode of use

So far as the tobacco itself is concerned, a mild light cigar is the least likely to produce ill effects, but many smokers find that they can use clean pipes with less injury than any cigar. When pipes are used the stem should be long, to cool the smoke and condense the volatile products, and the bowl should be porous to absorb the noxious constituents—the coloring of pipes depends on such absorption. The better pipes have a small res-

ervoir which collects an oily distillate, and when a drop or two of that is sucked in from a dirty pipe it gives violently poisonous effects. A little of it may be confidently relied upon to kill a young child. In smoking either a cigar or a pipe, the last portion of the tobacco is the most active, because it has taken up in addition to its normal constituents part of the products of the earlier consumption.

Cigarettes

The discussion of the use of cigarettes depends for its force upon the innate constitution of tobacco itself. Bearing that in mind, it will be unnecessary to interrupt the account by explaining how the cigarette intensifies the ordinary effect of this drug. The habit of cigarette-smoking is chiefly mischievous from what may be called its conditions, but these are important and pernicious. The mere act of smoking a cigarette need not in itself be more harmful than smoking as much tobacco of the same quality in the form of a cigar. But, generally speaking, it *is* more harmful. It is not probable that cigarette tobacco is commonly, or even frequently, adulterated (although the charge is sometimes definitely made that the cheaper grades are filled with powdered stumps of smoked and discarded cigars), nor that the paper is soaked with narcotic drugs. Possibly certain grades may contain other narcotics somewhere about them, so that if sedulously searched for they may be found. But these, if they exist, are prepared for special customers well advanced in the drug habit and are not those ordinarily sold over the

Adulteration

counter. The possibility may be disregarded until established, for the nicotine itself is harmful enough to warrant every man, and especially every young man, abstaining from the practice when he understands the evil. The ill effects of tobacco pure and simple have been explained. It is recognized that the normal body is sufficiently elastic to react more or less completely from violence or prostration however induced, provided the attack is not distinctly overpowering and directly fatal. But the rebound is not always complete, and the more frequent and the deeper the depression the less and less easily is the normal plane regained. It is there where the habit of smoking does harm, and especially the habit of cigarette-smoking which is so easily acquired, and cigarettes are so rapidly, so completely, and so frequently smoked that they act by multiple continuous shocks. One may not recognize any individual blow, but inappreciably the body falls below the normal and only after a long time does the victim realize that he has lost ground. The custom of inhaling the fumes, although no necessary part of the process, is well established out of proportion to the same practice in cigar-smoking, and seems to be so necessary a part of the "form," that the two are inseparably connected in thought and nearly so in fact. As already explained, such inhalation is particularly detrimental, for the nicotine at once enters the blood. Obviously the younger the subject the more injurious the habit.

Depression

Inhalation

Tobacco in excess impairs digestion, it checks nutrition, it diminishes growth, and frequently it induces serious nervous disorders, as illustrated. Careful observers believe that the tendency of tobacco is to encourage the desire for alcohol, and Decaigne, the French authority already quoted, speaking of young smokers whom he had examined, says "they furthermore became dull, lazy, and predisposed to alcoholic drinks." As Richardson insists: "The young should especially avoid the habit. It gives a doubtful pleasure for a certain penalty. Less destructive than alcohol, it induces certain nervous changes, some of which pass into permanent modification of function." Without quoting authorities and accusations in more detail, Gihon's indictment against tobacco is cited and adopted: "An agent that has mischievously been represented to be innocuous only because of the remarkable tolerance exhibited by a few individuals is actually capable of potent evil; through its sedative effect on the circulation it creates a thirst for alcoholic stimulation; by its depressing and disturbing effects on the nerve-centres it increases sexual propensities and leads to secret practices, while permanently imperilling virile powers; it determines functional disorders of the heart; and it impairs vision, blunts memory, and interferes with mental effort and application." In the great Polytechnic School of France, now more than forty years ago, "a comparison between smokers and non-smokers showed that the non-

Desire for alcohol

General indictment

smokers took the highest rank in every grade, and further that the smokers continually lost grade, so that in 1861 the Minister of Public Instruction issued a circular order forbidding the use of tobacco in the public schools of France." It may fairly be added that its tendency is to lessen physical growth as well, to deprive in every way the growing youth of his full measure of development. That it trammels the physique is notorious, so that all those in training for severe physical exercise are required to abstain from tobacco, and those engaged in very delicate manual work learn that they must refrain. But it does more than merely derange coördinate action, it puts a limit to expansion. These figures, believed to be trustworthy, should appeal to undergraduates, representing as they do groups of similar character. At one of the large eastern institutions, taking the statistics for nine years during which time all the entering men were examined and measured, it was found that the smokers averaged fifteen months older than the non-smokers but they were less in stature. A reasonable inference would be that both their mental and their physical equipments were inferior to those of their abstinent comrades, or that, starting in childhood on a virtual equality, the use of tobacco had dwarfed them in both respects. During the four-years' course the non-users, notwithstanding they were taller on entering, gained in height 24 per cent. more and in chest-girth 26.7 per cent. more than the habitual users.

Trammels physique

Stature

Chest-girth

Assuming that they lived under substantially similar conditions in other respects, it again shows the restraining influence of this narcotic. At a smaller New England college the differences were even greater and the inequality in lung capacity between the two sets of men was very striking. To interpret the statistics as to mental attainment, whether that means capacity or not, is more difficult; but it is reported that at one of the American universities among the highest scholarship men only five per cent. used tobacco, while sixty per cent. of those who failed to secure appointments used it. There are too many other factors that should be considered to make this conclusive as to the mental state, but it certainly is suggestive and it establishes a strong presumption against the tobacco habit for undergraduates. To be possessed of such a habit is very serious. Like the user of any other narcotic, the habitual smoker finds, when deprived of his accustomed drug, that there arises a consuming desire, a longing difficult to be translated into words, which sometimes is practically overpowering and unfits him for work or for enjoyment until it is gratified. The tobacco habit has not the moral nor the physical consequences of the alcohol or the opium habit, but that it is distinctly harmful must have been made clear, and is to be remembered that it is insidious in its approach and powerful in its hold. Smokers who pass beyond the border-line of moderation and realize that they must stop often find them-

Scholarship

Craving

selves in a grip from which it is difficult to escape, or on an incline down which it is easier to proceed than to pause. Even youths and very young men once under its fascination who analyze their sensations and desires may find themselves very uncomfortable without cigarettes. When there is an apparent necessity, or at the least a desire, strong enough to interrupt, as is sometimes the case, the requirements of academic life and of social decorum, it is putting it mildly to say that the sufferer is not in good condition. Dependence upon, or indeed aid received from, a nervous stimulant or sedative, the name is immaterial, implies deficient natural vigor; and the sooner the artificial support is rejected and that vigor is recovered the better. It is earnestly insisted that, in the opinion of all competent judges, for growing youth tobacco, especially in the form of cigarettes, quite apart from excess, is always deleterious.

It appears to be sometimes thought that the cigarette —the little cigar—is diminutive in its ill effects as well as in its name. Smoked like a cigar, an individual cigarette might be so. But in practice the action of the tobacco in the two forms is unequal because of the mode of use, and of the two the cigarette is the more pernicious. Physiologically either is bad, and no young man wants to dwarf himself, to diminish his possible physical or mental development, or to become entangled in the coils of a habit to secure release from which is practically to fight with disease. It is not asserted that, because

Youth

the tendency is always to increased indulgence, the temperate use of tobacco is impossible; but it is iterated that any use of tobacco by the young does harm, although the signs may be delayed. The younger the use of tobacco is begun, the more liable is the habit of its use, a habit that nourishes itself, to be formed.

It is a characteristic of youth, which has its advantages as well as its disadvantages, to disregard consequences—but the consequences follow all the same, regardless of the state of mind. The recklessness of a life-saving crew and of a careless yachtsman or swimmer are very different in quality. The "don't care" feeling of mere bravado is simply a sign of weakness or ignorance. Because of this disregard of what may happen in the future it is the more difficult for youth to realize the danger or to appreciate the necessity for abandoning a practice which has its present fascination. A good part of some lives is spent in repairing damages; in other lives the damage goes on without repair. There are quite enough evils that befall us through ignorance or by misfortune, without increasing the number with open eyes. If it were a mere question of pleasure to be attained at some expense of standing, or if it were a temporary draft upon bodily power sure to be regained later, abstention might not be insisted upon. But neither is the case. The essential object of undergraduate life is to acquire an education as well as to absorb learning, and the two are not identical. For obvious reasons all students cannot attain the highest grades, and it is very well that many

should broaden themselves by books plus other exercises. But it is not well, and it never will be well, deliberately to pursue practices which limit the expansion and the acuteness of the growing mind and the full development of the physical frame. The less disposed one may be to accept these remarks, the more important it is that he should heed them.

Manliness

Although most boys learn to smoke, and learn through much tribulation because they think it is manly, it is hardly necessary to argue seriously that smoking is in itself no evidence of manhood or of manliness. It is no more manly to smoke than it is to swear; and both begin by imitation. The newsboys of large cities, the street arabs and wharf-rats in nearly every town, the untrained boys of weak or ignorant parents puff cigarettes wherever they can find them. But they do not become manly thereby. It more clearly marks them as degenerate. It is a common belief that smoking is practically universal in what is ordinarily called Society, and that the young man who does not smoke is peculiar—which with some is worse than being immoral. But smoking is not a social necessity, and critical observation of the habits of educated and gentle men may cause a revision of that estimate.

Custom

Solace in maturity

It is by no means contended that tobacco in real moderation is appreciably harmful to all whose physical development, not merely their stature, is attained. As already said, to the mature

man a cigar after meals or before sleeping, a pipe after a tramp or in the intervals of work, may be a physical solace and relief. But that is entirely different from the burden of this discussion, and even with vigorous men the weight of testimony is against not only its excessive but its common and indiscriminate use. Many and many a man has had to give up smoking when he could, or to lessen his indulgence in the direct interest of his health. A fair proportion of the alleged nervous breakdown from overwork, the neurasthenia or nervous prostration of modern life, is a consequence of the abuse of tobacco.

This presentation of the subject is impelled by no sentimental motive, by no partiality for asceticism. The fellowship that is implied in the social feature of a good cigar is very attractive. What has been said is based on scientific observation supported by incontrovertible facts, which compels the teaching that to use tobacco before full maturity is attained, that is before the age of twenty-five, except in extremest moderation after complete growth, is harmful, and that even after that period its excessive use is apt to be mischievous. It is one of the signs of the liberty of an educated and expanding mind resolutely to forego such indulgence during undergraduate years, when bodily vigor and mental force should be maintained without risk of depression or harm to either. It will be quite time to consider the cultivation of tobacco among postgraduate accomplishments when that period is reached.

XVI

Alcohol

PRECONCEPTIONS concerning the use of alcoholic beverages are so tenaciously held by many, and half-truths have so wide an influence on this subject, that the utmost care is necessary to avoid error in one direction or the other. Some believe that it is immoral *per se* to drink a glass of wine; others think that alcohol may properly be used to invoke a hilarious delirium at the cost of a succeeding temporary disturbance of the body, regardless of the accompanying danger and shame. Most non-experts, when unprejudiced, seem to regard its use short of intoxication as negative, so far as any lasting mental or physical effect is concerned. Its primary action on the nervous system tempts barbarians, ignorant of its secondary consequences; and inferior races are speedily destroyed by its free use. With our own race "strong drink" is frequently regarded as analogous to strong meat, and to be deprived of beer or spirits is sometimes thought a positive injustice.

Popular views

Influence over lower races

Strong drink

But statistics are cumulative that the expectation of life is greater among non-drinking people, and Mussulman armies show that alcohol is unnecessary for the greatest feats of courage and endurance. Alcohol is a narcotic, "a medicine which acts first to exalt the nervous system and then to depress it, and to have a special action on the intellectual part of the brain." Intoxication, literally poisoning, is "a semi-narcotic condition with physical and mental want of co-ordination, and the exhilaration and stimulation are stepping-off stones in the order of progress to narcotism." But, as with opium and strychnine, alcohol may properly be administered, even in very large quantities, in some states of disease. Moderate amounts have different effects in health as taken before or after work, or with or not with food, and according to their degree of dilution. In health moderate amounts of wine appear to aid digestion of meat and other proteid substances in the stomach. Larger quantities retard it. Malt liquors in excess retard digestion, because of the vegetable extractives present. Intoxicating doses of spirits reduce digestion one-fourth or one-third. Alcoholic beverages stimulate the flow of saliva promptly but briefly. In small quantities alcohol does not interfere with intestinal digestion.

Abstinence

Action

Intoxication

Legitimate medicine

Digestion

Taken moderately, latent energy is given off by alcohol through oxidation, as with starches, sugars, and

fats, and it may afford energy for muscular work. Four parts by weight yield as much energy as seven of sugar, starch, or protein, or three of fat. Heat is yielded in the same way, but whether it yields muscular energy is still uncertain. It has been supposed that all the energy furnished is wasted by radiation, but the effect upon bodily heat developed by the maximum permissible quantity a healthy man may take is nothing either way. That maximum quantity within twenty-four hours is half a bottle of claret, four glasses of beer, or three ounces of whiskey well diluted and taken only at meals. Should it all be taken at once or ordinary intoxication be induced, there would be dilatation of the vessels of the skin, greater perspiration, more radiation and consecutive fall of temperature. In dead-drunkenness the heat-controlling nervous centre is depressed and the production of bodily heat retarded; this, with the increased radiation, lowers the temperature several degrees. Hence exposure to extreme cold easily destroys life, for the natural heat of the body is lowered while its power of resistance to cold is lessened. The subjective sense of warmth that follows drinking a little alcohol depends on the capillaries of the skin being dilated near the sensory nerves, so that as more blood is drawn to the surface from the interior the nerves recognize the additional superficial warmth—but it is a mere transference of internal warmth to the skin.

Energy

Heat

Resistance to cold

As stated, alcohol has qualities under certain circum-

stances that belong to food; but it is not the best food, and beyond very narrow limits it creates pernicious conditions. Still, when acting as food the various exhibitions of energy proceed in an orderly way and neither antagonize each other nor take on irregular forms. The important difference between starch or sugar and alcohol as food is that the former may be taken up to the limits of digestion and assimilation, but the latter acts upon the nervous system in health so peculiarly that it is impossible to take enough to be of any nutritive value. But in certain conditions of disease large quantities of alcohol are not only tolerated but sustain life through a stimulating and a possibly nutritive effect. The foregoing states the whole case in favor of alcohol as nutriment. Its potential food-value lies within three or four glasses of highly-diluted whiskey or as many glasses of beer, taken with meals in the course of twenty-four hours by fully developed men, and it only considers its possible nutritive value under very favorable conditions. Some authorities limit the permissible amount to a glass of wine, or a pint of beer, in twenty-four hours.

As food

Limit

Alcohol, habitually or occasionally, is no more required by the ordinary man of twenty-five than by the boy of fifteen. Its use in health only disturbs health, leading to numerous diseases some of which, of course, may also depend upon other causes, nor does any individual suffer from the entire catalogue. But so much ill health ultimately depends upon alcoholic indulgence

General morbific effect

that the habitual drinker both lays the foundation for serious disturbance and steadily builds upon it.

Does its limited nutritive feature allow a man with insufficient food-supply to do more work, or a tired man to put forth renewed exertion? Small quantities of spirits may act as supplementary fuel-food, but it is more expensive than ordinary food and dangers accompany it. **When underfed or fatigued**

To incite to renewed exertion when fatigued, is another question. Fatigue involves both nerve- and muscle-cells; chiefly the former, which become exhausted first and recover sooner. Thus, staleness from overtraining is a relative exhaustion of the central nervous system. The sense of fatigue, distinct from the cause of fatigue, depends upon the circulation in the blood of the débris of broken-down cells, and neither alcohol nor anything else can remove that débris from the blood. However, certain excitants call to renewed action moderately, or even greatly, exhausted nerve-cells, and that without reaction. Without reaction merely means without a subsequent depression due to the agent itself. It does not mean without adding to the sum total of fatigue on the completion of the work, for the wear of the vital machinery is one measure of the work done. Excitants do not re-create nerve-cells nor increase their number or their vital capacity, but some extract from them remnants of force without, by their own nature, pulling back again. Alcohol, on the other hand, which has reaction, is not one of these. Moder- **Fatigue** **Excitants**

ate amounts of alcohol assist immediately and temporarily in muscular work. This is promptly and invariably followed by retrograde action, so that the minimum is reached in about half an hour, after which more alcohol shows again a slight temporary stimulation. This consecutive paralysis overbalances the primitive excitement, and the aggregate work done under alcohol is less than that done without it and would be represented by the minus sign. Not taking account of accuracy, work involving no severe muscular draft is less; but, in general, moderate indulgence in alcohol injures the quality as well as diminishes the amount, of which there is accumulated evidence ranging from the experience of typesetters and telegraphers to that of navvies and heavy diggers. This seems attributable to its action on the central nervous system. Alcoholic loquacity and display of emotion are not to be confounded with true stimulation. Foster and Shore, eminent physiologists, summarize the effect of alcohol on nervous efficiency thus: A small amount may promote the action of the central nervous system and appears to quicken thought and excite the imagination; but usually, and always in excess of small quantities, it diminishes the power of concentrated thought and judgment. It diminishes susceptibility to sensory impressions, and blunts all the special senses. As it reduces the sensibility to cold and fatigue and allays mental stress and worry, it is often resorted to under such conditions and always with great danger.

Alcohol in muscular work

Foster and Shore on alcohol

When alcohol is said to affect the brain, we mean that it causes a more rapid flow of thought, then loquacity, unusual exhibition of emotion, suspended judgment and uncontrolled passion follow, and finally there is no response to sensation and no motion but the automatic action of the lungs and heart. Occasionally these movements also cease; but even while life is technically present, the mind is overpowerec and the body paralyzed. The most immediate and striking action of alcohol is on the brain. Even the moderate use of wine induces psychological changes, although not noticeable by any except the closest observers of their own mental states. The essential motive for drinking alcohol is to affect appreciably the nervous system, not to quench thirst. "The reason for craving alcohol is that it is an anæsthetic, even in moderate quantities. It obliterates a part of the field of consciousness and abolishes collateral trains of thought" (W. James). Four-tenths of one part per thousand (.0004) of body-weight noticeably affects the brain. That is, a trifle over half a pint of wine containing ten per cent. alcohol will induce in a person weighing 150 lbs. sufficient cerebral change to be studied. A much smaller quantity in one unaccustomed to its use occasions alteration appreciable to his own consciousness. Simple reaction-time is shortened by moderate quantities of alcohol, but processes that involve working up concepts are not facilitated. Ability in memorizing and adding figures

Successive effects of alcohol

Action on the brain

Quantity

Psychical effects

decreases. Eye measurements are distinctly depressed by a bottle of wine. Large quantities diminish acuteness of smell and touch. "Alcohol tends to lessen the power of clear and consecutive reasoning, and its action on the higher centres resembles fatigue of the brain, although associated with greater motor energy and ease." Under the influence of good wine "restraints are removed, too acute sensibilities are blunted, little acerbities are smoothed down, ideas and mental images follow each other with greater rapidity, there is a cerebral sense of richness, and lastly a condition of euphoria, a more serene state of consciousness, ensues." It is open to grave question whether such temporary serenity is worth certain accompanying risks, presently to be explained. But even this serenity is not attained by all. A man of the explosive type who drinks acquires motor energy and ease through the absence of scruples, of consideration of consequences, and in the extraordinary simplification of each moment's outlook. As James expresses it, the inhibitive type of mind is turned into the "hair-trigger" type. Larger quantities cause a lack of emotional control, affect the power of attention, clear judgment, and reason, lower the acuteness of the senses, and frequently anæsthetic action leads to all the phenomena of intoxication, ending in drunken sleep.

Removes restraint

One school of psychologists regards the primary action of alcohol as depressant for certain higher and more easily influenced brain-processes. In that view

alcohol paralyzes the central inhibitory mechanism. As Professor James expresses it, "inhibition is an essential and unremitting element of our cerebral life." In more homely phrase, the brakes are always on. Now if some of these inhibitory functions are weakened or paralyzed before other qualities are enfeebled, a loss of the finer shades of restraint is an early consequence. The nominal excitement thus becomes merely incoördination of the psychical activities. With the balance-wheel impaired the works run irregularly. As its anæsthetic quality removes the normal restraints of reason and the activities of speech and gesture are freer and less hampered, it is superficially assumed that the brain is "stimulated." The subject's own self-deception points to its paralyzing effect. That is, the stimulation is "fictitious and is in reality due to the removal of the barriers of self-restraint by the paralysis of the higher functions." It is of little consequence whether we call the route by which they are reached stimulation or depression, if we keep in mind the actual results. Alcohol certainly removes the curb over certain propensities; we must hope that it excites others. If not, if the terrible examples of brutality, of heartless cruelty and ruffianly licentiousness, as well as the minor violations of social decorum that it leads to, are merely the escape of the natural man from his keeper, are simply normal passions with relaxed restraint, we well may look upon ourselves with horror.

Depressant action

Paralysis of inhibition

Liqueurs and cordials, primarily after-dinner drinks in certain circles and gradually coming into greater vogue, are strong alcoholic preparations flavored with vegetable extracts, sometimes sweetened, and frequently colored. Of these absinthe and maraschino are typical illustrations. Absinthe is particularly perilous. It contains, according to its variety, from 47 to 80 per cent. of alcohol, and it derives its special character from the oil of wormwood and other aromatics. The coloring matter also is occasionally hurtful. The great proportion of alcohol is necessarily deleterious, but the aromatics, especially the wormwood from which it derives its name, act directly upon the nervous system and wreck it in a distressing way. With all of these, hallucinations commence sooner than with the use of mere alcohol, but absinthe in particular disintegrates the nerve-cells and predisposes to epileptiform disorders. The mischief of an ordinary drink of brandy is so much intensified in absinthe that comparison can scarcely be formulated. The absinthe habit, which seems to be peculiarly enticing, is recognized in France as so disastrous that to drink absinthe is absolutely prohibited in the army, and associations exist to discourage its use in civil life. Young men are liable to take the after-dinner cordial as a tribute to polite custom, ignorant of the extraordinary and increasing harm every such indulgence may inflict. We may hope that it is offered in equal ignorance.

Liqueurs

Absinthe

The explanations presented for both the harmfulness

and the innocuousness of alcohol are sometimes more sentimental than scientific. One group denounces it as a constant and invariable poison, in any amount and under all circumstances. Another maintains that a pure liquor may be taken habitually in considerable quantities, not only without harm but usually with advantage, and that the evil is entirely due to adulterations. The quality of being poisonous is usually an accident of its conditions rather than an essential attribute of any substance. There are conditions under which every drug commonly classed as poisonous may be used with beneficial, rather than injurious, results. An alcoholic beverage honestly made, sufficiently diluted, and taken at a seasonable occasion and in a proper amount cannot be regarded poisonous in the common use of the word. Further, adulterants, in the sense of deleterious substances intentionally added, are rare, even in the low-grade liquors sold over the commonest bars. But impurities from irregular distillation are common and harmful. Thus toxic alcohols, that is others than the ethyl alcohol which is the basis of the commoner beverages, from badly rectified spirits, collectively known as fusel-oil, may be dangerously present, although less prevalent than generally supposed. Spurious liquors, made outright from diluted alcohol, flavored with essences and colored with vegetable matter, usually contain nothing more injurious than the alcohol itself; and although the "essences" may sometimes be hurtful, the liquors themselves

Essential character of alcohol

Poison

Adulterants and impurities

are generally freer than genuine brandy or whiskey from the products of the higher distillation. There is a recent contention that, in its eagerness to get as much spirit as possible, modern distilling disintegrates the grain so completely that under heat and acids furfural (from the husk of the grain) and other aldehydes pass over. It is supposed that the real advantage of the older over the newer grades, of the output of the individual still as against that of high-pressure money-making establishments, is that they contain less of the products of extreme decomposition, and that alcohol from which furfural is removed is free from the pernicious agents found in that in which it remains. This view is not sustained by all investigators, for some hold that, whatever its character, the proportion of furfural, at least, is so small as to be negligible. However if the furfural hypothesis is correct it is possible that, notwithstanding the low range of fusel-oil proper, the cheap genuine whiskeys are intrinsically hurtful beyond the action of the alcohol itself.

Furfural

But in its broad effects the drink evil, whether for one man or a community, depends not upon possible adulterations but upon the abuse of ethyl alcohol, the ordinary intoxicant of the common beverages. The objective evils of drunkenness are so patent that they require no rehearsal nor explanation. But there is much ill health to which alcohol is a contributing or an active cause whose origin is not popularly appreciated. Thus Bright's dis-

Alcohol a cause of disease

ease, or congestion of the liver, or a variety of neuritis, may be reported as a cause of illness without distinguishing whether it has an alcoholic or a more innocent beginning. Practically alcohol is taken as a beverage simply to alter the range of emotional life. As already observed, "it is an anæsthetic. . . . It obliterates a part of the field of consciousness," and manifestly this occurs by its direct action on the nervous system. During acute intemperance it is probable that an actual change takes place in the nerve-cells themselves, although this has not been demonstrated. Fortunately they regain their normal state after recovery from an occasional drunken attack; but it is easy to believe that with each renewal of the strain they become more and more unstable and less and less capable of fulfilling the requirements of healthful exertion. This special affinity of alcohol for the nervous system is notorious, ranging from the flushed face of vaso-motor disturbance, through the loquacity of lost self-control, to the delirium and shameless stupor of the final stage. These aberrations increase in range with repetition, and the instability of the nervous centres becomes greater and greater. Such indulgences rarely induce insanity or even epilepsy in perfectly normal persons, as sometimes charged; but there "remain cases enough in which alcoholic poisoning *is* the cause of serious disease of the brain, spinal cord, and nerves in persons of previously normal constitution." Besides the more conspicuous consequences, of which delirium tremens and inflammation of the

Action upon nervous system

nerve-trunks (neuritis) may be taken as illustrations, there are conditions depending upon closely allied nervous changes, among which, not to make an exhaustive list, are thickening of the membranes enclosing the brain, wasting of the folds of the brain itself, brittleness of the arteries, and increase of the neuroglia in the superficial layers with consequent compression of the brain-cells there. If the brain deteriorates, the mind whose agent it is suffers. But, besides,

Toxæmia

closely dependent upon prolonged alcoholic indulgence is a toxæmia, or poisoning of the blood, due to that excess, so that the intervention of an acute disease like pneumonia, surgical shock or accidental injury, tuberculosis, privation, or some similar accessory cause, may disturb the balance and a crash follows. The character of the nervous change

Nervous change

may be illustrated by the different consequences to the vision that occasionally, by no means uniformly or even frequently, follow the abuse of tobacco and of alcohol. Tobacco may induce amaurosis, a loss of sight from functional causes, which passes off after cessation of the indulgence. The damage by alcohol is a positive change in the nerve itself, which abstinence does not relieve.

As just intimated, the habitual use of alcohol is responsible for much sickness as well as for many

Pathological action of alcohol

deaths. For example, one of its effects is to render the coats of an artery brittle. Now when a brittle artery in the brain snaps, apoplexy occurs. The cause is lost sight of in

the effect. Nor should we confuse minor with general conditions, for alcohol does not damage the arteries of all any more than all apoplexy is due to alcohol. For a recent period of twelve years, when recognized as a contributing cause of death alcohol has been thus noted on the mortality reports of Switzerland, which is classed as a country where its use is moderate. During this time the percentage of men over twenty years of age dying from its direct or its indirect effects has been ten. One man in ten of those who died, died of drinking habits; and it is easily supposable that the natural disposition to conceal such a cause in certain social grades makes this a minimum report. It is not creditable to drink oneself to death, even indirectly. But "alcoholic diseases are not limited to persons recognized as drunkards." An increasing number of cases of disease of the circulation, of the kidneys, and of the nervous system are being reasonably attributed to this cause in persons who never became intoxicated and who have always been regarded by themselves and by others as "moderate drinkers." There are no trustworthy figures of the frequency with such minor indulgence causes disease, but it is only natural to suppose that, if the direct mortality is so great, the incidental non-fatal morbidity must be very considerable. It is well established that those whose occupations tempt them to drink have a higher mortality, and we may believe a higher sick-rate, than others from diseases of the liver, kidneys,

Swiss statistics

Moderate drinking

heart and blood-vessels, and the nervous system, and indeed a higher general mortality. The evidence that alcoholic excess injures the kidneys is very strong. This is true of beer as well as of spirits, and the beer-heart and the beer-kidneys are apt to go together. The arteries gradually harden, and fat forms in excess not only on the surface of the heart, but, which is more dangerous, between its fibres. Sometimes general alcoholic obesity interferes with the heart's normal action. The disturbance of nutrition which leads to the obesity of alcoholism is most common in the drinkers of malt liquors, and sometimes not only is the liver loaded with fat, but an excess of fat appears in the drunkard's blood. Fat beyond the need of the system is not a sign of health, and certainly fat in the blood is out of place. Unreasonable beer-drinking gives one its signs in the full, rounded, frequently flushed, face, often with a peculiar glossiness, which represents precisely the reverse of the robust health that generally it is supposed to mean. The plump, smooth skin, like a child's, but without a child's delicacy, too full especially about the cheek-bone and the lower jaw, puffy as closely observed, means more than the beginning of a change. The inveterate beer-drinker, frequently gross and unwieldy in body and often dull and irresponsive in mind, is an unmitigated nuisance to others, and his more important internal organs gradually deteriorate. The wine-drinker, and often the beer-drinker, is in the end apt

Alcoholic obesity

Beer-drinker's face

Beer-drinker

to become the spirit-drinker also. The languid, imperceptible, and progressive changes from the normal increase, while they mask, the evil. The best-known of the slowly arriving penalties is gout, usually laid upon the next generation as well; but gout is relatively harmless, as compared with the insidious undermining of the system at large.

Secondary effects

The moral side of the question, whose deplorable evils deserve serious attention, is no part of this discussion; but physically the periodical, not the habitual, drunkard is—excluding risks of violence—less liable to damage his health permanently than the regular moderate drinker. He who plunges into an occasional wild and senseless drinking-bout and is abstinent in the interval (always excepting the great risk from violence and the disgrace that he inflicts upon himself and his friends) has a better prospect of comparative health than the other whose daily dram, gradually increasing under whatever name or by whatever excuse, besides inaugurating physical degeneracy, handicaps his organs against those diseases which, at one time or another, are the common heritage. Grave nervous complications suddenly arise in alcoholics under the coöperative influence of pneumonia, injury, surgical shock, privation, and some other conditions. And by "alcoholics" is not meant merely obvious drunkards, but those who, day by day, under the pretence of fortifying themselves, are really weakening their powers of resistance by the ingestion of alcohol. The drinking

Periodical drinker

habit distinctly lowers the power of withstanding many infectious diseases, as shown in both the increased liability to contract disease and the greater severity of the disease itself. Those attacked with pneumonia, erysipelas, cholera, infectious dysentery, and other communicable affections, among which typhoid fever should probably be included, have a smaller chance of recovery. It was formerly supposed that the free use of alcoholic drinks afforded a degree of protection against contracting tuberculosis and substantially aided in its treatment. Alcohol not only affords no protection against, but it appears to increase the predisposition to, consumption. Not that it directly induces that disease, but it so diminishes the resisting power of the body that the bacillus when introduced is less easily destroyed. Certainly in alcoholic patients its course is often more rapid than in others.

Influence on disease

In tuberculosis

This chapter refers to the use of ethyl alcohol in its various forms as a beverage. It is important to emphasize the fact that wood alcohol (methyl alcohol), extensively used in the arts, is a deadly poison, immediate in its effect, so that in justice to the community, especially to those ignorant of the distinction, every container of it should be distinctly marked POISON. Frequent deaths occur from its being drunk by those who do not know its true character.

Wood alcohol

Ordinarily when the physical changes induced by an article of food or drink are discussed, the subject is

ended. But in relation to alcohol the influence of habit, not only the ease with which nervous action repeats itself but the tendency to such repetition, must always be remembered. This repetition is not limited to thoughts or emotions, but it extends to conditions based upon the pleasurable excitation of certain nervous areas. Now the drink-habit, whether of beer or whiskey, is founded upon no natural impulse, no spontaneous desire. The craving that maintains it is purely artificial and rests upon no normal physical demand. As previously explained, alcohol is essentially a narcotic, and like all narcotic habits this constantly seeks further indulgence. No healthy person requires alcohol any more than he needs opium. The essential point is that the very narrow limit within which the body can legitimately use alcohol is soon passed, so that dependence upon it and craving for more constantly press toward greater indulgence. This is particularly true in the plastic period of life, which for the nervous system extends beyond that for the bones and the muscles. Very few understand their own limitations or can be sure not to exceed them, and no youth before he yields to temptation knows how easy it is to fall. "All men are mortal—except ourselves." Others may become drunkards, but we will not. Nevertheless every drunkard, and especially every man weakened by drink, becomes such only after he has begun to drink. The doctrine, sedulously maintained by a certain class seeking an excuse, that "abstinence from

The drink-habit

Proneness to grow

fear of excess argues a defective moral power and is a species of cowardice," is false. As a rule, less strength of mind is exhibited in drinking, that is in yielding to inclination or persuasion, than in refraining. There are innumerable illustrations of youths, so taught at home, doubtless in good faith, by parents possessed with an undue confidence of self-control, who constantly recruit those ranks of the ultimately infirm. Some, alas women as well as men, condone occasional alcoholic dissipation as evidence of animal vigor, as a sign of spirit, and look with forbearance, if not with pride, even upon their sons and their brothers who allow the demands of so-called good-fellowship and vital energy to overpower the mind and sicken the body. No one whose years are many but may recite a long list of those who began to drink during the newly-acquired freedom of undergraduate days, possibly encouraged by moderate example at home, and afterward filled unhonored graves. Almost every one can call to remembrance families distressed in various ways by the consequences of alcoholic intemperance, always from inconsiderable beginnings, and to some that distress may be nearer at hand. It is sadly true that few escape such a blot, either upon their living or upon those not long dead. It becomes every young man, above all every educated young man upon whom the responsibility of example also rests, not to add to the number.

Some offer for themselves, some present for others, as an excuse the plea that heredity has set its stamp so that the sins and weaknesses of the fathers rest with

the children. It is a false plea. If a young man suspects that he has inherited an unstable nervous organization, one poisoned by this subtle venom, it is by so much his graver duty to avoid the slightest risk, both for his own sake and for those who may come after him, as well as for those to whom he is bound by the ties of interest and affection. If one has a friend with such an ancestral strain, he should not add temptation to that burden. Still less may those in positions where authority and example carry weight, by offering the example or presenting the invitation to youths whose bodily, mental, and moral habits are in the determining stage, risk setting in operation that singular nervous law of habit and desire. Beer and wine open the road to spirits and further peril. No one, comrade or Lost, can know the vital history of all his acquaintances, nor against what they have to contend; and he has no right to risk spreading a net, even without intent, before uncertain feet. We are our brothers' keepers.

Heredity

Index