

AN  
ANALYTICAL OUTLINE OF  
PHYSIOLOGY  
AND HYGIENE

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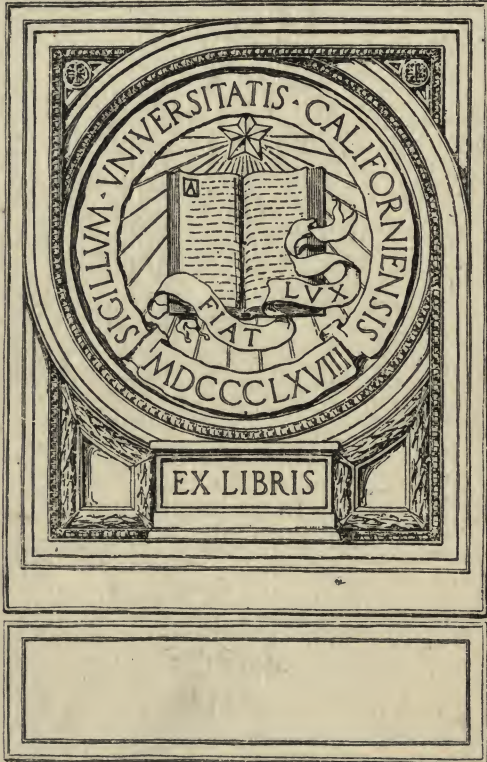


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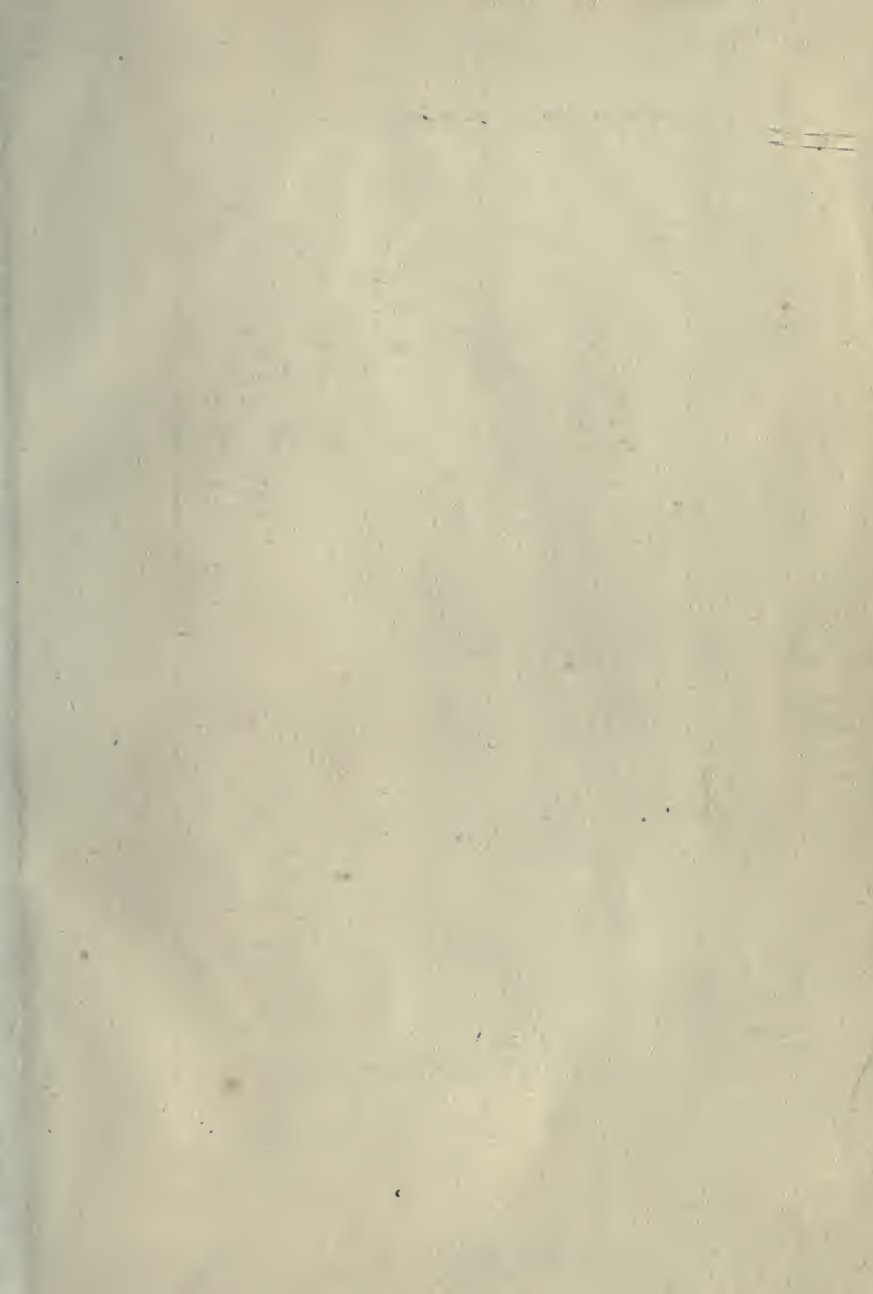
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# An Analytical Outline of Physiology and Hygiene

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DESIGNED TO SIMPLIFY THE STUDY OF THESE IMPORTANT SCIENCES

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*To cure was the voice of the past  
To prevent, the divine whispering of to-day*

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To  
*Those Physiology Classes with which  
the Author has labored for  
Sound Minds in Sound Bodies.*

284525





## PREFACE

Reuben Post Halleck, in his admirable little book on "Psychology and Psychic Culture," says: "Whenever we can discover any relation between facts it is far easier to remember them. The intelligent law of memory may be summed up in these words: Endeavor to link by some thought relation each new mental acquisition to an old one. Bind new facts to other facts by relations of similarity, cause and effect, whole and parts, or by any logical relation, and we shall find that when an idea occurs to us, a host of related ideas will immediately flow into the mind."

And in line with the same sentiment are these words of John Stuart Blackie: "Nothing helps the mind so much as order and classification. Classes are always few, individuals many; to know the class well is to know what is most essential in the character of the individual and what burdens the memory least to retain."

With a conviction that these statements express a truth with which all successful teachers are familiar, the author of this volume takes pleasure in presenting to teachers and pupils this classification and correlation of the leading facts of physiology. A work of this nature offers small opportunity for any originality save in the method of arranging, presenting, and showing the relative worth of the data selected from our best authors on the subject in hand. With this much of originality, and with an endeavor to collect and condense the latest and most pertinent facts of the subject, the author presents this work in the belief that his endeavor will aid all who use the volume to eliminate much of the waste of time and energy that often attends the study of this as well as of other subjects.

The sources from which most of our material has been derived are indicated in the correlated readings at the end of book.



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## 3' Care of war victims:

a' In *Spanish American War* (lasting about four months), where the sick were inadequately cared for, the loss was ten men by disease to one by bullets.

b' In *Russo-Japanese War*, where Japanese soldiers were carefully cared for, only *one-fourth* as many died from disease as in battle.

4' Plagues: By learning how to prevent and how to treat contagious diseases more successfully we have put a stop to flight into the wilderness to escape such plagues as cholera, yellow fever, black death, smallpox.

II. THE ORGANISM OF THE BODY: The different organs or parts, with separate functions but mutually dependent, essential to the life of the individual. It is made up of millions of

1. **Cells:** The living units of the organism, and subject to a controlling influence:

a. *Material:* protoplasm; the physical basis of life.

b. *Structure:* complex.

1' Cell wall.

2' Nucleus.

3' Nucleolus.

c. *General functions:*

1' Absorption.

2' Assimilation.

3' Excretion.

4' Reproduction.

5' Growth.

d. *Kinds of cells:* as many as there are kinds of tissues.

e. *Kinds of organisms:*

1' *Unicellular*, as ameba.

2' *Multicellular*, as man. This arrangement makes possible

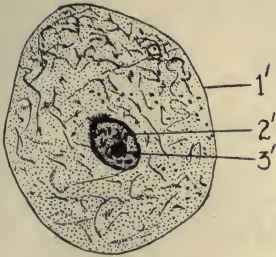


Fig. 1.—Cell.

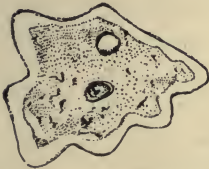


Fig. 2.—Amoeba (unicellular)

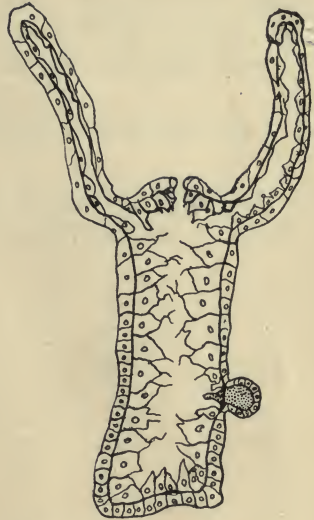


Fig. 3.—Hydra (multicellular)

CELL FORMATIONS  
(Highly magnified)

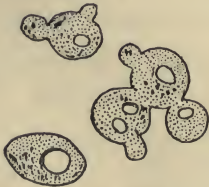


Fig. 4.—Yeast Bacteria (p. 9)



Fig. 5.—Disease Germs (p. 9)

BACTERIA  
(Highly magnified)





a' Division of labor, whereby the body is able to have several systems, each highly specialized, and each having a special work to do.

f. *Intercellular material*: lying between the cells in all tissues.

**2. Tissues:** Orderly groups of certain kinds of cells collected and held together to perform certain kinds of work.

a. *Kinds of tissue*:

1' Epithelial.

2' Muscle.

3' Gland.

4' Blood.

5' Nerve.

6' Fat (adipose).

7' Supporting.

a' Bone.

b' Cartilage.

c' Connective.

b. *Functions*:

1' Building materials: they *form* the body.

2' Working materials: they supply the *means* by which the work is carried on.

**3. Organs:** The different parts of the body; each of which has a special work to do.

**4. Systems:** A number of organs working together for the same purpose.

a. *The chief systems are*:

1' The digestive system.

2' The circulatory system.

3' The respiratory system.

4' The muscular system.

5' The nervous system.

6' The excretory system.

**5. Chemical Composition of the Body.***a. The chief elements:*

- 1' Oxygen.
- 2' Carbon.
- 3' Hydrogen.
- 4' Nitrogen.

*b. Sources of supply:*

- 1' Food.
- 2' Air.
- 3' Water.

**6. Metabolism:** The life processes.

*a. Anabolism:* the building up.

*b. Katabolism:* the tearing down.

*c. Metabolic equilibrium:* constructive and destructive processes going on at the same time.

## CHAPTER II

### FOODS AND FOOD HABITS

I. FOOD SUBSTANCES: These may be classified as

**1. Organic Compounds:** consisting of (*a*) proteids and (*b*) carbohydrates and fats; the former the nitrogenous, and the latter the carbonaceous substances.

*a. Proteids:* the tissue builders; derived from both animal and vegetable sources. The principal forms are:

1' Albumin: in eggs.

2' Myosin: in meat.

3' Casein: in milk and cheese.

4' Gluten: in wheat.

5' Legumen: in beans.

a' Chief sources of supply:

1'' Eggs; poultry; lean beef; lean mutton; cheese, milk; beans, peas; peanuts; oatmeal; cornmeal; wheat flour.

*b. Carbohydrates and fats:* the heat and energy producers.

1' Carbohydrates supply:

a' Sugar: found in most fruits and vegetables, and in large quantities in sugarcane, beetroot, honey.

b' Starch: in all grains and in most vegetables. Chief sources of supply:

1'' Rice, wheat flour, oatmeal, cornmeal, potatoes, etc.

- 2' Fats: produce about twice as much heat and energy as the carbohydrates. Found in:
- a' Butter.
  - b' Fat meats and fish.
  - c' Nuts and vegetable oils.

## 2. Inorganic Compounds:

- a. *Water*: indispensable in moistening and digesting food, flushing the system, and restoring waste of water in the body.
- b. *Salt*: required to preserve the vigor of the body.
- c. *Mineral substances*: salts of lime, soda, sulphur, potash, magnesia, and iron.

## II. FOOD HABITS:

1. **Diet**: A course of food which should be planned or selected with reference to health rather than to gratify the appetite. The daily bill of fare should be chosen with great care as to proper amount of each kind of food; *proteids* should form only about one-fifth. Diets or food habits are usually classified as:

- a. *Meat*: consisting chiefly of animal food.
- b. *Vegetable*: principally vegetables and cereals; the strict vegetarian uses neither eggs, milk, nor cheese.
- c. *Mixed*: best suited to the needs of the body, which requires all classes of nutrients for proper sustenance. Such a diet is favorable to
  - 1' Reducing the cost of living.
  - 2' Greater immunity from disease.
  - 3' Better chances of recovery from illness.

2. **Amount of Food**: Cannot be definitely stated. Careful experiments seem to show that a man in good health needs about two and one-half pounds of solid food and three pints of liquid food daily; individual needs should

be intelligently studied, always taking into consideration:

- a. *Occupation.*
- b. *Appetite.*
- c. *General health.*

**3. Condiments:** food adjuncts; used to add flavor to food and stimulate the appetite. Not harmful in small quantities:

- a. *Salt.*
- b. *Pepper.*
- c. *Mustard.*
- d. *Spices and flavorings.*

**4. Beverages:** liquids customarily used for drinking; usually artificially prepared.

a. *Some beneficial beverages:*

- 1' Water: the natural drink; essential to life.
- 2' Cocoa, chocolate: of value because of the nutriment it contains.
- 3' Lemonade: refreshing; sometimes medicinal.

b. *Some harmful beverages:*

- 1' Coffee: injurious if constantly used on account of the *caffeine* it contains.
- 2' Tea: injurious from the *theine* it contains and from the tannic acid developed by improper brewing. Both tea and coffee, however, are valuable stimulants in great fatigue.
- 3' Wines and malt and distilled liquors: cellular and nerve poisons on account of the alcohol they contain.

**5. Cooking:** Food is neither palatable nor healthful in its natural state; and cooking has three uses:

- a. *Destroys germs.*
- b. *Softens the food and makes it more digestible.*
- c. *Improves the flavor.*

**6. Preserving:** Decay of food is prevented by the following methods:

- a. *Sterilization:* destroying spores and germs by heat, as in canning.
- b. *Pasteurizing:* in preserving milk.
- c. *Salting:* for pork and other meats.
- d. *Sugar:* chiefly by cooking with fruits.
- e. *Cold storage:* for eggs, butter, poultry.
- f. *Smoking:* for meats, as in curing ham and bacon.
- g. *Drying:* used for fruits and vegetables (beans and peas).
- h. *Oil:* for olives and fish.
- i. *Antiseptics:* by borax, formaldehyde, etc.; always injurious to health.

**7. Food Hygiene:** The health and efficiency of the body depending chiefly upon the foods with which it is supplied, they should be

- a. *Pure.*
- b. *Of good quality.*
- c. *Perfectly clean.*
- d. *Selected with reference to food values.*

**8. Some Diseases Resulting from Impure Food:**

- a. *Typhoid fever.*
- b. *Ptomaine poisoning.*
- c. *Bowel troubles.*

## CHAPTER III

### FERMENTATION AND DISEASE GERMS

I. FERMENTATION: The means by which Nature performs many of her processes.

#### 1. Kinds of Ferments Employed:

a. *The organized or living ferments:* usually minute organisms which cause fermentation by their own growth and development, as seen in

1' *Mold*, mildew, putrefaction: Nature's way of returning dead animal and vegetable life to the soil and air to be built into living forms again.

2' *Yeast:* the most common ferment used is derived from the yeast plant, a minute vegetable organism or fungus composed of simple cells 1-3000 inch in diameter; grows rapidly in the wet starch and sugar of grains and fruits and changes them to alcohol. Used by man in the preparation of foods and drinks.

a' Beneficially in

1'' *Breadmaking:* the fermentation induced in the wet flour produces carbonic acid gas and alcohol. The gas makes the bread "light" and the alcohol is driven out by baking.

2'' *Acetic acid:* by which weak alcohol is changed to vinegar.

3'' *Butyric acid:* gives flavor to butter.

## b' Injuriously in

1'' *Fermented* drinks: all of which contain alcohol, and which are the source of much ill health and many serious diseases.

a'' Beer.

b'' Wine.

c'' Whisky.

b. *The unorganized* (lifeless) *ferments* or *enzymes*: those which produce chemical changes in the digestion of food.

1' In the saliva:

a' *Ptyalin*: turns starch to sugar.

2' In the gastric juice:

a' *Pepsin*: changes proteids to peptones

b' *Rennin*: curds milk.

3' In the pancreatic juice:

a' *Trypsin*: changes proteids into peptones and proteoses.

b' *Amylopsin*: converts starch into maltose.

c' *Steapsin*: digests fats.

II. DISEASE GERMS: Minute bacterial organisms that enter the body and are supposed to cause by their rapid growth and development nearly all germ diseases. They destroy the protoplasm and form waste products called *toxins*, which act as poisons. Nearly all infectious or contagious diseases are caused by disease germs.

**1. Some Infectious or Contagious Diseases:**

- a. *Diphtheria*.
- b. *Typhoid fever*.
- c. *Tuberculosis*.
- d. *Measles*.
- e. *Whooping cough*.
- f. *Scarlet fever*.
- g. *Pneumonia*.
- h. *Colds*.



- 1' Disease germs are conveyed:
  - a' Through the air.
  - b' By water.
  - c' In milk and other foods.
  - d' By clothing, personal contact, etc.
- 2' They can be guarded against:
  - a' By isolation.
  - b' Sterilization.
  - c' Use of antiseptics and disinfectants.

## CHAPTER IV

### DIGESTIVE ORGANS AND DIGESTION

#### I. THE DIGESTIVE ORGANS.

##### 1. The Alimentary Canal: Comprises the

- a. *Mouth.*
  - 1' *Teeth.*
  - 2' *Tongue.*
- b. *Pharynx*
- c. *Esophagus.*
- d. *Stomach.*
- e. *Intestine.*

##### 2. Digestive Glands: Comprise the

- a. *Salivary glands.*
- b. *Gastric glands.*
- c. *Liver.*
- d. *Pancreas.*
- e. *Intestinal glands.*
- f. *Spleen.*

#### II. DIGESTION.

##### 1. The Process begins with

- a. *Mastication*, in the
  - 1' *Mouth*, where the food is broken and ground by the
    - a' *Teeth*. It then undergoes
- b. *Ensalivation* by the
  - 1' *Salivary glands*, and is guided by the
    - a' *Tongue* to the
      - b' *Pharynx*, which pushes it downward; and

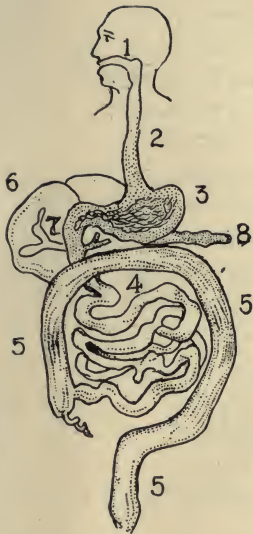


Fig. 1.—Alimentary Canal

- |                     |                     |
|---------------------|---------------------|
| 1. Pharynx.         | 5. Large intestine. |
| 2. Esophagus.       | 6. Liver.           |
| 3. Stomach.         | 7. Pancreas.        |
| 4. Small intestine. | 8. Spleen.          |

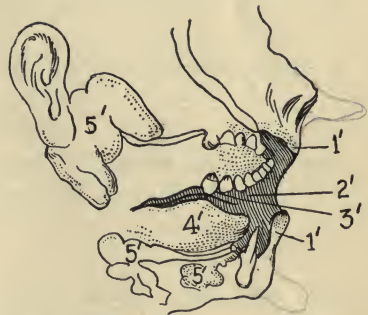


Fig. 2.—The Mouth (p. 13)



Fig. 3.—Salivary Glands (p. 15)

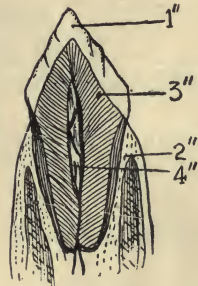


Fig. 4.—Tooth Structure (p. 14)



- c. *Deglutition or swallowing* occurs in the  
 1' *Esophagus*, from which the food enters the  
 2' *Stomach*. Here occurs
- d. *Stomach digestion*, in which the proteids are acted upon by the  
 1' *Gastric juice*. The partly digested mass is then passed on to the  
 2' *Small intestine*, where
- e. *Intestinal digestion* occurs. Here the carbohydrates and fats are acted upon by the  
 1' *Intestinal juice*.  
 2' *The bile*.  
 3' *The pancreatic juice*; after which the thin milky liquids formed from the nutrients are absorbed by the blood and lymph and the waste matter is passed to the
- f. *Large intestine*, from which it is excreted.

### III. ANATOMY AND FUNCTION OF THE ORGANS.

#### 1. The Mouth.

##### a. *Parts*:

- 1' *Lips*: guard the entrance.  
 2' *Mucous membrane*: lines cavity.  
 3' *Teeth*: bony structure supporting the lips and cheeks.

a' *Function*: to grind the food preparatory to digestion.

b' *Sets*: two.

1'' *Temporary* or milk teeth of children.

2'' *Permanent* set of adults consisting of thirty-two teeth:

a'' *Incisors* (for cutting) = 8,

b'' *Canine* (for tearing) = 4,

c'' *Bicuspids* (for grinding) = 8.

d'' *Molars* (for grinding) = 12.

## c' Structure:

- 1'' Enamel: the hard, smooth outer layer of the exposed portion.
- 2'' Cement: a softer outer layer beneath the gums.
- 3'' Dentine: a uniform layer just inside the enamel and cement. It is of the same composition as enamel, but not so hard.
- 4'' Pulp: the innermost part; contains:
  - a'' Fatty tissue;
  - b'' Connective tissue;
  - c'' Blood vessels;
  - d'' Nerves.

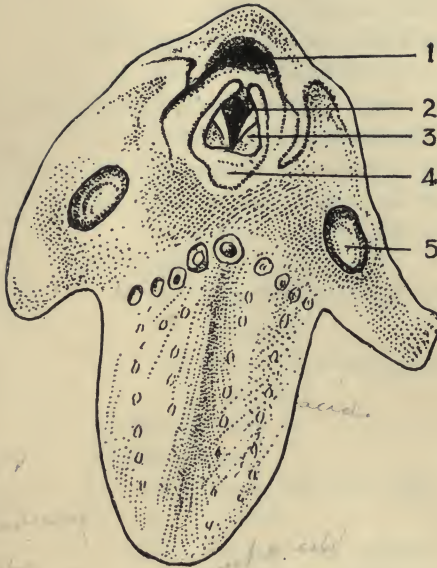
## d' Care:

- 1'' Avoid injuring enamel.
- 2'' Do not allow food to collect in or around the teeth.
- 3'' Have teeth examined at least twice a year.
- 4'' Have all cavities promptly filled.

4' *The tongue:*

## a' Structure:

- 1'' Muscle fibers: the structural basis.
- 2'' Papillæ: minute projections on the upper surface.
  - a'' Circumvallate: short and blunt; at the very back of the tongue.
  - b'' Filiform: slender and thread-like.
  - c'' Fungiform: short and pillar-like.



The Tongue

- |             |                 |
|-------------|-----------------|
| 1. Gullet.  | 3. Vocal cords. |
| 2. Glottis. | 4. Epiglottis.  |
| 5. Tonsils. |                 |





3'' Taste buds (located in circumval-  
late and fungiform papillæ):

a'' Bitter: at back of tongue.

b'' Sweet and salt: at front of  
tongue.

c'' Acids: on sides.

b' Function: shifting food and aiding vol-  
untary swallowing.

5' Salivary glands (three pairs), viz.:

a' *Parotid*: region of the ear.

b' *Sublingual*: beneath the tongue.

c' *Submaxillary*: beneath the tongue (on  
each side, near angle of the jaw).

d' Structure (*racemose*).

1'' Clusters of alveoli (like clusters of  
grapes).

2'' Ducts (like stems leading from the  
grapes).

e' Action: reflex.

f' Secretions:

1'' Water (99 per cent): softens the  
food.

2'' Ptyalin: an *enzyme* or ferment;  
converts starch into sugar.

2. The Throat (*pharynx*): a cavity c. four and one-half  
inches long, just back of the mouth.

a. *Boundaries*:

1' Below: tongue, root end.

2' Above: soft palate and uvula.

3' At sides: pillars of the *fauces* (vertical folds  
of tissue hanging down sides of throat).

b. *The tonsils*:

1' Location: one between each pair of the pil-  
lars of the *fauces*.

2' Size: usually about as large as half a walnut.

- c. *Openings to the pharynx* (throat) from
- 1' Mouth.
  - 2' Nares (from nose).
  - 3' Eustachian tubes.
  - 4' Glottis (to trachea).
  - 5' Epiglottis (to esophagus or gullet).

### 3. Esophagus and Plan of Body Cavity:

a. *Esophagus:*

- 1' Length: c. nine to ten inches.
- 2' Structure:
  - a' Two layers of muscle (one longitudinal and one circular).
  - b' Epithelium.
- 3' Function:
  - a' Swallowing:
    - 1'' Voluntary: consists of rolling the masticated food into a ball and pushing it through the opening into the throat.
    - 2'' Involuntary: all swallowing beyond entrance to pharynx.
    - a'' *Peristalsis*: the movement of the food caused by a wave of contraction of the circular muscles.

b. *Plan of the body cavity:*

- 1' Partition: the diaphragm.
  - a' Structure:
    - 1'' Tendinous material.
    - 2'' Radiating muscles.
  - b' Position: about one-third of way down from shoulders.
- 2' Lining: the serous membrane:
  - a' Structure: one-celled glands.
  - b' Function: to afford a smooth surface, thus preventing friction.



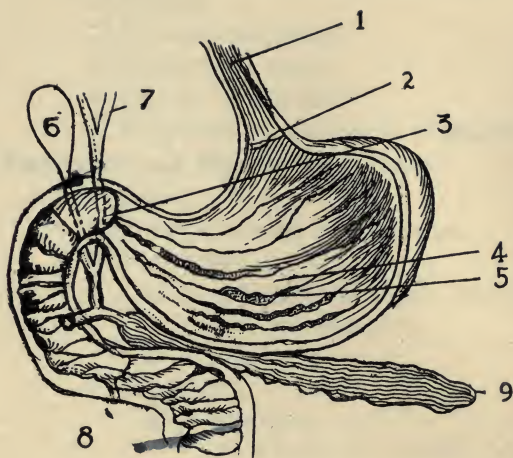


Fig. 1.—Stomach—interior view

- |                    |                  |
|--------------------|------------------|
| 1. Esophagus.      | 6. Gall bladder. |
| 2. Cardiac valve.  | 7. Liver ducts.  |
| 3. Pyloric valve.  | 8. Duodenum.     |
| 4. Rugæ.           | 9. Spleen.       |
| 5. Gastric glands. |                  |

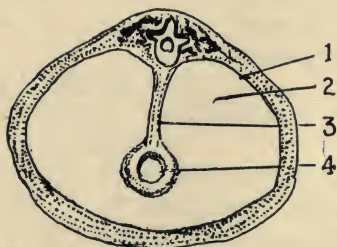


Fig. 2.—Small Intestine

- |                 |               |
|-----------------|---------------|
| 1. Peritoneum.  | 3. Mesentery. |
| 2. Body cavity. | 4. Intestine. |

c' Location: lines the whole body cavity;  
called

1'' *Pleura*: in the thorax.

2'' *Peritoneum*: in the abdomen.

a'' *Mesentery*: holds the intestine in place.

3' Subdivisions:

a' Thorax (chest): upper portion; contains

1'' Heart.

2'' Lungs.

b' Abdomen: lower portion; contains

1'' Stomach.

2'' Intestine.

3'' Large glands.

4. **The Stomach:** The large dilatation in the alimentary canal which serves as a receptacle for food to be digested.

a. *Location*: just below the diaphragm. Lies with the larger end and greater bulk to the left of mid-line.

b. *Shape*: like a pouch; has been compared to the air-bag of a Scotch bagpipe.

c. *Size*: about ten inches long by four to five inches wide; holds from three to five pints.

d. *Openings*: has two openings, both at top:

1' The *cardiac orifice*: where esophagus enters.

2' The *pylorus*: where food passes on to the small intestine.

e. *Valves*: two powerful circular muscles which guard the openings:

1' Cardiac valve: at cardiac orifice

2' Pyloric valve: at smaller end.

f. *Structure*: has three coats or layers of covering:

1' Peritoneum: smooth outer covering of serous membrane.

- 2' Middle layer: strong complex muscular fibers; muscles run in three directions:
  - a' Longitudinal.
  - b' Circular.
  - c' Oblique.
- 3' Mucous membrane: inner lining; thick and highly developed. Contains many
  - a' *Rugæ*: wrinkles or folds, which add much to its surface:
  - b' *Gastric glands*: minute tubes resembling pinpricks. Each gland is lined with *epithelial* cells, which secrete:
    - 1'' Gastric juice from the blood; it consists of:
      - a'' *Pepsin*: changing proteids into peptones.
      - b'' *Rennin*: curds milk.
      - c'' *Hydrochloric acid*: dissolves connective tissue.
    - 2'' Action: action reflex; controlled by the sympathetic nervous system.
- g. *Function of the stomach*: main use is to act as a storehouse for food; to mix it with gastric juice, and reduce it to a still more liquid form. Digests only albumin.
- h. *Movement (peristalsis) of the stomach*: When food is introduced into the stomach a continuous and regular motion is set up caused by the contraction and relaxation of the fibers of the muscular coat of the stomach. This action thoroughly mixes the gastric juice with the food. Stomach digestion changes the food into
  - 1' *Chyme*, which is passed on through the pyloric opening to the



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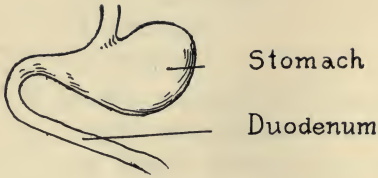


Fig. 1.—Stomach and Small Intestine

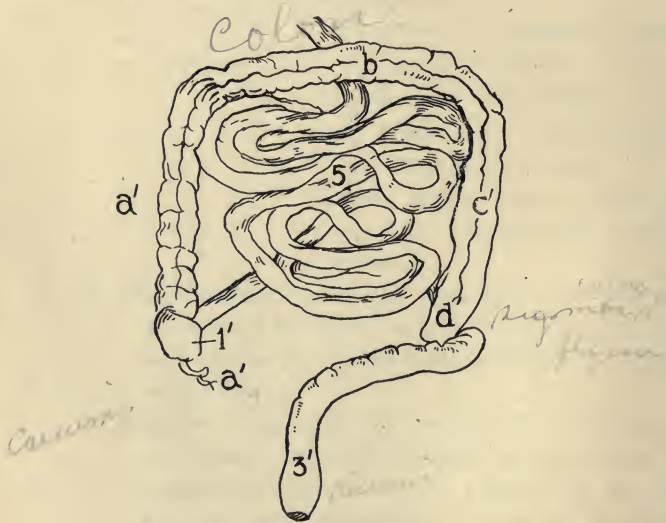


Fig. 2.—Small Intestine (5) and Large Intestine (6)



**5. Small Intestine.** Here the greater part of digestion is carried on.

a. *Divisions:*

1' *Duodenum:* part which first crosses abdomen below the stomach.

2' *Jejunum.*

3' *Ileum:* joins large intestine at

a' *Ileocaecal* valve.

b. *Length:* about twenty feet.

c. *Size:* one inch to one and one-quarter inches in diameter.

d. *Support:* a fanlike fold of the peritoneum about four inches wide at the back, where it is fastened to the spinal column, and twenty feet at the edge, to which the intestine is attached; it is called the *mesentery*.

e. *Function:* performs most important work of the alimentary canal.

f. *Structure:* has three coats:

1' Mucous membrane: inner coat. Its inner surface is covered with numberless

a' *Villi:* tiny tubes of epithelial tissue that perform the work of absorption.

2' Muscular: middle coat.

3' Peritoneum: smooth outer covering.

**6. Large Intestine.**

a. *Divisions:*

1' *Cæcum.*

a' *Vermiform appendix.*

2' *Colon:*

a' *Ascending colon.*

b' *Transverse colon.*

c' *Descending colon.*

d' *Sigmoid flexure, or sigmoid colon.*

3' *Rectum.*

b. *Structure*: similar to small intestine; only mucous membrane has no *villi*, and muscular coat not so complex.

c. *Function*:

1' Serves as receptacle for materials from small intestine, also collects and retains undigested food particles and other waste and ejects them.

2' Expulsion of fæces.

## 7. The Digestive Glands.

a. *The liver*: The largest gland of the body and one of the most important.

1' *Size*: weighs about four pounds.

2' *Location*: just below the diaphragm on the right side.

3' *Structure*:

a' Divided into two lobes.

b' Intricate system of ducts and blood vessels for secretion and other functions.

4' *Color*: dark red, because of the great amount of blood it contains.

5' *Chief blood vessels*:

a' The *portal vein*.

b' The *hepatic artery*.

c' The *hepatic veins*.

6' *Secretion*:

a' The *bile*: a thick golden-colored fluid, which consists of waste matter from albuminous food and other material.

1'' *Function*: while not thoroughly understood is known to assist greatly in the process of nutrition.

2'' *Amount of secretion*: about a quart daily.

b' Gall bladder: a small membranous sac for storing the bile.

1'' Location: under side of liver. Receives bile from three

a'' Ducts: which unite with the *pancreas* gland and empty into

1''' The duodenum.

7' Function of the liver: to act as the *regulator* of the body; eliminates poisons; aids digestion.

b. *The pancreas:*

1' *Location:* lies behind the stomach with the large end to the right.

2' *Size:* about six inches long by one in diameter.

3' *Function:* chief agent in digesting fatty foods.

4' *Secretion:*

a' Pancreatic juice: a thin watery liquid; pours about one and one-half pints a day into small intestine. About five per cent of juice is composed of *three ferments*, which perform main part of digestion:

1'' *Trypsin:* changes proteids to peptones.

2'' *Amylopsin:* changes starches into sugars.

3'' *Steapsin:* changes fats to emulsions.

a'' Fatty acids.

b'' Glycerine.

c. *The spleen:* soft red organ, composed of cells and fibers, shaped like a tongue, lying just to left of stomach. Blood circulates through it like a sponge; is supposed to form red blood cells, which are also formed in marrow of bones.

## IV. HYGIENE OF THE DIGESTIVE ORGANS.

**1. The Health of the Digestive Organs:** May be said to depend chiefly

- a. *On the proper kind and amount of food.*
- b. *On regularity of meals, and*
- c. *On regularity of the bowels.*

**Things to be Avoided:**

- a. *Intemperate eating and drinking.* Simple food and healthful beverages only should be taken.
- b. *Insufficient mastication.* Saliva is necessary to good digestion. .
- c. *Excessive amount of food.* Stretches and weakens the stomach.
- d. *Eating between meals.* Does not give stomach time to rest.
- e. *Eating when tired.* A rest of fifteen minutes for health's sake should be taken before and after each meal.

**3. Diseases of the Stomach:** The stomach cannot be abused without suffering. One of the most common stomach troubles is

- a. *Fermentation of food:* manifests itself in
  - 1' "Sour stomach": fermenting food forming
    - a'' Gases on the stomach: these give rise to
      - 1'' Pain.
      - 2'' Palpitation of the heart.
      - 3'' Headache.
      - 4'' Burning sensation.
- b. *Ulceration of stomach:* caused by
  - 1' Aggravated indigestion.
  - 2' Use of alcoholic liquors.

**4. Diseases of the Liver:** The liver normally destroys the poisons of the body and aids in digestion; when it does not act properly

- a. *Biliousness results*: indicated by headache, dullness, often vomiting.
- b. *Jaundice*: when the liver fails to excrete poisons bile is thrown through body making skin a deep yellow. Often fatal.
- c. *Ulceration*: caused chiefly by use of alcohol.

**5. Causes of Liver Trouble:** Chiefly

- a. *Excess of proteid diet.*
- b. *Constipation.*

**6. Torpid Liver:** is benefited by the use of drugs which excite it to action. Best treatment is to avoid cause.

**7. Diseases of the Intestine:**

- a. *Indigestion in the small intestine.*
- b. *Constipation.*
- c. *Peritonitis*: inflammation of the peritoneum. Very dangerous.
- d. *Appendicitis*: inflammation of the *vermiform appendix*.

## CHAPTER V

### ABSORPTION, ASSIMILATION AND OXIDATION

I. ABSORPTION: The process by which dissolved nutrients are transferred after digestion from the alimentary canal to the circulation.

#### 1. Chief Organ of Absorption:

a. *The small intestine*: performs its work chiefly by means of the

1' *Villi*: minute finger-like projections which cover the entire folds of the mucous lining. They consist of a thin covering of

a' *Epithelial cells*: each *villus* being supplied with

b' *Lacteals*, or lymph ducts: these take up the emulsified fats that soak through the membrane.

c' *Capillaries*: a fine network of blood vessels; these take up the peptones and other nutrients.

2. **Dialysis**: The process of passing a liquid through a living animal membrane. This is extremely difficult to explain because

a. The liquid substances actually pass out through the thin walls of the epithelial cells of the

1' Mucous membrane of the intestinal wall and pass into the

2' Lacteals and blood vessels on the other side of the mucous membrane, while

b. *The blood and lymph do not flow out into the intestine.*



Fig. 1.—Small Intestine  
Piece removed to show inner folds (a).

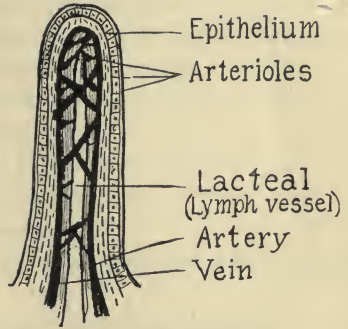


Fig. 2.—Single Villus  
(Highly magnified)

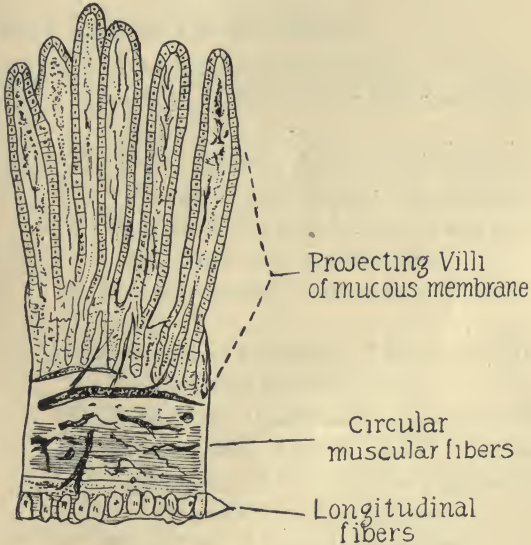


Fig. 3.—Muscular Coat and Villi

**5. Storage of Absorbed Materials.** When more energy food has been absorbed than can be at once assimilated it is stored away for future use.

- a. *Carbohydrates*: as glycogen in the liver and muscle tissues.
- b. *Fats*: as fat in the cells of the connecting tissue.
- c. *Proteids*: in the tissues.

II. **ASSIMILATION:** The appropriation of the absorbed nutrients by the protoplasm of the cells and incorporation into the various fluids and tissues of the body, when they are ready for the chemical process of oxidation, by which the life of the body is sustained.

**1. Where Assimilation Occurs:**

- a. *Fats*: in the lungs.
- b. *Glucose*: in the liver and blood.
- c. *Proteids*: in blood and cells build up the tissues of the body.

III. **OXIDATION:** The chemical process which is continually going on in the body whereby the assimilated food materials combining with the oxygen entering the body are made to supply the organism with heat and energy. This may be illustrated by:

**1. Analogy.**

a. *Burning of fuel in a stove or in the firebox of an engine.*

1' Air enters at the draft; the oxygen of the air unites with the carbon and hydrogen of the fuel, forming

a' *Carbonic acid gas* and water, which pass off with the smoke.

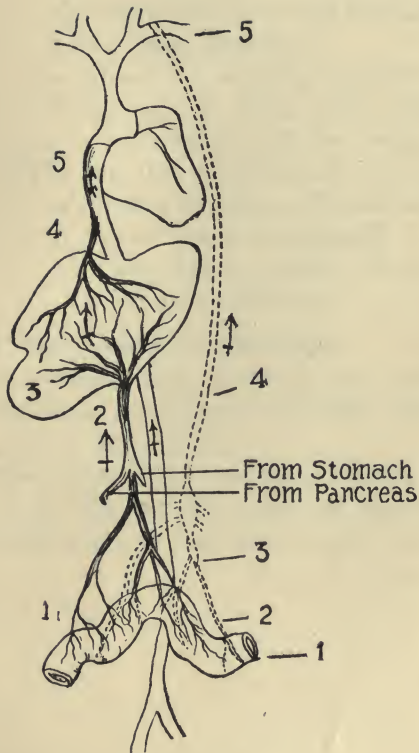
b' *Ashes*: the mineral residue.

2' The burning produces heat and flame, which may be utilized for

a' *Warmth.*

b' *Power or force.*





**Carbohydrates and Proteids.**

1. Capillaries of villi.
2. Portal vein.
3. Liver.
4. Hepatic veins.
5. Inferior vena cava.

**Fats, via**

1. Intestine.
2. Lacteals.
3. Mesentery.
4. Thoracic duct.
5. Left subclavian.



b. *Oxidation in the human engine:*

- 1' The oxygen breathed into the body unites with the food and cells just as it does with the fuel in the stove and firebox and *slowly burns* them, producing
  - a' Heat: for warming the body.
  - b' Energy or force: heat changed from potential to kinetic energy.
- 2' The chemical combinations are expelled:
  - a' *Carbon dioxide* is released at the lungs.
  - b' *Water* passes off as liquid.
  - c' *Urea*: waste product of proteids, excreted by kidneys.

**2. Relative Food Values in Oxidation:**

- a. *Fat*: greatest heat producer; one ounce of fat consumes three ounces of oxygen, twice as much heat as the proteids.
- b. *Carbohydrates* (converted into sugar): one ounce to one and one-fifth ounces of oxygen.
- c. *Albumin*: one to one and one-half ounces.

## CHAPTER VI

### THE BLOOD AND THE CIRCULATORY SYSTEM

I. THE BLOOD: A thick red liquid, constituting about one-thirteenth of the weight of the body, which carries on the life processes through an intricate arrangement of closed tubes and channels called the *Circulatory System*.

1. **Function:** That of distributing agent.

- a. Carries food and oxygen to all the cells of the body.
- b. Carries away waste material.
- c. Distributes heat.
- d. Destroys disease germs.

2. **Composition:**

- a. *Plasma*: the liquid part; of a light straw color; ninety per cent water. It is made up of
  - 1' Absorbed foods from the intestine.
  - 2' Waste products from the body.
  - 3' Fibrinogen, the active principle in the clotting of blood.

b. *Corpuscles*: minute flat cells that float in the plasma.

- 1' Red corpuscles: minute jelly-like albuminous cells, which make up forty-five per cent of the weight of the blood.

a' Size: 1-3200 inch wide and 1-12000 inch thick.

b' Shape: slightly concave circular disc.

c' Number: about 5,000,000 to one drop.

d' Peculiarities as cells:

1'' No nuclei.

2'' No power of division.

## e' Parts:

1'' *Stroma*: spongy framework of the corpuscle.

2'' *Hemoglobin*: the essential part of the corpuscle; four-fifths of substance; contains iron; oxygen carrier of body; gives color to blood.

## f' Life history:

1'' Start in bone marrow.

2'' Serve as an oxygen carrier.

3'' End life in liver.

## g' Function: to carry

1'' Oxygen from lungs to tissues.

2'' Carbon dioxide from tissues to lungs.

2' White corpuscles (*or leucocytes*): transparent bluish color:

a' Size: from that of red to three times same.

b' Number: probably 1-300 of red.

c' Shape: constantly changing.

## d' Cell characteristics:

1'' They contain nuclei;

2'' Are able to move by their own efforts (ameboid motion); and to

3'' Penetrate the walls of blood vessels (*leucocytosis*).

e' Functions: have an important part in destroying disease germs and in healing wounds.

## 3' Platelets:

a' Size: c. one-third that of red corpuscles.

b' Number: c. 600,000 per drop.

c' Shape: ovoid.

## d' Life history:

1'' Numerous in unshed blood.

2'' Disintegrate after blood is drawn.

e' Probable function: to aid clot formation.

### 3. Clot Formation.

a. *Substances found in the blood clot:*

1' Corpuscles.

2' Serum: a thin, yellowish fluid.

3' Fibrin: not found while blood is in the blood vessels, but is formed while the blood is clotting.

b. *Method of formation:*

1' Fibrin ferment (probably released by the platelets when they go to pieces upon coming into contact with the air or with some foreign substance) unites with the

2' Fibrinogen contained in the plasma of the blood, and thus causes clotting.

c. *To prevent clotting of blood:* apply such chemicals as:

1' Sodium sulphate or magnesium sulphate.

2' Pepsin or trypsin.

3' Leech's saliva.

4' Snake's venom.

d. *To make blood clot more rapidly:* bring it into contact with some foreign substance; e. g., a cloth.

e. *Function of blood clotting:* to prevent excessive waste of blood from wounds.

### 4. Checking the Flow of Blood from Wounds and Hemorrhages:

The loss of any considerable amount of blood is so important a matter that every one should know how to check it.

a. *Nose bleed:* if persistent may become serious.

Try first to check it by pressing a small wad of paper under the lip at the base of the nose.

If persistent insert a small plug of clean paper or cotton into the nostril; allow it to remain for quite a while. Salt and witch hazel are good styptics.

b. *Wounds:* In cases of large wounds a physician should be called at once. In the meantime try

to check the flow of blood. Wounds to arteries and veins require different treatment.

1' Injury to artery: the blood stream comes in jets and spurts. Bandage the limb *tightly between* the wound and the heart. Close edges of wound and cover with cotton fiber. If a large handkerchief is at hand fold diagonally, tie knot in middle and place knot over injured blood vessel. Tie and tighten bandage with short stick inserted in loop. Requires immediate attention. Physician should be summoned at once.

2' Injury to blood vessel: blood flows in steady stream. Bandage on side of wound *farthest away* from heart. Compress edges of wound while bandage is being procured.

II. THE CIRCULATORY SYSTEM. The chief organs of circulation are (1) the heart; (2) the blood vessels.

1. **The Heart:** The central organ of the circulatory system is a hollow bag composed of strong contractile muscles.

a. *Location:* in the thorax, between the lungs, with the larger part a little to the left of the sternum.

b. *Size:* about as large as the doubled-up fist of the person.

c. *Shape:* a cone; resembling a strawberry.

d. *Outer structure:*

1' The *base:* the large upper end.

2' The *apex:* the small end, pointing downward.

3' The *pericardium, or covering:* a double-bag-like fold of serous membrane, which covers and protects the heart.

a' *Cardiac pericardium:* the fold covering the organ itself.

b' *Parietal pericardium:* the loose outer fold; continuous with the first fold at

the base, but separated below, which leaves a cavity filled with the

1'' *Pericardial* fluid: a liquid which prevents friction from the heart's action.

e. *Inner structure*: planned as a receiving and pumping station for the blood, which gives it a double circulation. To provide for this the heart cavity is divided by a thick vertical wall of strong muscular tissue into *right* and *left* chambers.

1' The *right* chamber: receives the blood from the veins and sends it to the lungs to be purified. This constitutes

a' The *pulmonary* circulation.

2' The *left* side: receives blood from the lungs and sends it to build up all parts of the body. This is

a' The *systemic* or *general* circulation.

3' The *cavities* and *valves*: Each side of the heart is subdivided into two cavities:

a' *Auricles*: the upper cavities; these are smaller than the lower and are receptacles for the blood.

1'' *Right auricle*: receives blood from

a'' *Superior vena cava*.

b'' *Inferior vena cava*.

— c'' *Coronary veins*.

2'' *Left auricle*: from the pulmonary veins.

b' *Ventricles*: receive the blood from the auricles and distribute it to the body. Their walls are very much thicker than are those of the auricles.

1'' *Right ventricle*: distributes to lungs.

2'' *Left ventricle*: distributes to all parts of body.



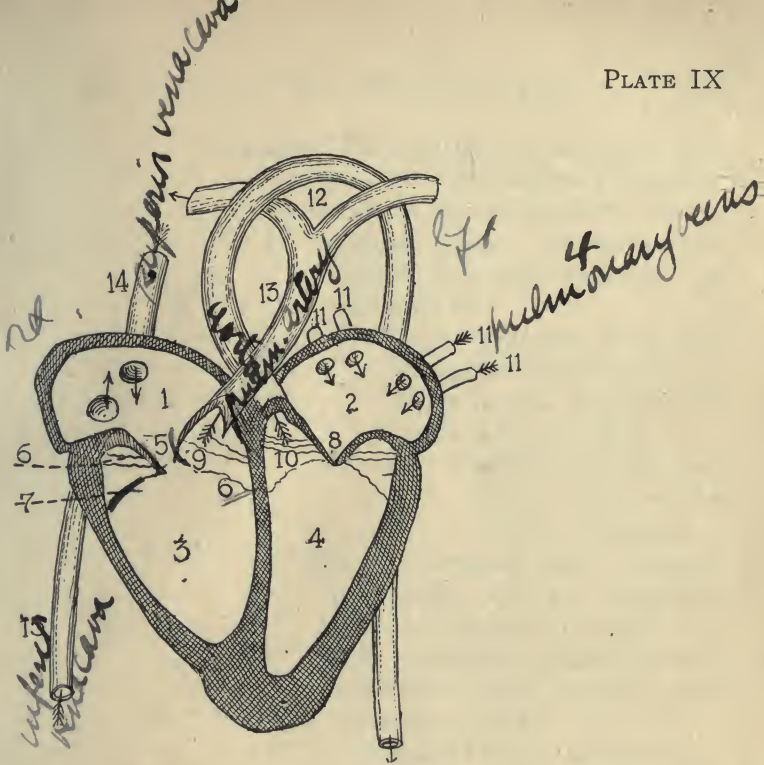


Fig. 1.—Heart Cavities and Valves (II-1-e)

- |                              |                           |
|------------------------------|---------------------------|
| 1. Right auricle.            | 9. Right semilunar valve. |
| 2. Left auricle.             | 10. Left semilunar valve. |
| 3. Right ventricle.          | 11. Pulmonary veins.      |
| 4. Left ventricle.           | 12. Aorta.                |
| 5. <u>Tricuspid valve.</u>   | 13. Pulmonary artery.     |
| 6. <u>Chordae tendinae.</u>  | 14. Superior vena cava.   |
| 7. <u>Papillary muscles.</u> | 15. Inferior vena cava.   |
| 8. Mitral valve.             |                           |

*Presert  
Bulldging*

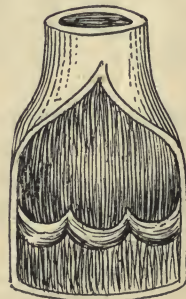


Fig. 2.—Right Semilunar valve



c' Valves: The ventricles of the heart are furnished with four valves to prevent the backward flow of the blood; *viz.*:

1'' Tricuspid valve: between right auricle and right ventricle. Is regulated by

a'' Chordæ tendinæ: stout, fine threads extending from the edges of the valves to the walls of the ventricle.

1''' Papillary muscles: regulate length of the chordæ tendinæ.

2'' Mitral or bicuspid valve: between left auricle and left ventricle; twice as strong as tricuspid.

3'' Right semilunar valve: around opening of right ventricle into pulmonary artery.

4'' Left semilunar valve: around opening of left ventricle into aorta.

f. Order of circulation in the heart:

1' With the right auricle: the superior and inferior venæ cavæ and the coronary veins.

2' With the left auricle: the four pulmonary veins.

3' With the right ventricle: the pulmonary artery.

4' With the left ventricle: the aorta.

g. Action: The heart is like a muscular pump, and does its work by contracting and relaxing its walls.

1' Systole (contracting): act of sending out the blood; lasts about .3 second per beat.

2' Diastole (relaxing): the period of filling up; lasts about .5 second.

3' Sounds: two distinct sounds are given out by

the heart action as detected by the stethoscope:

a' Dull heavy sound: believed to be due to contraction of heart muscle and valve flaps; followed by

b' Short, sharp sound: caused by closing of semilunar valves.

4' Throb at breast and pulse:

a' *Throb*: due to fact that when the heart beats the apex turns forward with sufficient force to lift the body wall.

b' *Pulse*: due to wave of pressure starting in the large arteries and traveling on to the surface, especially at the wrists.

h. *Nerves of the heart*: the heart is furnished with nerves that regulate its action. They are

1' The inhibitory nerves: these have the power of checking the heart's action.

2' The accelerator nerves: the power of increasing its action.

i. *Work of the heart*: exerts sufficient energy per day to lift ninety tons to a height of three feet. Of this the *left* side does the greater part of the work.

2. **The Blood Vessels**: All tubes carrying blood, whether from or to the heart. They are divided into three kinds: (a) arteries; (b) capillaries; (c) veins.

a. *Arteries*: the blood vessels carrying the blood away from the heart to all parts of the body.

1' Gradation of arteries as to size.

a' Large: near the heart.

b' Smaller, tapering, and branching: in the limbs.

c' Extremely small by infinite subdivision: at ends of limbs, hands, feet; and in head, skin, and intestine.

Vagus  
Accelerator  
Sympathetic



1''' *Brachial*: in region of the armpit along the humerus. It subdivides into: (1) *radial*, along the radius; and (2) *ulnar*, along ulnus. Both undergo other divisions.

d'' *Right subclavian*: whose subdivisions are similar to c''.

3'' *Thoracic aorta*: that part of the aorta contained in the thorax.

4'' *Abdominal aorta*: that contained in the abdomen. It gives off:

a'' *Cæliac artery*, which subdivides into:

1''' *Gastric*: to stomach.

2''' *Hepatic*: to liver.

3''' *Splenic*: to spleen.

b'' *Superior mesenteric*: supplies blood for mesentery and upper part of intestine.

c'' *Renal*: to kidneys.

d'' *Inferior mesenteric*: to lower part of the intestine.

e'' *Two common illiacs*: one to each side of the pelvis; each continues into the leg, and is called:

1''' *Femoral*: in thigh.

2''' *Popliteal*: at knee, where it divides into two branches and supplies calf and foot as (1) *peroneal*, and (2) *posterior tibial*.

*flat endothelial cells*

b. *Capillaries*: network of extremely small blood vessels which connect the terminations of the smallest arteries with the beginnings of the smallest veins.

1' *Structure*: have but one coat; identical with inner layer of the arteries, of which they are continuations.

2' *Size*: average diameter, less than 1-2000 of an inch; average length, less than 1-25 of an inch.

3' *Number*: so great that the point of a pin cannot enter a tissue without piercing one or more.

4' *Function*: serve the purpose of carriers of both cell food and waste, by

a' Admitting materials into the blood vessels.

b' Allowing materials to pass from the blood vessels into surrounding tissues.

*help transport into surrounding tissues*

c. *Veins*: all blood vessels carrying blood *toward* the heart.

1' Gradation as to size: same as arteries.

2' General structure: similar to that of the arteries except that they contain less

a' Muscular and elastic tissue; while they contain more

b' Connective tissue; which makes them more yielding. They are also provided with

c' Valves: to prevent the backward flow of the blood.

3' Names of the principal veins:

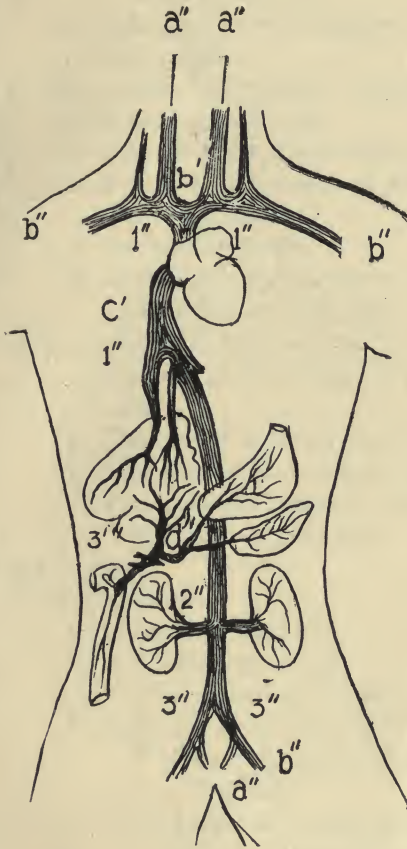
a' *Pulmonary veins*: the veins that collect the blood from the lungs and empty it, through four separate openings, into the left auricle.

- b' *Superior vena cava*: union in chest of
- 1'' Two *innominates*: one from right, the other from left side of body; each made up by union of
    - a'' *Jugular* veins: from head and neck; and
    - b'' *Subclavian* veins: from hand, arm, and shoulder; subdivided like the subclavian artery.
  - 2'' *Azygos*: drains the spaces between the ribs.
- c' *Inferior vena cava*: a union of
- 1'' *Hepatic* veins: from liver; these collect the blood that has been brought to the liver by the
    - a'' *Portal* vein: a union of
      - 1''' *Gastric* veins: from stomach;
      - 2''' *Splenic* vein: from spleen;
      - 3''' *Mesenteric* vein: from mesentery and intestine.
  - 2'' *Renal* veins: from kidneys.
  - 3'' The *common illiacs*: one from each of the lower extremities; each of these is formed by the union of
    - a'' *Interior illiac*: along inner side of leg.
    - b'' *Exterior illiac*: along outer side of leg.

d. *The blood systems*:

- 1' The *pulmonary* circulation begins in the
  - a' Right ventricle; then through the
  - b' Pulmonary artery, which leads to the





Showing the principal Veins (See 3'-p. 37)



- c' Lungs, where the blood is oxygenated.  
Then through the
- d' Pulmonary veins into the
- e' Left auricle.
- 2' The *systemic* circulation (requiring about 28 seconds) begins at the
  - a' Left ventricle; thence through the
  - b' Aorta, to all parts of the body; then through the
  - c' Veins back to the
  - d' Right auricle of the heart *via* the superior and inferior venæ cavæ.
- 3' In addition to the two main divisions of the circulation of the blood are three special circuits:
  - a' The *portal* system: in the liver.
  - b' The *renal* system: in the kidneys.
  - c' The *coronary* system: blood supply to the walls of the heart.

XV + e. *Blood pressure:*

- 1' In the arteries.
  - a' Cause of pressure:
    - 1'' The heart beat.
    - 2'' Resistance offered by capillaries.
  - b' Amount: c. nine inches of mercury.
    - 1'' Greatest: while the heart is contracting.
    - 2'' Least: when the heart is resting.
    - 3'' Most: where the arteries are the largest.
    - 4'' Disappears: in the capillaries
- 2' In the veins: Effect of heart beat has been overcome in the capillaries, and the nearer the blood comes to the heart the less the resistance. Hence, the veins have no great pressure.

f. *The vasomotor system* of regulating the size of the blood vessels and the flow of the blood. This is effected by

1' The vasomotor nerves: these come from the posterior brain (*medulla oblongata*) and from the spinal cord.

a' The vaso-constrictor nerves: act all the time; keeping most of the vessels slightly tightened, especially the vessels of the skin and intestine.

b' The vaso-dilator nerves: cause the vessels to enlarge, especially those of the muscles and glands.

2' The vasomotor muscles: regulate the size of the vessels according to the unconscious orders sent out to them over the vasomotor nerves.

g. *The influence of heat and cold*:

1' By heat: capillaries are expanded, and flow to surface is increased, causing the sensation of warmth, but in reality providing a way for the blood to cool.

2' By cold: capillaries are contracted, and flow to surface is diminished. Thereby the heat is retained within the body, though we feel a sensation of coldness.

### III. THE LYMPH SYSTEM AND THE DUCTLESS GLANDS.

1. **The Lymph System**: Is an important adjunct of the circulatory system, there being more lymph than blood in the body.

a. *Function*: to fill the space between the capillaries and the cells and to be the medium for transferring materials from one to the other.

b. *Chief sources of lymph*:

1' Plasma of the blood.

2' Wastes from the cells themselves.

Lyons



THE LYMPH SYSTEM

c. *Composition*: similar to that of the blood.

- 1' Food materials: in smaller amounts.
- 2' Waste: in larger amounts.
- 3' Red corpuscles: none.
- 4' White corpuscles: about the same number.

d. *Lymph vessels*:

- 1' *Lymph spaces*: minute cavities surrounding cells, in which most of the lymph is found.
- 2' *Lymphatics*: the smallest of the lymph tubes and the most numerous; are connected with *lymph spaces*. They gradually converge toward and empty into the two
  - 3' *Main lymph tubes* of the body.
    - a' The *right lymphatic*: the smaller of the two, receives lymph from right side of head and arm, and empties into the
      - 1'' *Right subclavian vein*.
    - b' *Thoracic duct*: receives lymph from all other parts of the body and empties into the
      - 1' *Left subclavian vein*, and is provided with
        - 2' Valves throughout.
        - 3' *Lacteals*, that drain to thoracic duct from intestine perform a special work in digesting fats.
  - 4' *Lymphatic glands*: sometimes called *lymph nodes*; small rounded bodies along the lymphatic tubes; provide for development of white corpuscles and separate harmful germs.

e. *Lymph movement*:

- 1' From capillaries toward cells.
- 2' From cells toward capillaries.
- 3' Of entire lymph body to the ducts by which it enters the blood.

*f. Bad effects due to improper flow of lymph:*

- 1' Water on joints (especially knee).
- 2' Blisters.
- 3' Dropsy.

**2. Ductless Glands:** Those which pour their contents directly into the blood.

*a. Lymph glands:* found in many parts of the body, especially the shoulder and hip joints; probable seat of formation of white corpuscles.

*b. Spleen:* near lower wall of the stomach; supported by folds of mesentery; use unknown.

*c. Thyroid glands:* one on each side of esophagus a little below "Adam's apple"; regulate manner in which the blood nourishes the different parts of the body.

1' *Cretinism:* a condition of stupid brain, weak limbs, and misshapen body, due to absence of these glands at birth.

*d. Adrenal bodies:* just in front of each kidney; their secretions influence the muscles in the artery walls, increasing or decreasing their activity.

#### IV. HYGIENE OF THE BLOOD AND CIRCULATORY SYSTEM.

**1. Diseases of the Blood:** Health is not determined by the condition of the blood, but the state of the blood is determined by the condition of the body.

*a. Blood poisoning:*

1' Cause: bacteria.

2' Seat of cause: a cut or abrasion of the skin.

3' Origin of name: due to the fact that the blood carries the germs through the body.

4' Mode of attack: enters through a rupture of the skin; takes up abode within skin, muscle, gland, or some other active organ; multiplies rapidly, and produces a poison.

5' Results: in extreme cases fatal.



**6' Methods of avoiding blood poisoning:**

a' Keep all discharges from sores or boils away from cuts.

b' Cleanse carefully, in boiled water, all places where the skin is broken, cut or bruised and apply an antiseptic.

c' On deep wounds: cleanse well; use a disinfectant, and go to a physician.

**b. Malaria, chills and fever, and fever and ague:**

1' Cause: a parasite that can live in the red corpuscles.

2' Activity: Intermittent (due to the fact that a generation of the germs breaks up a set of red corpuscles about every forty-eight hours, at which time a little poison is let out into the blood, producing a chill, which is followed by a fever.

3' Remedy: quinine.

4' Spread of disease: due to *Mosquito anopheles*.

5' Protection *vs.* spread of disease: best accomplished by exterminating the mosquitoes.

**c. Yellow fever:**

1' Yellow fever localities: tropical regions.

2' Cause not yet known.

3' Spread of disease: due to *Mosquito stegomyia*.

4' Mosquito extermination:

a' Drain stagnant pools, protect rain barrels.

b' Pour kerosene on surface of pools that cannot be drained.

**2. Diseases of the Heart: The most common troubles are:**

a. *Palpitation of the heart:* can be avoided by care; caused by

1' Violent exercise.

2' Uncontrolled emotions.

3' Nervousness.

4' Habitual use of alcohol and tobacco.

- b. *Fainting*: caused by the failure of the heart to send sufficient blood to the brain; cold water thrown in the face will revive patient.
  - c. *Fatty heart*: a common change in the heart's muscles, in which particles of the cells are changed to fat. Weakens heart walls; excitement and overwork should be avoided.
  - d. *Diseases of the valves*: another common form of heart trouble, usually caused by *rheumatism*, the most dangerous of heart troubles, is the thickening and puckering of the valves, causing a leakage. The heart grows larger and stronger to pump enough blood; but a limit is set, beyond which the heart fails in strength; often fatal.
3. **A Good Circulation**: Bodily health and strength are impossible without a vigorous circulation of the blood in healthy blood vessels. It can be obtained by
- a. *Plenty of fresh air.*
  - b. *Proper exercise.*
  - c. *Frequent bathing.*
- Handwritten notes:  
The heart is a muscle  
and it contracts  
and relaxes  
to pump the blood  
through the vessels  
of the body.

## CHAPTER VII

### RESPIRATION

I. **RESPIRATION:** The process of breathing; or taking in and giving out air.

**1. The Function of Respiration:**

- a. To supply oxygen to the body.
- b. To eliminate carbon dioxide.

**2. The Organs of Respiration:**

a. *Nose and pharynx.*

1' Two nostrils; lead into

2' Two nasal chambers:

a' Cartilaginous partition: separates the chambers.

b' Turbinated bones: a much folded, wrinkled, spongy arrangement of thin bones, which form the outer wall of each chamber. They serve a double purpose:

1'' Strain out coarse particles that would otherwise enter with air.

2'' Serve as radiators, warming the air in cold weather.

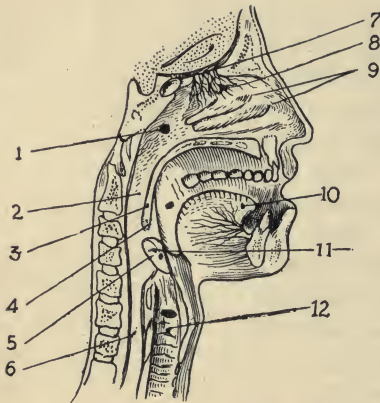
c' *Epithelium:* lines the walls of the nasal cavities. It contains innumerable

1'' *Mucous gland cells;* also microscopic hairs called

2'' *Ciliated cells:* these wave continually in an up-and-down motion which tends to keep dust away from the lungs.

- d' *Lachrymal canals*: lead from inner corner of each eye to the tear sac, which is located very near the eye, in the tissues of the nose. From each of these sacs, a canal leads to the nose chamber of that side.
- e' *Ethmoid bone*: a thin partition separating the nose passages from the brain. Through the numerous short canals in this bone pass the
- 1'' Olfactory nerves: subdivided into numerous fine fibers, which end among the *olfactory cells* located high up in the nasal cavities.
- b. *The trachea*: the windpipe.
- 1' Size: about five inches by three-quarters inch.
- 2' Origin: leaves pharynx cavity just back of tongue.
- 3' Epiglottis: the lid which prevents food from "going down the wrong way."
- 4' Anatomy: made rigid and held open by a series of *cartilaginous rings* shaped like horse-shoes, with their open ends behind, thus permitting food to pass down the esophagus with less resistance.
- c. *Bronchial tubes*: a right and a left fork of the trachea given off in thorax. These immediately enter the
- d. *Lungs*: the essential organs of respiration; elongated bags of spongy elastic tissue surrounded by the *pleura* (similar to the pericardium around the heart) and divided into *lobes* (right lung having three, and left two). Within these lobes, the bronchial tubes subdivide into the
- 1' *Bronchioles*, and these, in turn, subdivide into still smaller branches (*bronchiolets*), at the ends of which are the





1. Eustachian tube.
2. Pharynx.
3. Soft palate.
4. Uvula.
5. Epiglottis.
6. Esophagus.
7. Lachrymal glands.
8. Nasal chambers
9. Nostrils.
10. Tongue.
11. Epiglottis (open).
12. Trachea.

Fig. 1.—Section of Head showing Upper Air Passages

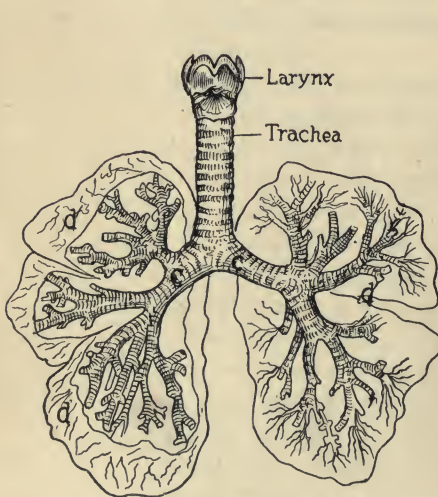


Fig. 2.—Bronchi and Air Passages

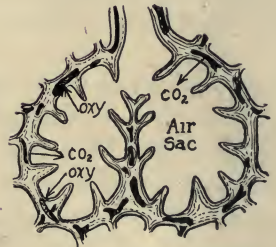


Fig. 3.—Alveoli

a' *Alveoli*: little air sacs, which are very elastic. Here the blood and the air are able to exchange gases, because the walls of the alveoli contain a complete network of

1'' Small *capillaries* with very thin walls. (These are the capillaries that form the connecting links between the pulmonary arteries and the pulmonary veins.)

e. *Cilia*: tiny, waving, hair-like bodies found in the whole series of air passages. They are in constant motion, producing a current which flows upward toward the pharynx, thus expelling into the sputum injurious particles that may have been inhaled.

f. *Summary of the air passages*:

1' Two nostrils, through which air enters and passes to the

2' Two nasal chambers, where it is warmed and partly filtered. Thence on to the

3' *Trachea*, an ever-open passage leading from the *pharynx* into the *thorax*, where it subdivides into

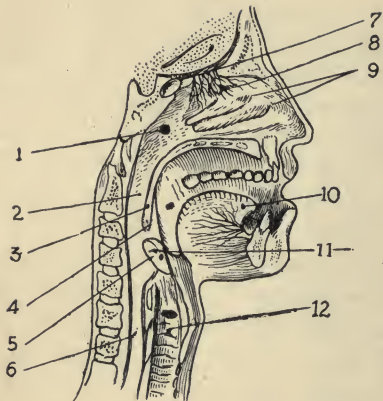
4' Two *bronchi*, which further divide into

5' Numerous *bronchioles*. These divide still further into

6' Minute twigs (*bronchiolets*), at ends of which are small sacs,

a' The alveoli; within and around the walls of which are

1'' Countless *capillaries*, through whose thin walls the exchange of gases in the lungs takes place.



1. Eustachian tube.
2. Pharynx.
3. Soft palate.
4. Uvula.
5. Epiglottis.
6. Esophagus.
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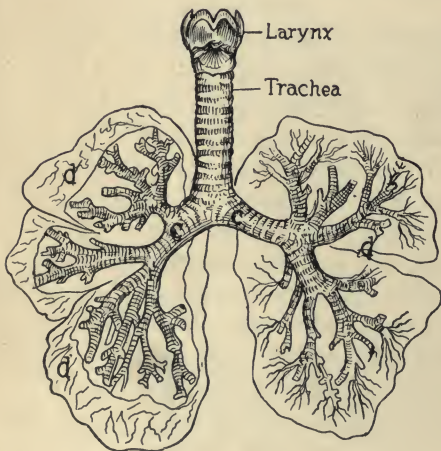


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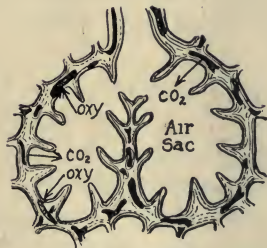


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13 } **3. The Mechanism of Respiration.** The lungs never fill of themselves; they fill because air is driven into them. This is done by the vacuum principle. Since the thoracic cavity is air-tight, any motion that will enlarge the cavity of the chest will force air into the lungs. Chest is so constructed it admits of two such motions:

a. *Rib motion*: made possible by:

- 1' Inclination of the ribs: downward and forward.
- 2' Hinges of ribs: to backbone and to sternum.
- 3' Two sets of muscles:

a' *External intercostals*: capable of lifting the ribs; thus pushing the sternum forward farther from the backbone. They also cause a greater distance between the ribs laterally. In these two ways the external intercostals enlarge the cavity and force air into lungs (inspiration).

b' *Internal intercostals*: pull ribs downward, thus decreasing size of the cavity and expelling air (expiration).

b. *Diaphragm breathing*:

- 1' Natural position of diaphragm: a dome extending from bottom of thoracic cavity upward into the thorax.
- 2' Structure of diaphragm: center, a tough membrane; from the edges of which muscles radiate to the walls of the cavity.
- 3' Action of diaphragm:

a' *Inspiration*: the radiating muscles contract, drawing the center of the diaphragm downward, enlarging the cavity and forcing air into the lungs.

b' *Expiration*: the muscles simply relax, permitting the organs of the abdomen to force the diaphragm to return to its dome shape, expelling some of the air.

*capitulum + dissection of parts*

**4. The Control of Respiration:** Unlike the heart, the breathing muscles are not automatic, but are governed by a rather complex

a. *Mechanism of control:*

1' The respiratory center: a portion of the medulla, from which nerve fibers extend for some distance down the

2' Spinal cord; thence issue, from each side of the neck.

3' Three roots (between second and third, third and fourth, fourth and fifth vertebræ). These roots unite to form *on each side* a

4' Phrenic nerve, which passes down through the thorax behind the lungs, and spreads out in the muscles of the diaphragm. These branches carry messages from the brain to diaphragm, but not *vice versa*.

5' *Intercostal* nerves: a second set of nerves from the respiratory center. They emerge from the spinal cord, in the region of the ribs, into the intercostal muscles.

6' Respiratory branches of the *vagus* nerves: carry messages from the organs to the brain, giving information as to conditions in the lungs.

b. *The normal rate of action:* about fifteen to twenty times per minute, depending upon condition of the blood flowing through the medulla.

c. *Kind of action:* partly voluntary; and partly involuntary.

**5. Amount of Respiration:**

a. *Tidal air:* air regularly taken in at each inspiration: = c. 30 cu. in.

b. *Complemental air:* air that, with some effort, can be inhaled in addition to the tidal air: = c. 120 cu. in.

c. *Supplemental air:* air that, with some effort, can be expelled in addition to tidal air: = c. 100 cu. in.

- d. *Residual air*: air that cannot be expelled: = c. 100 cu. in.
- e. *Total amount* that lungs of ordinary individual contain: = c. 230 cu. in.

## 6. Respiratory Habits:

a. *Need of care concerning methods of breathing*: One type of breathing alone causes part of lungs to be inactive, a result that may lead to lung disease.

- ? / 1' *Rib breathing* alone: fills only the upper lobes.
- 2' *Diaphragm breathing*: fills only lower part of lungs.

b. *Care in methods of dressing*: avoid obstructing free action of both ribs and chest.

c. *Suggested exercises*: Breathe deeply in open air several times each day.

- 1' Men should practice using more *rib* breathing.
- 2' Women should practice using more *abdominal* breathing.

## 7. The Chemistry of Respiration:

a. *Chemical changes in the air during respiration*:

1' Inhaled air:

a' Contents:

1'' Oxygen: c. twenty per cent.

2'' Carbon dioxide: none, or practically none.

3'' Moisture: varies with humidity of the atmosphere. On a dry day very slight.

b' Temperature: varies with the day.

2' Exhaled air:

a' Contents:

1'' Oxygen: only sixteen per cent.

2'' Carbon dioxide: four per cent.

3'' Moisture: as much as it can hold.

b' Temperature: about four per cent.

!!!  
!!!

- b. *Changes in the blood:* reverse of changes in the air.
- 1' Receives: oxygen.
  - 2' Gives up:
    - a' Carbon dioxide.
    - b' Moisture.
    - c' Heat.
- c. *Means by which the changes are accomplished:*
- 1' The entrance of oxygen: Due to:
    - a' Atmospheric pressure (fifteen pounds per square inch): causes the air within the *alveoli* to penetrate the capillaries, and enter the plasma of the blood by *absorption*.
    - b' Chemical combination: means by which the larger part is received. This is accomplished by the *hemoglobin*, which has an affinity for oxygen, and each particle of which is able to unite with a definite amount of oxygen, forming a chemical union. (This it is able to do from either pure oxygen or from oxygen greatly diluted by nitrogen.)
  - 2' The distribution of oxygen: accomplished by difference of pressure, whereby red corpuscles give up the oxygen they are carrying.
  - 3' The exclusion of oxygen: breathing *carbon-monoxide*.
    - a' Sources of carbon monoxide: coal gas, and all illuminating gas.
    - b' Action: combines more readily with hemoglobin than does oxygen. Hence, when both are in the same air, carbon monoxide is taken and oxygen excluded, resulting in suffocation. (Hence the danger arising from the use of stoves and leaking gas pipes.)

4' The expulsion of carbon dioxide:

a' The *blood*, as it flows through capillaries of the tissues, absorbs this gas, because there its pressure is high. From these tissues it then carries the carbon dioxide to the

b' *Capillaries* of the lungs, which cast it off with the expired breath, because in the air sacs in the lungs the carbon dioxide pressure is very low. (But, in case the inhaled air contains very much carbon dioxide, the blood is unable to rid itself of its burden of the gas, and death soon results, as is shown by the quick fatality from the "damps" that collect in deep wells.)

## II. HYGIENE OF THE RESPIRATORY ORGANS.

### 1. Breathing and Exercise:

a. *Necessity of breathing:*

1' One cannot live without oxygen.

2' Carbon dioxide would soon poison one if not expelled.

b. *Necessity of rapid breathing during vigorous exercise:*

1' Extra activity requires an extra amount of oxygen.

2' The extra energy, in being liberated, creates more carbon dioxide.

c. *Insufficiency of rapid breathing alone during vigorous exercise:*

1' The second wind: the extra supplies of oxygen and carbon dioxide, in being transported to or from the tissues, require an increased activity of blood flow. When this accommodation has been made, one is said to have received his "second wind."

d. *The value of fresh air:*

- 1' Fresh air renders those who have plenty of it less liable to lung diseases, and makes them more active and alert.
- 2' Lack of fresh air brings stupidity, sleepiness, disease, partly because:
  - a' Air previously breathed contains a large amount of water, and has a
  - b' High temperature.

e. *Ventilation:*

- 1' The need:
  - a' To supply fresh air.
  - b' To carry off foul air.
- 2' Amount required: about 2,000 cu. ft. of fresh air per individual per hour.
- 3' General principles:
  - a' Temperature should never be higher than seventy degrees, unless for very aged persons or for infants.
  - b' Constant motion of air is needed.
    - 1'' Open fireplace: excellent.
    - 2'' Stove: good.
    - 3'' Gas burners: poor.
    - 4'' Steam or water furnaces: poor.
  - c' The greater the difference in temperature between the air in a room and that outside, the easier it is to produce currents of air.
  - d' Rooms of an ordinary dwelling usually require no special attention to ventilation.
  - e' Sleeping rooms should be more carefully ventilated than living rooms; school rooms need extreme care.
  - f' Expired air is warmer than the ordinary air of a room, and rises at first, but sinks as it cools.

f. *Suffocation*: its treatment.

- 1' First of all, remove the source of the trouble.
- 2' Start artificial respiration immediately.
  - a' Place patient on back.
  - b' Force arms down by sides, lowering the ribs at the same time.
  - c' Press patient's abdomen, raising the diaphragm, and expelling as much air as possible.
  - d' Release pressure on abdomen, and lift arms outward and high above head.
  - e' Repeat about twenty times per minute.
- 3' Keep up your courage at least one hour (unless recovery comes sooner).
- 4' Wrap patient warmly and cease artificial respiration as soon as signs of natural breathing are shown.

g. *Drowning*: a form of death by suffocation, complicated by the lungs being filled with water.

Treatment:

- 1' Do not take time to remove patient.
- 2' Lay him face downward and forcibly compress back to remove water from lungs, or
- 3' Suspend him head down, and raise him up and down by grasping about lower part of chest.
- 4' Proceed as in artificial respiration.

h. *Electric shock*: Life may possibly be restored by artificial respiration, if resorted to at once.

## 2. Diseases of the Respiratory Organs.

a. *Colds*: Primarily, inflammation of mucous membrane, which should receive prompt treatment.

- 1' Usual seat of trouble: nose and throat.
- 2' Symptoms: too much blood in region affected, causing sensitiveness, pain, and perhaps fever, as well as swollen mucous membrane and an abundant flow of mucous secretion.



- 3' Cause: not exactly known (somehow related to vasomotor control).
  - 4' Remedy:
    - a' Soak feet in hot water.
    - b' Drink hot lemonade, and go to bed.
  - 5' Prevention:
    - a' Do not neglect regular bath.
    - b' Do not keep rooms too warm. Be especially careful not to go from a very warm room to a very cold one.
    - c' Avoid use of too much clothing, especially indoors.
    - d' Get plenty of fresh air; sleep with your window up.
- b. *Bronchitis*: inflammation, acute or chronic, of the bronchial tubes or their branches. In case of a child or an old person, severe illness or death may result, or it may develop into bronchial consumption.
- c. *Pneumonia*: a germ disease which involves the lung tissue.
- 1' Cause: presence of bacteria, usually after parts have been irritated by severe colds.
  - 2' Symptoms: violent inflammation accompanied by high fever; breathing difficult because the secretions fill, wholly or partly, many of the air sacs (alveoli).
  - 3' Results: serious, very often fatal.
  - 4' Remedy: go to bed and send for physician at once.
  - 5' Prevention: guard against colds.
- d. *Pleurisy*: inflammation of the pleura or covering of the lungs.
- 1' Cause: usually the result of a cold.
  - 2' Effect: painful breathing; rarely dangerous if treated by a competent physician.

- e. Tuberculosis: man's greatest foe.*
- 1' Cause: *tubercle bacillus*.
  - 2' Chief methods of entering the body:
    - a' Through mouth with food.
    - b' Through nose with air.
  - 3' Forms of the disease:
    - a' Diseases of the digestive organs.
    - b' Lupus: a skin disease.
    - c' Scrofula: when germ works in glands of skin, causing them to swell.
    - d' Nephritis: germ grows in kidneys.
    - e' Meningitis: germ grows in brain.
    - f' Joint troubles: especially hip disease.
    - g' Consumption: in lungs; most general and serious of all.
      - 1'' Nature of action: formation of tubercles, causing lungs to degenerate, sometimes producing rupture of blood vessels, and causing hemorrhages.
  - 4' The war against tuberculosis must be waged by preventing the disease *vs.* trying to cure it. This must be done by spreading
    - a' The chief facts concerning it: viz., that
      - 1'' It is not hereditary.
      - 2'' It is contagious.
      - 3'' The germs may be carried in the air.
      - 4'' Dried sputum or dried scrofulous discharges may contain the germs of tuberculosis.
      - 5'' Cows sometimes have tuberculosis and transmit it through their milk.
      - 6'' There is no medicine that cures it.
      - 7'' Every one has considerable power of resisting it.



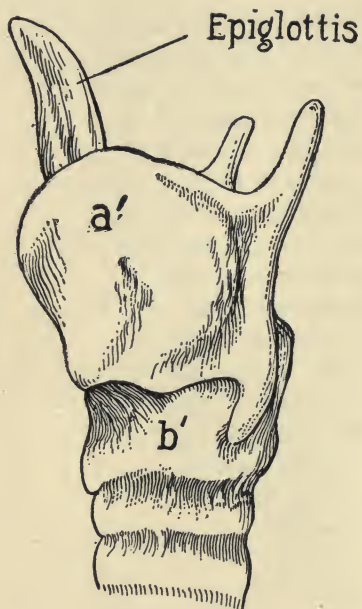


Fig. 1.—The Larynx

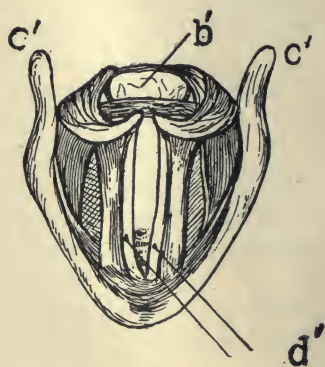


Fig. 2.—The Cricoid Cartilage

b' Chief weapons against it:

1'' Right food; correct habits.

2'' Extreme care, especially in regard to

a'' Milk used.

b'' Air inhaled in sick room.

c'' Contact with sputum.

f. Adenoid growths: abnormal obstructions.

1' Location: just back of nasal canals, in the region where they open into the pharynx; occasionally as far down as tonsils, in which case, the tonsils too are usually inflamed.

2' Form: small grape-like bodies, from size of a pea to that of an almond; sometimes presenting the appearance of tiny mushrooms.

3' Time of occurrence: most frequently in children between ages of ten and fifteen.

4' Cause: growth of useless tissue. (Apparently not due to any particular exposure.)

5' Effects:

1'' Induce mouth *vs.* nose breathing.

2'' May impair hearing.

3'' May cause imperfect development of whole body, especially of mouth and face.

6' Remedy: simple operation by a good surgeon.

### III. THE VOICE.

#### 1. The Vocal Organs:

a. *The tongue*: simply a modifying agent.

b. *Larynx*: the voice box, of triangular shape, about three-fourths inch across, made of cartilages.

1' Location: just below the glottis, in the trachea.

2' Anatomy:

a' The *thyroid* cartilage: a broad U-shaped cartilage (Adam's apple). On each arm of the U a prong extends upward, and another downward.

b' *Cricoid*: a complete ring, narrow in front and broad at the back; hinged behind to the lower prong of the thyroid.

c' Two *arytenoid*: small, triangular cartilages, located on the upper edge of the hind border of the cricoid.

d' Vocal cords: two transverse, curtain-like membranes, attached at the back to the *arytenoids*, at front and sides to the *thyroid*.

## 2. Production of Voice, and Some Characteristics of Same :

- a. *Action of the vocal cords*: In making a sound, they are drawn very near each other, and stretched tightly, and air is forced through the slit between them.
- b. *Pitch of voice*: varied not by change of length of cords, but by tension.
- c. *Difference between the voices of men and women*: due to the fact that woman's larynx is smaller than man's.
- d. *Quality of voice*: due to the shape and size of the larynx and of the various air spaces of the throat, mouth, and nose.
- e. *Loudness of voice*: depends upon the amount of the vibration of the vocal cords, which is determined by the strength of the air current expelled from larynx.
- f. *Pronunciation*: not governed by loudness, but by putting the lips, teeth, tongue, and palate into proper position.

## CHAPTER VIII

### EXCRETION

I. DEFINITION. The process of eliminating the oxidized and waste matter of the body. This is accomplished by five organs, which also excrete the poisons produced by germ diseases: lungs, liver, intestine, kidneys, and skin.

1. **The Lungs:** expel the *carbon dioxide* carried to them by the blood vessels from the decomposed tissues. (See Respiration.)
2. **The Liver:** is constantly destroying poisons it receives from the blood of the intestines, and also from other parts of the body, passing the waste through the intestine. If the liver fails to excrete the waste biliary matters they pass off through the kidneys.
3. **The Intestine:** waste intestinal matter discharged as *fæces*.
4. **The Kidneys:** perform the larger part of the work of excretion.
  - a. *Their excreta (urea):* broken-down proteid material.
    - 1' Average daily amount: about three pints.
    - 2' Frequency of discharge: depending upon rate of formation in the body; also upon
      - a' Certain altering foods and drugs.
      - b' Amount of liquids swallowed.
      - c' Nervousness.
  - b. *Location:* two in number—one on each side of the backbone, half-covered by the two lower ribs. They are about four inches long by two wide, and one inch thick; and are covered by peritoneum.
  - c. *Color:* dark red.

d. *Shape*: bean-shaped, i. e., oval, with a depression on the side toward the spine. Here in *each* kidney exit or enter

1' The *renal artery*: coming direct from the aorta.

2' The *renal vein*: to *inferior vena cava*.

3' The *ureter*: a tube about the size of a large quill lined with mucous membrane and surrounded by muscles, which leads to bladder, whither, by peristalsis, it conducts urea.

e. *Anatomy*:

1' The *pelvis*: a continuation of the hollow space of the ureter (as the large end of a funnel) into the body of the kidney.

2' *Malpighian* pyramids: globular dilatations of tissue protruding from "meat" of kidney.

3' *Medulla*: the inner part of the kidney, bordering on the pelvis and composed of:

a' Connective tissue.

b' Large blood vessels.

c' Collecting tubules.

4' *Cortex* (the bark): the surface layer; contains

a' Blood capillaries—myriads of them.

b' The real glands of excretion:

1'' The *Malpighian tubules*: drain the glands of the cortex, carrying their excretion through the *medulla* to the *Malpighian* pyramids, pouring it into pelvis; thence into bladder through the ureter.

a'' *Malpighian capsule*: a bulb, deeply indented on one side. Within this bulb is the

1''' *Glomerulus*: knot of minute capillaries that permit *water* and *salt* to filter into capsule.



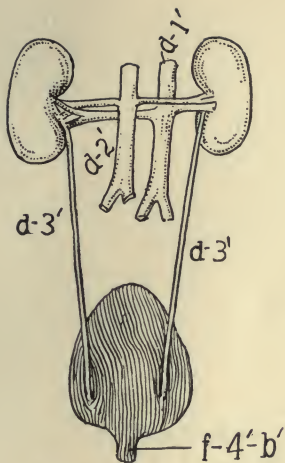


Fig. 1.—Kidneys and Bladder

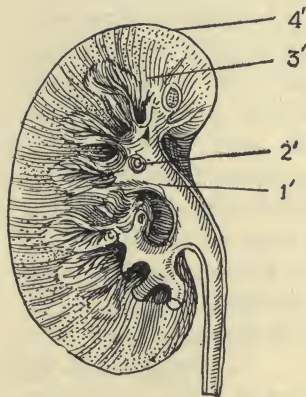


Fig. 2.—Anatomy of the Kidneys

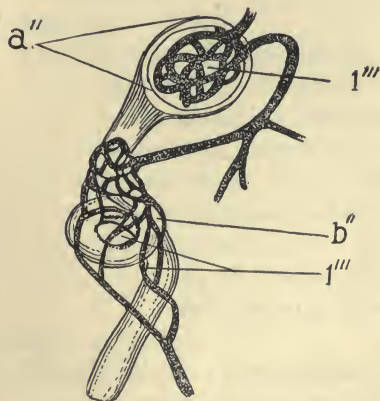


Fig. 3.—Malpighian Capsule (highly magnified)



b'' Convoluted part of tube: portion running from capsule to pelvis; then returning to cortex; then turning again and passing to one of pyramids.

1''' Network of capillaries, coming from *glomerulus* and leading along outside of convoluted portion to *renal vein*. These permit *waste organic matter* to pass through walls of same.

f. *The bladder*: storage tank of the kidneys.

1' Location: center abdominal cavity; in front of rectum.

2' Shape: oval sac.

3' Size: five by three inches; capacity about two-thirds pint.

4' Anatomy:

a' Muscular fibers: extend in every direction around the inside of the wall, and, by contracting, decrease the bladder dimensions, emptying it.

b' Urethra: single tube leading from middle of lower end of bladder to exterior.

1'' Circular muscles: pass around opening of bladder and keep it closed until message is sent them.

g. *Diseases of the kidneys*:

1' *Bright's disease*: a condition usually inflammatory, which prevents the proper excretion of poisonous matter.

a' Symptoms: scanty amount of urine, with some albumin deposit.

b' Effects: very dangerous; but recovery from some forms of it are frequent.

- 2' *Diabetes*: a disease marked by persistent, excessive urine, in which are large deposits of sugar. Aggravated by starch and sugar in diet. Usually fatal.
- 3' *Nephritis*: inflammation of the kidneys; very dangerous.
- 4' *Kidney stones*: small hard nodules formed in the pelvis; often cause severe pain as they pass down the ureter to the bladder; can often be dissolved by medicine; sometimes require a surgical operation.

*h. Hygiene of the kidneys:*

- 1' Avoid the use of alcoholic beverages, as more than one-half of the kidney diseases are due to their use.
- 2' Drink plenty of pure, fresh water, thus keeping the kidneys well flushed.
- 3' Avoid an excessive meat diet, as it forms more waste matter than the kidneys can care for.

**5. The Skin:** The covering of the body; a thick elastic integument made up chiefly of thick interlacing fibers.

*a. Anatomy:* composed of two principal layers.

1' The *epidermis*: the surface layer; also called the *cuticle* or *scarfskin*; has two layers:

a' The outer one composed of epithelial cells, flattened and overlapping each other like scales. Has no blood vessels or nerves, and is being constantly worn away.

b' The inner surface contains

1'' The *growing cells*, which furnish new cells to take the place of the dead cells of the outer surface, which fall off as dried skin, and the dandruff that collects around the roots of the hair.

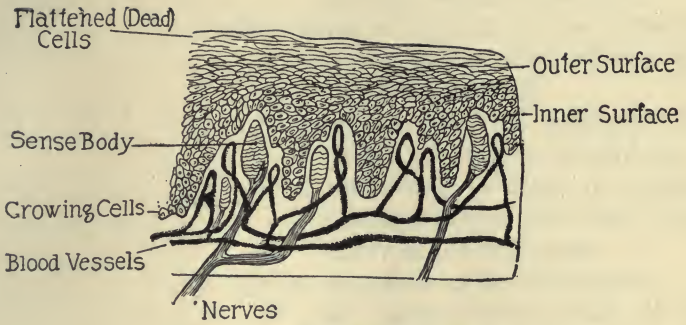


Fig. 1.—Section of Epidermis (5-a-1')

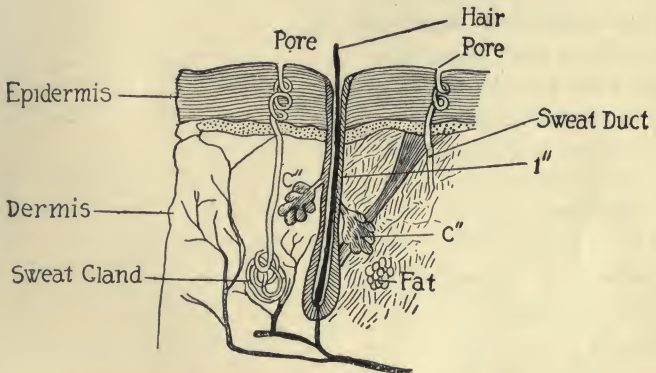


Fig. 2.—Section of Skin showing special Structures (d'-p. 63)



- 2'' The *pigment cells*, which give the coloring matter to the skin.
- c' The effects of friction on the epidermis:
  - 1'' Calluses: produced by ordinary wear on hands and feet.
  - 2'' Corns: a point of hardened cells caused by pressure or rubbing.
  - 3'' Blisters: due to drugs or vigorous rubbing, which kills the deeper layers of the epidermis.
- d' Special structures of the epidermis:
  - 1'' *Hair follicles*: tiny canals of epidermal cells, enlarged at lower end and extending far down into the dermal layer.
    - a'' *Papilla*: a projection extending upward into the follicle; on it grows
    - b'' The *hair*: a hollow tube of epidermis; has three layers:
      - 1''' *Medulla*: a kind of pith within center of hair;
      - 2''' *Cortex*: a horny layer, surrounding the medulla; contains
        - a''' Pigment of hair.
      - 3''' *Cuticle*: a transverse, overlapping series of cells on the outside of the cortex.
    - c'' Oil or sebaceous glands: one empties into each follicle. They secrete a substance which moistens the surface of the hair and keeps it soft and flexible.

- 2'' Nails: thickened parts of the epidermal tissue at the ends of the fingers and toes; their growth is caused by growing cells of epidermis.
- 2' The *dermis*: the inner layer, or true skin, is composed chiefly of
  - a' Connective tissue. It contains, beside a number of structures including blood and lymph vessels and hair follicles:
    - 1'' Fat: in spaces between the fibers; fills out the skin and conceals the outline of muscles and bones.
    - 2'' *Papillæ*: many small elevations in the outer surface of the dermis.
      - a'' Nerve endings abundant in the papillæ. These are the end organs of
        - 1''' Touch.
        - 2''' Temperature (both heat and cold).
    - 3'' Sweat glands.
    - 4'' Ducts to sweat glands.
      - a'' Pores: the exterior openings of the ducts.
- b. *Functions (physiology) of the skin*:
  - 1' Protecting organ: debar bacteria.
  - 2' Excreting organ.
    - a' Amount of its daily excretion: estimated one to five pints.
    - b' Form of excretion: "sweat," perspiration (chiefly water and salts).
      - 1'' Sensible perspiration: that of which we are conscious.
      - 2'' Insensible perspiration: that of which we are not conscious.



c' Excretory ("sweat") glands: minute tubes of uniform diameter, closed and coiled at their inner ends and opening to the surface through very small pores.

1'' Control: a special set of nerves (*secretory nerves*) stimulates the cells of the glands causing them to expel "sweat" through their pores *via* the ducts. These nerves may be stimulated by

a'' Reflex influences (as when we work).

b'' State of the atmosphere.

c'' Fright.

d'' Abnormal condition of the internal organs.

2'' Functions:

a'' Excretion (cf. above).

b'' Regulation of the body temperature.

1''' For the purpose of carrying on life processes, the body temperature *must be high* (about ninety-eight degrees normal).

2''' The temperature is also almost *uniform*.

3''' A *marked rise* or *fall* in temperature causes or results from disease or death.

4''' The *source* of all body heat — the oxidation of foods.

5''' Blood *distributes* but does not produce heat.

6''' The *method* of heating the body gives rise to a classification of animals into *cold-blooded* and *warm-blooded*.

c'' Control of body temperature accomplished:

1''' By changing the amount of heat produced.

2''' By varying the amount of heat lost.

a''' By expansion and contraction of blood vessels in the skin — direct radiation.

b''' By perspiration: lowers the temperature by evaporation.

c. *Care (hygiene) of the skin:* consists chiefly in keeping the pores free and open.

1' Cold baths: by acting through stimuli sent to the brain cause

a' Contraction of the blood vessels in the skin, followed by a

b' Reaction: bringing more blood to the skin and causing an "afterglow." This afterglow may be greatly increased by vigorous rubbing immediately after the bath. If there is no afterglow but a chilliness the cold bath is not beneficial.

2' Hot baths: produce expansion of the blood vessels of the skin. This may be beneficial when it is desirable to draw the blood away from the brain or some inflamed region.

3' Clothing: Serves primarily as a

a' *Protection for the body:* for this purpose materials that are non-conductors of heat should be used in order to preserve an even temperature at the surface of the body. *Wool* is the best material for health; cotton not so good; linen very bad.

b' *Amount to be worn:* should always be determined by the weather and not by the season. Most people make the mistake of wearing too much, and thereby lessen their power of resistance.

4' Burns and frostbites:

a' Remedy for burns: ordinarily, p l u n g e burned part into cold water or bathe with soda water, then apply vaseline or some other oily substance to exclude the air, and bandage.

b' If clothing has caught fire: smother flames by wrapping with a blanket, rug, or woolen garment. Send for physician instantly.

c' Remedy for frostbites: cause the affected parts to thaw slowly by applying snow, ice, or very cold water; wrap patient up warmly and give him a hot stimulant, preferably coffee.

## CHAPTER IX

### THE SKELETON

I. DEFINITION: The bony framework of the body.

#### 1. Functions of the Skeleton:

- a. To give shape and support to the body.
- b. With the aid of the muscles to make motion possible.

#### 2. Parts of the Skeleton:

a. *The axial skeleton:* Forms the main axis of the body.

1' *The spinal column* (backbone): The central part of the axial skeleton, to which other parts of the bony structure are attached. It is composed of twenty-four small, flat bones called *vertebræ*, piled one above another, and strongly bound together with a pad of elastic cartilage between each two, and two bones found below the *vertebræ*, called the *sacrum* and the *coccyx*.

a' The parts of a vertebra:

1'' *Centrum:* the body or axis.

2'' *Neural arch:* bony arch on dorsal side of centrum.

3'' *Neural foramina:* a long tube formed by the *vertebræ* being placed one above the other in such a way as to make the cavity between the neural arch and the centrum of each vertebra continuous. It encloses the spinal cord.

b' The groups of vertebræ:

1'' *Cervical vertebræ*: seven (in the neck).

2'' *Dorsal vertebræ*: twelve (central part).

3'' *Lumbar vertebræ*: five (small of back).

4'' *Sacrum*: five vertebræ enlarged and grown together (region of hip joint).

5'' *Coccyx*: two to four small vertebræ partly joined.

2' *Ribs and sternum*:

a' *Sternum*: the breastbone.

b' *Ribs*: a series of slender, arching bones, fastened to the backbone and bending forward to form the thoracic cavity.

1'' The groups of ribs:

a'' *Floating ribs*: the two lower ribs on each side; attached to nothing in front.

b'' *False ribs*: three on each side; attached to each other in front; then indirectly

c'' Joined by cartilage to the sternum (*via* the lowest one of the true ribs).

d'' *True ribs*: seven on each side; directly attached to the sternum.

3' *The skull*: Irregular-shaped structure made up of complex arrangement of twenty-two bones.

a' Parts of the skull:

1'' The *cranium*: a large, roundish box, composed of eight large bones:

a'' *Occipital* (1): rests on spine.

b'' *Parietal* (2): form the crown.

c'' *Temporal* (2): one to each temple.

- d'' *Frontal* (1): forming forehead.
  - e'' *Sphenoid* (1): wedge-shaped; in front of temporals.
  - f'' *Ethmoid* (1): together with sphenoid, forms base of the cranium, and separates it from the face.
- 2'' The facial bones: fourteen in number, form the outline of the face:
- a'' *Malar*: cheek bones (2).
  - b'' *Maxillæ*: upper jaw (2).
  - c'' *Palatal*: with maxillæ form roof of mouth (2).
  - d'' *Nasal*: roof of the nose (2).
  - e'' *Lachrymal*: form that part of the eye socket nearest the nose (2).
  - f'' *Turbinated*: outer walls of the nasal chamber (2).
  - g'' *Vomer*: nasal partition (1).
  - h'' The *mandible* (lower jaw): a single bone, hinged to the temporal bones.
- 3'' Bones of the ears (six in number):
- a'' *Malleus* (2).
  - b'' *Incus* (2).
  - c'' *Stapes* (2).
- b. *The appendicular skeleton:*
- 1' Shoulder and arm.
    - a' Pectoral girdle: composed of
      - 1'' *Scapula* (shoulder blade): to which the upper bone of the arm is hinged.
      - 2'' *Clavicle* (collar bone): extends from sternum to scapula; braces the scapula.

b' The arm: each arm and hand consists of—

1'' *Humerus*: extends from shoulder to elbow.

2'' *Radius*: together with

3'' *Ulna*: lies between elbow and wrist.

4'' *Carpals*: eight wrist bones; they are followed by

5'' *Metacarpals*: five elongated bones, forming the framework of the body of the hand.

6'' *Phalanges*: fourteen finger bones.

2' The hip and the leg:

a' The pelvic girdle: formed by the union of

1'' The *sacrum*, and

2'' *Os innominatum* (hip bone).

b' The leg: each leg and foot consists of

1'' *Femur* (thigh bone): extends from pelvis to knee.

2'' *Patella*: the knee cap.

3'' *Tibia*: extends from knee to ankle.

4'' *Fibula*: lies alongside the tibia.

5'' *Tarsals*: seven bones supporting each ankle.

6'' *Metatarsals*: fifteen elongated bones, forming the skeleton of the body of the foot.

7'' *Phalanges*: the fourteen bones of the toes.

3. **Deformities of the Skeleton:** are due chiefly, not to accidents, but to

a. *Incorrect positions of the body.* Among those most frequently seen are:

1' Curvature of the spine.

2' Crook in the neck.

3' One hip or shoulder higher than the other, etc.

- b. *Cured or prevented* by proper positions in
  - 1' Sitting.
  - 2' Standing.
  - 3' Sleeping.
  - 4' Posture in work, and by
  - 5' Military exercises to improve the form and give a good carriage.
- c. *Hygienic footwear*: necessary to erectness and ease in walking. Uncomfortable and ill-fitting shoes permanently deform the feet.

#### 4. Structure of Bones:

- a. *Shape*: Always designed to render them as strong and yet as light as possible.
  - 1' Flat bones: *e. g.*, ribs, shoulder blade, cranium.
  - 2' Irregular bones: *e. g.*, ethmoid, sphenoid, vertebrae.
  - 3' Short bones: *e. g.*, in wrist and in ankle.
  - 4' Long bones: *e. g.*, in arm and in leg.
  - 5' Sesamoid bones: *e. g.*, patella.
- b. *Parts*:
  - 1' Shaft: the middle portion; contains a
    - a' Medullary canal: a hollow cavity extending lengthwise of the bone. This cavity is filled with
      - 1'' Marrow, a soft, yellowish-red substance, chiefly fat.
  - 2' Ends: the large, porous portion on which the joints are formed.
- c. *Covering*: the *periosteum*, which surrounds every bone, affording attachment for muscles and containing numerous blood vessels which supply nourishment to the bone.
- d. *Composition*:
  - 1' Mineral substance: chiefly phosphate of lime; hard and brittle; gives rigidity to the bone.



2' Animal matter: a tough material; neither hard nor brittle; gives strength and toughness to the bone.

e. *The age element*: In children, the major part of the bone is animal matter, but with the increase in age comes an increased deposit of lime, until, in old age, the greater part is not animal but mineral matter. Thus, age causes the bones to pass from a very plastic state to a very brittle one.

f. *Nature's provision for repair*:

1' *Blood vessels*: carry nourishment to every minute portion of bone.

2' *Bone cells*: exist in myriads; are minute, living cells, able to grow and reproduce.

3' *Periosteum*: able to perform both of above functions.

g. *Microscopic structure of bone tissue*:

1' *Lamellæ*: concentric layers of bone tissue around

2' *Haversian canals*: which run lengthwise of bone and contain:

3' *Lacunæ*: small lens-shaped spaces between the layers of lamellæ. From these radiate

4' *Canaliculi*: numerous minute tubes, passing from one row of *lacunæ* to another.

h. *Bone fractures*: not often serious mishaps, but always require the services of a surgeon, as the limb will be permanently deformed if the bone is not properly set.

5. **Cartilage**: Differs from bone in that it is softer and is not supplied with blood vessels:

a. *In early life*: the substance of most of the skeleton.

b. *In adult life*: some remains, e. g.:

1' Vertebral cushions.

2' Rings of trachea.

3' Ends of ribs.

4' Joint cushions.

5' Outer ear.

## 6. Joints:

### a. *Types of joints:*

#### 1' Imperfect joints, *e. g.*:

a' Sutures: as of cranium.

b' Gliding: as of vertebræ.

#### 2' Perfect or movable joints, *e. g.*:

a' Hinge joints: permit motion back and forth; *e. g.*, knee, elbow, and fingers.

b' Ball and socket: one bone has a round, ball-like head which fits into a socket of another; permits at least one of the members composing the joint to be either flexed, extended, adducted, abducted, or rotated; *e. g.*, hip joint and shoulder.

c' Pivot: the two bones concerned rotate on one another; *e. g.*, atlas and axis vertebræ.

b. *Lever formations:* Nearly all joints are crossed by muscles. They act as ligaments and keep the bones in place; thus when a muscle acts on one side of a joint a muscle contracts on the opposite side to keep the bone from being pulled out. The bone is the bar, the joint the fulcrum, the muscle the power. This arrangement gives rise to several lever formations in the body, viz.:

#### 1' First-class levers:

a' Definition: A first-class lever is one that has the weight on one end, the power on the other end, and the fulcrum between.

b' Example: the skull (cranium = *w*; atlas vertebra = *f*; chin = *p*).

#### 2' Second-class levers:

a' Definition: A second-class lever is one that has the fulcrum on one end, the power

on the other end, and the weight between.

b' Example: when we raise ourselves upon our toes (toes =  $f$ ; ankle =  $w$ ; heel =  $p$ ).

3' Third-class levers:

a' Definition: A third-class lever is one that has the fulcrum on one end, the weight on the other end, and the power between.

b' Example: when we bend the forearm (elbow =  $f$ ; hand =  $w$ ; point at which the tendon joins the bone =  $p$ ).

c. *Structure of joints:*

1' *Cartilage:* furnishes padding.

2' *Synovial membrane:* a membrane surrounding the ends of the bones and secreting the

3' *Synovial fluid* (joint water), which moistens the surface and prevents friction.

4' *Ligaments:* very tough bands which hold the bones together.

d. *Injuries to joints:*

1' Sprains: due to overstretching some ligament.

a' Treatment: Place joint in most comfortable position; apply successively very hot, then very cold water; bandage tightly. If serious send for physician.

2' Dislocation: bones are pulled out of position.

a' Treatment: Bones must first be pulled back into position (by a skilled surgeon—unless the joint is a minor one or a surgeon is not available), then treated like a sprain.

## CHAPTER X

### THE MUSCLES

I. **DEFINITION:** The organs which by contraction produce the motions of the body. They are composed of contractile tissue and cover almost the entire skeleton. They give symmetry and beauty to the body as well as motion.

#### 1. Properties of Muscles:

- a. **Irritability:** enables the muscles to respond to a stimulus; a condition which is necessary to their control.
- b. **Contractility:** enables muscles to draw up and produce motion.

2. **Muscle Tissue:** There are two kinds: the voluntary and the involuntary.

- a. **Striated:** makes up the *voluntary* muscles—those under the control of the will. Characterized by light and dark bands of muscle cells running cross-wise of the lengthwise fiber.

#### 1' Parts:

- a' **Fleshy portion:** composed of great numbers of long fibers of a reddish color, bound together in bundles and enclosed in a sheath of connective tissue. Usually bulge at the center, where contraction occurs. They end in
- b' **Tendons:** tough white cords or bands of fibrous connective tissue that unite the muscle either to a bone or to some other muscle.

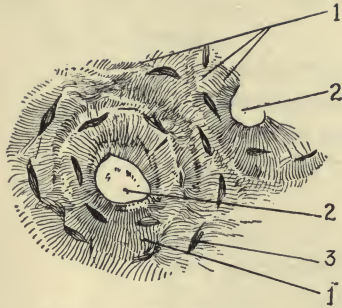


Fig. 1.—Microscopic Bone Structure (4-g. p. 73)

1. Lamellæ. 2. Haversian canals. 3. Lacunæ. 4. Canaliculi.



Fig. 2.—Striated Muscle Cell (2-a-2')

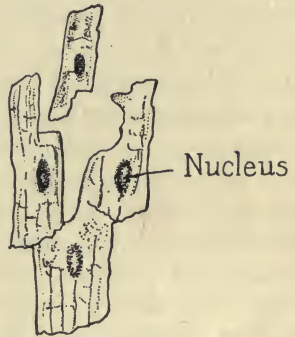


Fig. 3.—Cardiac Muscle Cell (2-c-1')

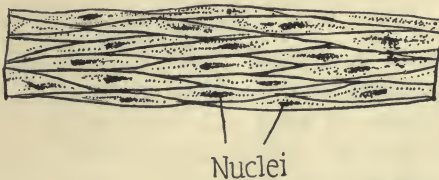


Fig. 4.—Nonstriated (involuntary) Muscle Cell (2-b-3')



- 2' Microscopic structure: the cross-section of a muscle reveals
  - a' *Fasciculi*: elongated fibers loosely bound together by connective tissue and running lengthwise of the muscle; consist of a large number of minute threads called
    - 1'' Muscle cells: too small to be seen with the naked eye. They are cylindrical bodies traversed by fine cross lines called *striæ*.
    - 2'' *Sarcolemma*: the fiber sheath, or outer tube surrounding the jelly-like substance of each muscle cell.
- 3' *Contraction* of the muscles: Every striated muscle is attached at each end to a fixed point in the body, and there is always a joint between the two ends of a muscle, so that when the muscle is contracted, or the two ends brought closer together, motion is produced in the limb or joint to which that particular muscle is attached. In contracting the muscle becomes shorter and thicker. When the tension is released the muscle returns to its elongated shape. To accomplish this nearly all the muscles are arranged in opposing pairs.
- 4' Nerve control: Each action of a voluntary muscle is due to some stimulus or order sent out from the brain or spinal cord. "Practice makes perfect" because the brain thus learns to exercise this wonderful power most effectively.
- 5' *Tetanus*: a state of prolonged contraction, due to a long series of *stimuli* in rapid succession.

- 6' Fatigue: due, primarily, not to overwork of the muscles themselves, but to fatigue of the nerves.
- 7' Names of some important muscles. In the
- a' Head: *temporal* and *masseter*.
  - b' Neck: *sterno-mastoids*.
  - c' Upper arm: *biceps* and *triceps*; *deltoid* beyond shoulder.
  - d' Forearm: *flexors* and *extensors*.
  - e' Trunk: *pectoralis major*; *trapezius*; *rectus abdominis*; *erector spinæ*.
  - f' Hip: *glutens maximus*.
  - g' Upper leg: *rectus femoris*.
  - h' Lower leg: *tibialis anticus*, and *gastrocnemius* in calf of leg, largest muscle in body; connected with heel by
    - 1'' Tendon of Achilles.
- b. *Non-striated muscles*: These muscles are involuntary, and are not attached to the bones. They are always found in the walls of hollow organs. They are interwoven with the other tissues of the organ and are so small they can only be seen with a microscope.
- 1' Parts: same as of striated, except that they have no tendons.
  - 2' Microscopic structure: composed of
    - a' *Fasicculi*, with
      - 1'' No *striæ* on fibers.
      - 2'' No sarcolemma.
      - 3'' Cells: flattish bands of elongated fiber, which are all attached to each other.
  - 3' Power of contraction: quite unlike that of the striated muscles. They contract much more slowly, and act with apparent spontaneity.



c. *The cardiac muscles*: involuntary.

1' Parts: are somewhat similar to both the striated and unstriated in respect to cell structure.

2' Microscopic structure:

a' Like striated: in that its fibers are striated.

b' Like unstriated: in that it has no sarcolemma; the fibers interlace each other.

3' Power of contraction: unique. They act quickly, though not as rapidly as the voluntary; always contract to their shortest possible length, be the stimulus great or small; can "beat" when not connected with the brain; cannot be thrown into tetanus.

**3. Blood Supply to Muscles:** By means of numerous arteries, veins, and capillaries, each fiber in every muscle is reached and supplied.

**4. Effects of Heat and Cold upon Muscle Action.**

a. *Cold rigor*: about five degrees Fahrenheit.

b. *Heat rigor*: about one hundred and four degrees Fahrenheit.

**5. Hygiene of the Muscles.** The most needful thing for the health and strength of the muscles is

a. *Exercise*. It gives

1' Increased strength and size to the muscles, and

2' Tones up the internal organs by spurring them to increased activity in supplying the working muscles with energy and removing waste.

b. *Proper kind of exercise* should include a systematic well-regulated use of all the muscles in order

1' To preserve good form and health, and

2' To secure high bodily and mental activity and efficiency.

c. *Amount of exercise*: should never be carried to the point of exhaustion.

## 6. Diseases of the Muscles and Bones.

- a. *Hip disease*: due to attack on the bones of the joints, especially at the hip, by the tuberculosis bacillus.
- b. *Rheumatism*: appears around the joints, and interferes with their free action; caused by too rich a proteid diet.
- c. *Tetanus* (lockjaw):
  - 1' *Cause*: *tetanus bacillus*, which lives in the soil, and may enter a wound produced by something that has been lying on the ground, as a rusty nail. Toy pistols and fireworks are responsible for many cases of this disease.
  - 2' *Symptoms*: The muscles of the jaw contract so tightly that the mouth cannot be opened. The other muscles of the body soon undergo a similar contraction. Usually fatal.

## CHAPTER XI

### THE NERVOUS SYSTEM

I. DEFINITION: The complex organism by which the brain receives impressions and controls the work of the body. Usually considered under three groupings; the *Central*, the *Peripheral*, and the *Sympathetic* systems.

1. The Central System: has its center in

a. *The brain*: which bears the same relation to the nervous system that the heart does to the circulation.

1' Functions: to receive impressions from and give orders to the nerves

2' External features:

a' The *cranium*: the bony structure which encloses and protects the brain.

b' The coverings: three membranes:

1'' The *pia mater*: the delicate membrane that closely invests all the surface of the brain and carries its blood vessels.

2'' *Arachnoid*: the thin serous membrane that lies between the *pia mater* and

3'' The *dura mater*: the periosteum of the cranial bones; a very thick membrane which lines the skull and sends prolongations into the main fissures of the brain to hold it in its place.

4'' *Arachnoid fluid*: acts as a cushion between the different membranes.

c' Fissures of the brain: divide it into several lobes.

1'' *Cerebrum*: front brain; divided into two hemispheres (right and left).

2'' *Cerebellum*: hind-brain; also divided into right and left hemispheres.

3'' Midbrain.

4'' *Medulla*: back of cerebellum; extends downward without separation into the spinal cord.

5'' *Olfactory lobes*: lie just under front lobes of cerebrum; give off nerves of smell.

6'' *Optic lobes*: lie between the cerebral hemispheres; give off the optic nerves, which cross each other in an X-like structure called the

a'' *Chiasma*: just back of cerebral lobes, and pass on to eyes.

7'' *Pituitary body*: gland-like body just below optic chiasma; function unknown.

8'' *Crura cerebri*: two large bundles of nerve fibers in the midbrain which connect the cerebrum with the medulla.

9'' *Pons Varolii*: large transverse band of fibers that connects the two parts of cerebellum.

10'' *Cranial nerves*: twelve pairs.

3' Internal features:

a' The *cortex*: the surface layer of the cerebrum; made up largely of cell bodies. Area greatly increased by ridge-like

1'' *Convulsions*, between which are deep, narrow furrows or fissures.

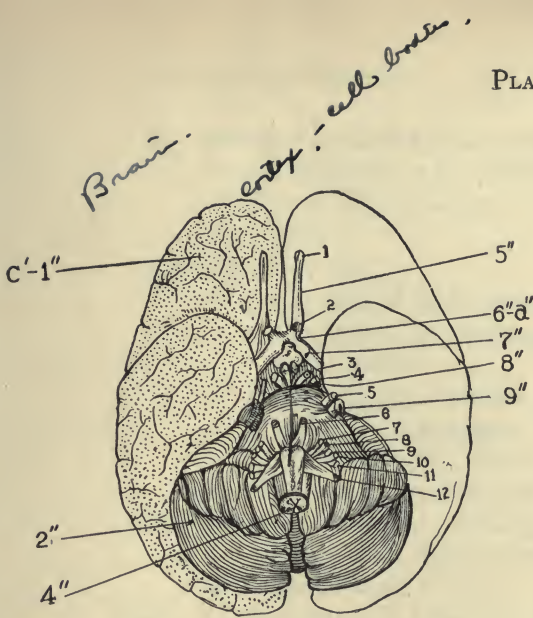


Fig. 1.—External Features (*c'-p.* 82)  
1-12 (small figures) Twelve pairs Cranial Nerves.

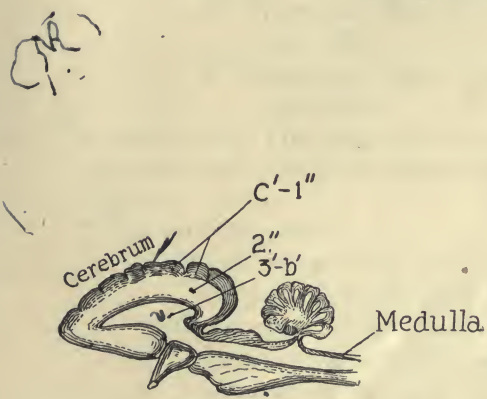


Fig. 2.—Internal Features (*a-3'*)



b' *Ventricles*: small irregular cavities in cerebrum, midbrain and cerebellum filled with clear liquid similar to the arachnoid fluid.

c' Brain substance:

1'' Gray matter: the substance of which the cortex is composed; largely brain cells.

2'' White matter: consists almost entirely of nerve-fibers outgrowths of nerve cells; forms the larger part of brain structure.

d' Regions of cerebrum: divided by convolutions into four definite regions, each with special work to do.

1'' Frontal: just behind forehead.

2'' Parietal: upper part of each side of skull.

3'' Temporal: above and in front of the ear.

4'' Occipital: lying under the back of the skull.

b. *The spinal cord*: The great nervous cord extending from the brain along the dorsal side of the spinal column.

1' External features:

a' Spinal column: the strong protective tube through which the cord passes.

b' Coverings: three membranes same as those surrounding the brain.

c' Arachnoid fluid: same as that between membranes of the brain.

d' Two fissures: the anterior one wide and shallow; the posterior one deep and narrow. They divide the cord into a right and left half.

e' The *spinal nerves*. Each half of the spinal cord gives off at intervals, from both the anterior and posterior side, *nerve roots* which unite a short distance from the cord into common nerve trunks (the spinal nerves). They emerge through openings between the vertebræ. There are thirty-one of these nerves on each side of the cord.

1'' Nerve ganglia: swellings, one of which occurs on the posterior root of each spinal nerve, just before it joins its companion from the anterior side.

2'' The brachial plexus: a union of five spinal nerves which supply arm.

3'' The lumbar plexus: a union of four spinal nerves, which pass down each leg as one nerve.

2' Internal structure of the cord:

a' White and gray matters, as in the brain, except that here the *white matter* is on the *outside*. The inner gray matter is in the form of a letter H, two horns of which project forward, and two backward. The central part corresponds to the cross bar of the H, and shows a small cavity in its center.

b' Ventricle: a continuation of the ventral cavities of the brain.

2. The Nerves. The nerves arise from the nerve centers, and penetrate all the organs and tissues of the body.

a. *Kinds of nerves*:

1' As to location:

a' Cranial nerves (twelve pairs): those united to the base of the brain.



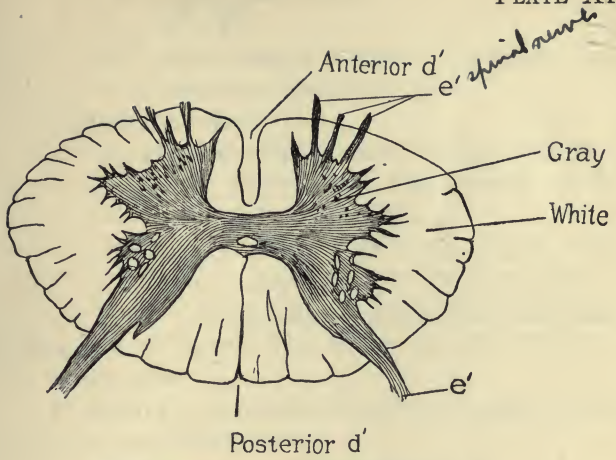


Fig. 1.—Section of Spinal Cord (b-1)

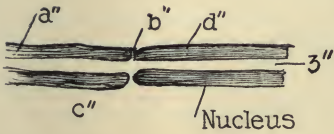


Fig. 2.—Axis Cylinder

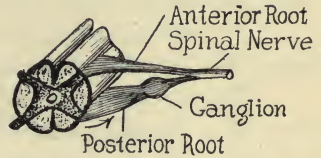


Fig. 3.—Spinal Nerve (b-e')

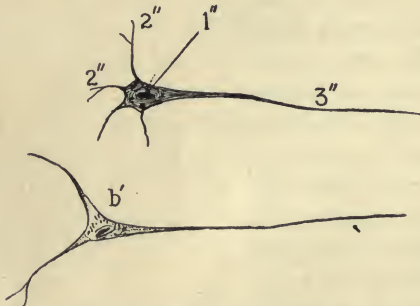


Fig. 4.—Neurons or Nerve Cells (2-b-1)



*Cranial - 12 pairs*  
*Spinal - 31 pairs*  
 b' *Spinal* nerves (thirty-one pairs): those united to the spinal cord.

2' As to function:

a' *Motor* nerves (efferent): those which transmit orders from the central nervous system to the muscles.

b' *Sensory* nerves (afferent): those which carry messages from various parts of the body to the spinal cord and brain.

b. *Structure of nerves*: The whole nervous system is made up of:

1' *Neurons*: the units of nerve structure; are of two kinds:

a' *Mon-axonic*, which consist of

1'' *Nerve cell*: usually of a very irregular shape, and containing both a nucleus and nucleolus.

2'' *Dendrites*: thread-like outgrowths from the angles of the cell,

3'' *Axon*, or *axis cylinder*: a long process growing out from nerve cell.

a'' Medullary sheath: the covering of the axis cylinder.

b'' Nodes: segments occurring at short intervals along the medullary sheath.

c'' Internodes: the parts of the medullary sheath between the different nodes; each of these has a nucleus, showing that this sheath is made up of many cells.

d'' Primitive sheath (*neurilemma*): thin membrane similar to the *sarcolemma* of muscle fiber; covers the medullary sheath.

*afferent touch & pain*  
*efferent muscles & gland*  
*sensory*

b' *Di-axonic*: these have cell-body, and two axons extending from it in opposite directions; but have no parts like dendrites.

c. *Nerve endings*. There are two different types:

- 1' The *afferent* nerve endings (cf. structure of the skin): vary from 1-300 to 1-600 of an inch in diameter. In general, they may be said to start in very minute spheres or oblong bodies called *corpuscles*. The nerve fibrils begin here as fine branches, either on the exterior or in the interior of these organs. They receive mainly impressions of touch and temperature, extremes of either taking the form of pain.
- 2' The *efferent* nerve endings: are distributed almost entirely to muscles and glands, which they excite to action.

*How*

d. *The nerve groupings*:

- 1' *The central nervous system*:
  - a' Consists of the nerves of the brain and spinal cord;
  - b' Carries on the highest and most complicated functions of life, and also exerts a direct or indirect control of all bodily activities.
- 2' *Sympathetic nervous system*: has control of the involuntary processes of life, and co-ordinates the action of the internal organs of the body. It consists of small.
  - a' *Ganglia*: in the head, neck, and trunk, where they form clusters of intricate network called a
    - 1'' *Plexus*. The large and important plexus back of the stomach is called the *solar plexus*; its nerves

supply the muscles of the stomach and abdomen. A severe blow here will cause instant death. The "vital knot" in the medulla oblongata, which controls respiration, if paralyzed by blow also causes instant death.

2'' The *efferent* fibers supply (1) unstriped muscle tissues, (2) cardiac muscles, (3) the glands.

3'' All the sympathetic ganglia are connected with the *central nervous system* by *medullated fibers* from the cranial or spinal nerves.

3' *Peripheral nervous system*:

a' Consists of a network of nerves and nerve endings connecting the central system with the different organs of the body in

b' Two groups already described.

e. *The nerve actions* consist of

1' Voluntary: those under conscious control of the will.

2' Involuntary: beyond or even in spite of the control of the will.

3' Reflex action: action that has occurred without asking the consent of any conscious center of the brain. It is this sort of action that gives importance to the lower centers, for it enables us to establish in them many fixed and ready-made reactions that leave our higher centers free to work on higher things. Thus habit and training are acquired.

f. *The nerve impulses*:

1' Rate of travel:

a' Inward: c. 140 feet per sec.

b' Outward: c. 110 feet per sec.

2' Theories as to the nature of the impulse:

a' The *chemical theory* maintains that when a nerve is stimulated, a chemical disturbance passes along the axis cylinder of the neuron involved.

b' The *mechanical theory* assumes that the molecules of the nerve fibers are in close contact, and that any unusual movement of them at one end of a nerve is transmitted through the whole line until it is felt at the other end.

c' The *electrical theory* looks upon the nerve impulse as an electric phenomenon.

### 3. Hygiene of the Nervous System.

a. *Nerve food.* Since the protoplasm of nerves is built up of identically the same sort of materials as are used by other cells, they need no special food, but any food that is nourishing to the laborer is equally so to the brain worker.

b. *Air supply.* Since the chemical changes which take place in the nerve cells are essentially similar to those in the muscle cells, in that the production of energy or action involves the oxidation of cell substance and food, the nerve cell must receive a plentiful supply of oxygen.

c. *Rest.* Needed that supply of food may be renewed and excess of waste removed. Therefore, sleep is Nature's greatest remedy for tired nerves.

d. *Self-control.* Since injurious habits of living are known to be the greatest wasters and destroyers of nervous energy, nothing is more needful to the health and efficiency of the nervous system than self-control.

e. *Avoid drug habits:* the most *fatal* foes of the nervous system.

## CHAPTER XII

### ORGANS OF SPECIAL SENSE

#### I. THE EYE.

##### 1. External Parts:

a. *Encasement*: The structures which hold the eye in place and protect it.

1' The eye-socket: a cavity in the skull called the orbit of the eye. Space between skull and eye lined with fat and crossed by muscles, nerves, and blood vessels.

2' Eyelids: movable curtains formed of the skin of the face and supplied with muscles:

a' The *orbicular* muscle, encircling both the upper and lower lids, closes the eye.

b' The *elevator* muscle—in upper lid; runs upward from lower edge and raises the lid.

c' Lashes: a fringe of stiff curved hairs on the edges of the lids which protects the eye from dust and other foreign substances.

d' *Meibomian* glands: arranged in little clusters on the inner surface of the lids. Their secretions keep the eye moist.

3' *Lachrymal* or tear glands: prevent the eye from becoming dry and opaque.

a' Location: just above the outer corner of each eye.

b' Size: c. three-fourths by one-fourth inch.

c' Secretion: principally water; contains small amount of salt; is poured under upper lid through several minute canals and leaves eye through two tiny chambers which unite to form the nasal duct leading to the nose chamber.

4' *Conjunctiva*: the mucous membrane which forms the lining of the eyelids and the front side of the eyeball except the cornea.

5' The *eyebrows*: a ridge of hair above the eyes to keep out perspiration.

b. *The muscles that move the eye*:

1' The *rectus* muscles: four in number, pass from attachment to eyeball far back in the socket and produce all motions of the eye in a vertical or horizontal plane.

a' *Internal rectus*: next to nose.

b' *External rectus*: on outside.

c' *Superior rectus*: above.

d' *Inferior rectus*: below.

2' The *obliques*: used not only alone, but also to adjust the rectus muscles:

a' *Inferior oblique*: attached to the lower surface of the eyeball and to the bones on the side of the nose.

b' *Superior oblique*: on upper surface of eyeball; passes toward nose through a pulley, and then passes backward to a point of attachment near the same part of the socket to which the rectus muscles are joined.

2. **Anatomy of the Eyeball**: The eyeball is a round, hollow shell containing the organs of sight. It is surrounded by three protective coverings, or

a. *Coats*:

1' The *sclerotic-coat*: the outer covering—a white



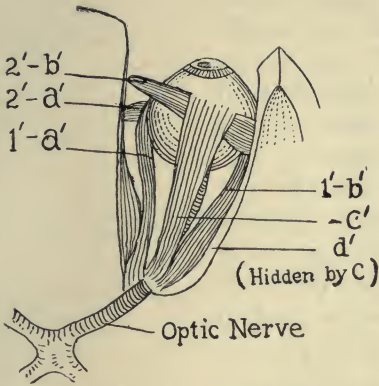


Fig. 1.—Muscles that move the Eye

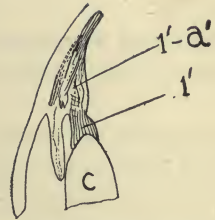


Fig. 2.—Crystalline Lens

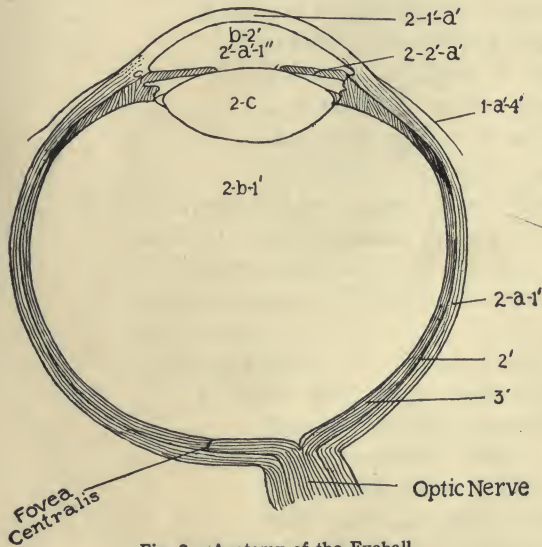


Fig. 3.—Anatomy of the Eyeball



fibrous tissue, exceedingly tough and strong. Where it is visible in front forms the white of the eye. This coat has an opening in front in which

a' The *cornea*, a transparent membrane, is set much as a crystal is set in the case of a watch.

2' The *choroid* coat: lies inside the sclerotic coat. It is composed of softer tissue and contains the blood vessels which nourish the eye, and is lined with a black pigment to absorb the excess rays of light. In the center of this coat under the cornea is

a' The *iris*: the colored curtain hung in front of the lens and furnished with contractile muscles to regulate the supply of light. In the center of the iris is

1'' The *pupil*: an opening which admits the rays of light to the retina, and through which you can see the color of the choroid coat at the back of the eye.

3' The *retina*: the inner coat, is a delicate, transparent membrane made up of nervous tissue. It is very complicated and consists of eight distinct layers. The layer next the choroid coat is the

a' *Sensory* layer. It contains the

1'' *Rods and cones*: a peculiar formation of the cells packed together like sunflower seeds, some of which are shaped like cylinders and others resemble cones.

2'' The *arborations*, or endings, of the optic nerve, together with the blood vessels of the retina, spread out over the front or inner surface.

b. *The humors of the eye:* The eyeball or shell is filled with jelly-like, transparent humors which hold it in shape:

1' The *vitreous* humor, which fills the back part of the eye and constitutes the bulk of the humor substance.

2' The *aqueous* humor, composed chiefly of water, fills up the space between the iris and the cornea.

double convex.

c. The crystalline lens: a double convex body composed of a perfectly clear transparent substance, just back of the iris. Its function is to concentrate the rays of light as they enter the pupil and to bring them to a focus on the retina. It is held in place by a

1' Suspensory ligament: a thin sheet of ligament tissue going entirely around the lens and having the power of adjusting it. It, in turn, is controlled by

a' The *ciliary* muscles which are attached to its base.

### 3. The Formation of Images:

a. *The law of refraction of light rays:* When a ray of light passes from an optically rarer to an optically denser medium, it is bent toward the perpendicular to the surface at that point. When it passes from an optically denser to an optically rarer medium, it is bent from the perpendicular.

(b) *Focus:* a point at which all refracted rays are made to meet.

(c) *Accommodation:* the adjustment of the lens necessary in changing the focus of the eye from a distant object to a nearer one, or *vice versa*.

1' The mechanism of accommodation:

a' Suspensory ligament runs from edge of lens to choroid coat; is regulated by

b' Ciliary muscles, extending from choroid layer to iris and inner layer of cornea, able to adjust the tension of the suspensory ligament.

2' Faulty accommodation:

a' *Nearsightedness* (myopia): eyeball a little too long or lens a little too convex; rays from a distance do not come to a focus on the retina, but in front of it; may be remedied by properly fitted glasses.

b' *Farsightedness* (hyperopia): conditions reverse of myopia; remedied by slightly convex glasses.

c' *Astigmatism*: either the surface of the cornea or the lens is not that of a true sphere. Hence the rays from one plane come to a focus in a point, but from some other plane they spread over a line; may be remedied by properly fitted glasses.

d. *Effect of light in the eye*:

1' The *chemical* theory: supposes that light changes the chemical composition of the pigment layer as of the sensitized camera plate.

a' The basic facts:

1'' The amount of pigment decreases with an increase of light in the eye and *vice versa*.

2'' *Optograms*: *i. e.*, pictures developed from the eyes of dead animals.

b' Chief opposition: the incredible rapidity with which it would be necessary for the pigment to be broken down and restored.

2' The *mechanical* theory: supposes that the wave motions which produce light jar the rods and

cones, and that the rapidity of these jars is interpreted in terms of vision.

a' Chief opposition: the enormous rapidity with which the rods and cones would need to vibrate in order to produce interpretation of any single color; also, rapidity and accuracy required in a change from one color to another.

3' A combination of these two theories is the probable solution.

e. *Color vision:*

1' Cones are especially abundant in the back of the eye, and diminish toward the sides; rods, prior *vice versa*.

2' Rods are sensitive to light and shade, but not to color; cones are sensitive to both.

3' A larger area of the retina is sensitive to one color than to another, e. g.: area that can see violet is larger than that which can see green.

f. *Color blindness:* consists in inability to see any difference between two colors which seem very unlike and distinct to most people.

4. **Care of the Eyes:** The eyes are very apt to be neglected, e. g.: because even when very defective, one may see fairly well and so neglect to attend to them; also, many troubles really due to defective eyes are thought to come from other sources.

a. *Lighting:* should not be

1' Too bright.

2' Too dim.

3' Flickering.

b. *Rest:* needed, especially where work is exacting, that they may remain strong for a longer time.

c. *Injuries:* may arise as from particles of dust getting into the eye; may be made worse by rubbing;

usually set right by the flow of tears, sometimes by holding the lid away from the ball, allowing the flow of tears to flood away the disturbing particle. Sometimes, a physician is needed.

- d. *Diseases*: in all serious affections consult physician.  
Never tamper with your eyes yourself.

## II. THE EAR.

### 1. The External Ear: Consists of

- a. *The pinna*, or auricle: a convoluted shell-like organ so constructed as to collect and convey sound-waves to the eardrum. It is composed of cartilage and covered with skin.
- b. *External auditory meatus or canal*: a passage about one and one-quarter inches long leading directly to the interior of the head.
- c. *Ear wax*: a waxlike secretion from the glands of the external ear. It is very bitter in taste and designed to keep insects from entering the ear; it also prevents dust from accumulating.

### 2. The Middle Ear, or Tympanum: A small cavity in the bone structure about one-third of an inch long and a quarter of an inch high. At the outer end is

- a. *The eardrum*: a thin membrane which is stretched tightly between it and the auditory canal. It resembles the head of a drum, and receives and passes on the sound waves to the inner ear.
- b. *The eustachian tube*: a short tube about one and one-half or two inches long leading from the throat to the inner ear. Its purpose is to supply air to the cavity, in order to preserve an equal pressure on both sides of the eardrum. The passage should be kept free.
- c. *Foramina*: openings leading to the inner ear, but closed by membranes. There are two:
  - 1' *Foramen ovale*, the upper opening; and
  - 2' *Foramen rotundum*, the lower opening.

- d. *Mastoid cavities*: spaces in the bones surrounding the *middle ear*.
- e. *Bones of the ear*: a chain of three minute bones in the cavity of the middle ear:
  - 1' *Malleus* (hammer): is attached to the membrane of the tympanum at one end and to the second bone at the other.
  - 2' *Incus* (anvil): connects first and third bones.
  - 3' *Stapes* (stirrup): ends in a flat projection that fits into the *foramen ovale*.
- f. *Tiny muscles*: minute muscles attached to these three small bones.
  - 1' *Tensor tympani*: extends from wall of eustachian tube to the malleus; tightens drum indirectly by pulling on bone.
  - 2' *Stapedius*: from wall of cavity to neck of stapes; changes position of membrane over the foramen ovale by contracting.

**3. Internal Ear, or Labyrinth:** A series of exceedingly complicated passages branching off from the foramen ovale; consists of a bony canal, inside of which, and smaller than which, is a membranous sac.

- a. *The bony labyrinth*: consists of three parts:
  - 1' The *vestibule*: the central portion; has on its exterior the foramen ovale, into which the base of the stirrup lies.
  - 2' The *semicircular canals*: extend behind the vestibule; communicate with the back of the vestibule at each end; dilated near one end to form an *ampulla* (swelling).
  - 3' The *bony cochlea*: spiral canal, shaped somewhat like a snail's shell, and lying in front of the vestibule.
- b. *The membranous labyrinth*: lies loosely within the bony labyrinth and is divided into corresponding portions.



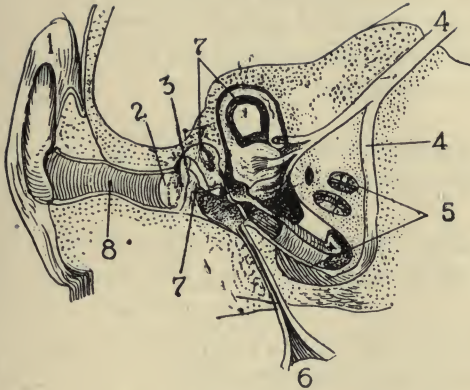


Fig. 1.—Diagram of the Ear

- |                    |                         |
|--------------------|-------------------------|
| 1. Outer ear.      | 5. Cochlea.             |
| 2. Tympanum.       | 6. Eustachian tube.     |
| 3. Middle ear.     | 7. Semicircular canals. |
| 4. Auditory nerve. | 8. Auditory canal.      |

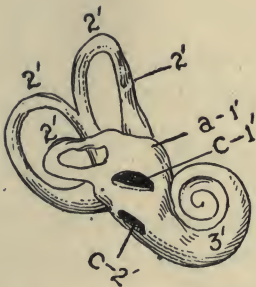


Fig. 2.—The Bony Cochlea

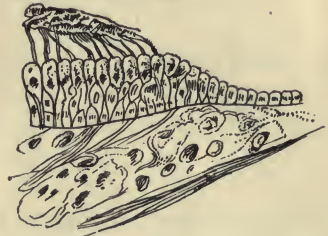


Fig. 3.—The Membranous Cochlea



- 1' Membranous vestibule: consists of two sacs, communicating by a narrow opening.
    - a' The *utricle*: the posterior sac. Into it open the membranous semicircular canals.
    - b' The *sacculus*: the anterior sac; communicates by a tube with the membranous cochlea.
  - 2' Membranous semicircular canals: greatly resemble the bony canals of the same name; each has an
    - a' *Ampulla* at one end, where it leaves the utricle; contains numerous nerve fibers which mingle among the
      - 1'' Hair cells, which bear short stiff cells, among which are
      - 2'' Lime granules.
  - 3' Membranous cochlea: a complicated, triangular tube, attached by its base to the bony spiral of the cochlea.
    - a' *Organs of corti*: certain solid structures seated on the basilar membrane of the cochlea. In it are the endings of the fibers of the nerves of hearing.
- c. *Fluids of the inner ear*:
- 1' *Perilymph*: a watery fluid filling space between membranous and bony labyrinths.
  - 2' *Endolymph*: a similar fluid filling the membranous labyrinth.
- #### 4. Functions of the Ear.
- a. *Hearing*: accomplished by sound vibrations entering the outer ear, striking the tympanic membrane, then being transported by the three small ear bones across the middle ear to foramen ovale, thence *via* the fluids of the vestibule and cochlea to the organs of corti, the nerves of which trans-

mit stimuli to the brain, which interprets them in terms of sound.

1' The perception of pitch: usually explained by the principle of sympathetic vibration. (Sound is the result of air waves, and the different pitches are due to waves of different degrees of rapidity. It is thought that sections of the organs of corti vibrate at different rates, and that, therefore, for every variation in pitch there will be a corresponding variety in nerve stimuli).

2' Loudness of sounds depends, not upon the rate, but upon the size of air waves, violent stimulation being interpreted as loudness.

3' Quality of sound: is due to its wave length.

b. *Balancing the body*: accomplished by the fact that the semicircular canals lie in three different planes (one horizontal, one vertical right to left, and one vertical front to back). Motion in any direction causes friction between the fluid within the membranous labyrinth and the granules and hairs of same. This friction is reported by the nerves to the brain, and there interpreted as motion in some given direction.

## 5. Ear Troubles.

a. *Deafness*: may result from many causes:

1' In elderly people: it is generally due to the stiffening of the eardrum or other delicate membranes.

2' In younger people: generally due to stoppage of eustachian tube or broken eardrum from scarlet fever or measles.

b. *Ringing noises*: may be due to the fact that the fluids cannot move in the normal way.

c. *Abscesses and gatherings*: often very dangerous; consult physician at once.

## CHAPTER XIII

### NARCOTICS AND STIMULANTS

I. NARCOTICS. Drugs which in medicinal doses relieve pain and produce a state of rest or sleep, but in poisonous quantities produce stupor, coma, and often death.

#### 1. General Effects:

a. *Local anesthetic*: insensibility to pain in only one particular part of the body, without causing unconsciousness. (As when cocaine is injected at root of a tooth.)

b. *General anesthetic*: when the drug's action on the brain is strong enough to cause unconsciousness. (As when a patient has been given chloroform.)

2. **Usefulness**: a means of relieving pain in emergencies.

3. **Danger**: formation of a habit of using them constantly and to excess, as in the opium habit, small doses becoming ineffective and the patient becoming a slave to the drug, demanding larger and larger doses to get the same effect.

#### 4. Common Kinds:

a. *Opiates*: relieve pain and induce sleep. The patient (who may unwillingly and even unknowingly develop into an opium fiend) usually gets his first "taste for" these narcotics through the use of headache powders or some mixture containing a narcotic. Opiates in common use are

1' Laudanum.

2' Paregoric.

3' Morphine.

4' Soothing syrup: injurious to infants.

- b. *Cocaine*: often used in "painless" dentistry with good effect.
- c. *Chloral*: an ingredient of many headache remedies.
- d. *Chloroform*: much used as a general anesthetic in surgery.
- e. *Ether*: a general anesthetic.
- f. *Tobacco*: owes its narcotic effect to the presence of a substance called *nicotine*, three drops of which are sufficient to kill a man. By dulling the nerves whose business it is to tell of fatigue, a false sense of restfulness is produced which beguiles the patient and induces him to continue its use until he becomes its slave.

1' Smoking: dangerous; some of the poison being thus inhaled.

a' Cigarets: especially injurious. Their use is apt to be prevalent among boys who think it "big" to smoke; for the contents of a single cigaret are not enough to produce such nausea as a cigar does. However, the youth who begins their use soon becomes dissatisfied with merely one. He comes to demand that each one shall be followed by another, and that at an increasingly short interval of time. Thus the actual amount of tobacco consumed by the cigaret boy in the course of a day soon comes to be as great as that consumed by the man who smokes cigars. In view of the vital importance of full and symmetrical growth of bones, muscles, and brain, and in view of the fact that the cigaret contains all of the regular tobacco poison plus the poisonous fumes of burning paper, it is well for every boy

to remember that tobacco renders the user susceptible to

- 1'' Chronic *pharyngitis*: the outcome of the irritative action of tobacco upon the mucous membrane of the mouth and the upper air passages.
- 2'' Poisoning of the red blood corpuscles: diminishing their oxygen-carrying capacity (giving rise to pallor and stunted development of user).
- 3'' Sallow and unhealthy skin.
- 4'' Tobacco heart: poisoned and weakened muscle with the attendant irregularity of heart action, rendering the boy ineligible for athletics or for military service.
- 5'' Deranged nervous system: rendering the hand less steady and the eye less sure.

2' Chewing: most dangerous, more or less of the juice being swallowed.

II. STIMULANTS. In the general use of the word substances that excite the cells to increased activity without supplying any material food.

### 1. General Effects:

- a. *Temporary*: They whip the organ to more exertion for a short time (similar to the effect of an occasional application of the whip to a horse). They add no strength, but only enable the body to call upon its reserve force.
- b. *After-effect*: depression. (Just as excessive use of the whip causes the horse to refuse to go without constant application of it.) Hence, most stimulants are also narcotics.

## 2. Usual Kinds and Specific Effects.

a. *Coffee*: prepared from the seeds (called "beans") of a tropical plant. Its activity

1' As a food: food value depends almost entirely upon the amount of milk and sugar which are usually added. Otherwise has no proved food value.

2' As a stimulant depends upon its

a' Caffeine: which mildly stimulates the brain, heart, and respiratory organs. By increasing the blood flow, it enables tired cells to obtain more food from the blood, and the sense of fatigue disappears for the time; but, since it furnishes no food to replenish the store, some ill effects which may follow its habitual use are:

1'' Dyspepsia.

2'' Sleeplessness.

3'' Nervous disorders.

4'' Heart trouble.

b' Tannic acid: delays digestion, and is therefore especially potent in causing dyspepsia.

b. *Tea*: consists of the dried leaves of an evergreen plant grown in China, India and Japan. As a food and stimulant about the same as coffee. Its active principles are:

1' Theine: practically the same as caffeine.

2' Tannic acid: usually in greater strength than in coffee; worse in green tea than in black; worse where "grounds" have been allowed to remain long than when merely "steeped" and removed. To render tea as harmless as possible it should be used a few minutes after brewing.



- c. Cocoa or chocolate:* a preparation of finely ground roasted seeds of the cacao tree (cocoa is ground finer than chocolate and contains less fat).
- 1' As a food: makes a nutritious drink, containing considerable
    - a' fat: part of which has been removed in case of cocoa.
    - b' Starch.
    - c' Proteids.
  - 2' As a stimulant: its active principle is
    - a' Theobromin: a mild stimulant followed by no ill effects, largely because the food content replaces the nutriment the cells have put into immediate use.
- d. Beef extract:*
- 1' As a food: very slightly nutritive, its real value being
  - 2' As a stimulant: sets the digestive glands to work, thus preparing for true food, which should follow a little later; a preparation not a substitute. Harmful in case of too frequent and extensive use.
- e. Drugs:*
- 1' Strychnine: a very poisonous alkaloid; powerful heart and nerve stimulant.
    - a' In minute doses quickens the heart beat. Should be used only by physicians in cases of critical illness.
    - b' In unprescribed doses, the risk of violent death.
  - 2' Alcohol: the essence of pure spirit; popularly applied to all beverages produced by the process of fermentation in substances which contain starch and sugar.
    - a' Food value: a matter of dispute. (However, no one claims for it more or other

than a modicum of heat value. But, even if it should be proved to possess such value, its injurious effects enumerated below make it too dangerous and expensive. Gunpowder would produce heat in a furnace, but its injurious effects upon the furnace make it unwise to use such fuel.)

b' Injurious effects upon the individual: "If you want to keep a dead man, put him in alcohol; if you want to kill a live man, put alcohol in him."

1" On stomach: *chronic catarrh*; inflammation plus great damage to functional activity.

2" On liver: *cirrhosis*; liver becoming hardened and enlarged ("hob-nailed liver").

3" On kidneys: enlargement by the formation of excessive connective tissue, thus weakening their activity.

4" On heart: fatty degeneration.

5" On blood vessels: permanent dilation, especially of the capillaries (often noticeable in the red nose of the drunkard); also a hardening of the walls, impairing regularity of circulation and making large wounds very dangerous.

6" On brain:

a" Weakens the individual's power of self-restraint (thus paving way for criminality, etc.).

b" Dulls perception.

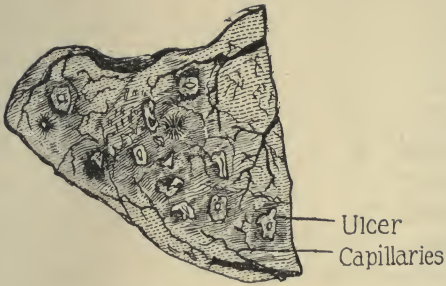


Fig. 1.—Alcoholic Stomach



Fig. 2.—Small internal Portion

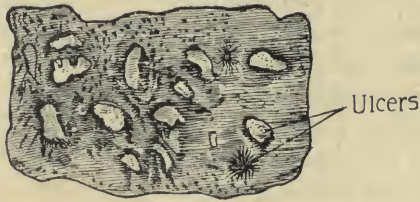
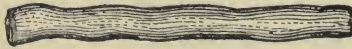


Fig. 3.—Alcoholic Liver



Normal



Alcoholic

Fig. 4.—Blood Vessels



- c'' Decreases accuracy and efficiency (seventy-five per cent. of all industrial concerns realize this and refuse to employ users of alcohol).
  - d'' Makes the individual a slave to appetite.
  - e'' Leads toward and often to *delirium tremens*.
- 7'' On vasomotor nerves: a paralyzing effect, causing them to cease keeping the small arteries partly closed. This lets the blood rush through the small arteries at an abnormal rate, causing cheeks to become flushed, skin warmed, and brain affected in such a way as to create a feeling of excitement, a hilarity of spirits which is often falsely interpreted as increased mental activity.
- c' Alcoholism and heredity. While at present there is great dispute as to whether any characteristic acquired by the parent during his lifetime can be transmitted to his children by heredity, facts seem to show conclusively that the injurious effects of alcohol are transmitted as follows:
- 1'' From the father. When, in any given family, the maternal side of the household is not addicted to alcoholism, but the paternal side is, children of this union may suffer the injurious effects produced upon the father:

- a'' Because of the specific poisoning of the germ cells from the father; or the
  - b'' Inherited constitutional weakness which caused the father to abandon himself to the use of alcohol; or through the
  - c'' Early nutrition, environment, or education to which the father has subjected his child. Many a man is a drunkard, or suffers a drunkard's injuries, simply because when he was a mere child his foolish father fed him bread soaked in whisky or beer, or gave him whisky in sweetened water, etc. Heredity in such cases has little to do with the matter.
- 2'' From the mother. When the mother is addicted to alcoholism, then, indeed, is the child in grave danger, for
- a'' Her nutritive capacity is greatly weakened.
  - b'' Her weakness (bodily and mental) which led her to become alcoholic (only a weakling in will power becomes a user of alcohol) may be transmitted to her child, thereby making it an easier victim for alcoholism (or any other vice).

c'' General abnormalities. The thousands of cases of unhealthy, insane, and criminal persons among the offspring of drunkards are not mere coincidences. There is a casual connection between these cases and the physical condition of the parents, which connection has expressed itself through hereditary transmissions in such forms as

1''' Nervous disorders (ranging from excitability to dementia).

2''' Debility and lack of developmental ability (infantilism, want of control, imbecility).

3''' Structural abnormalities (especially of the head and brain. "The variety of results is great, but it is never on the right side").

3' Whisky, champagne, wines, beer, patent medicines all come under the general category of alcohol, because they all contain alcohol in varying quantities, and, whatever good effects they may seem to have for a while, their influence, in the end, is the same as that of alcohol. The difference is only of degree, not of kind.

### 3. Agencies in Active Combat vs. Intemperance.

- a. *Prohibitionists*: a political party seeking to stop the manufacture and sale of spirituous liquors by putting strong temperance men at head of governmental affairs.
- b. *Anti-Saloon League*: a voluntary, non-sectarian association actively engaged in creating sentiment against all use of intoxicants, in obtaining strong general temperance legislation; in promoting abolition of saloons by popular vote in local and state option elections; and in demanding that present temperance legislation be strenuously enforced.
- c. *Women's Christian Temperance Union* (W. C. T. U.): similar in purpose and organization to Anti-Saloon League, but membership is limited to women and the burden of their efforts centers around the home and the training of the youth, although in recent years they are actively engaged in securing temperance legislation.
- d. *Loyal Temperance Legion* (L. T. L.) and the *Lincoln Legion*: aim is to organize adolescents and to secure their pledges vs. the use of intoxicants and their co-operation in eliminating them.
- e. *Insurance companies and industrial concerns* eliminate those addicted to the use of alcohol from their privileges and employ.
- f. *Schools*: fortify youth vs. the perils of alcoholism by dispensing information concerning same.



## CHAPTER XIV

### SANITATION AND PUBLIC HEALTH

#### I. CONTAGIOUS AND PREVENTABLE DISEASES.

##### 1. Definitions:

- a. *Infectious*: any disease caused by parasites feeding upon the human body.
- b. *Contagious*: such infectious diseases as may be contracted by breathing in the germs floating in the air or coming in contact with the sufferer, *e. g.*:
  - 1' Smallpox.
  - 2' Scarlet fever.
  - 3' Consumption (tuberculosis).
- c. *Non-contagious*: infectious diseases which are not transmitted from one patient to another except by bite, sting, prick of an insect, or wound, *e. g.*:
  - 1' Yellow fever.
  - 2' Lockjaw.
  - 3' Malaria.
- d. *Non-infectious*: diseases due to changed methods of work and growth on the part of cells in certain regions of the body; not caused by germs, *e. g.*:
  - 1' Alcoholism.
  - 2' Diabetes.

##### 2. Progress of Medical Science:

- a. *Several centuries ago* all disease was thought to be due to evil spirits which took up their abode in the human body and remained there until driven out by the magic of a priest or medicine man.

- b. *During the seventeenth century* the annual death rate in the city of London was 80 per 1,000 of population; due to ignorance of the principles of sanitation.
- c. *In 1876 Louis Pasteur*, of France, demonstrated the presence and power of germs in infectious and contagious diseases, thereby revolutionizing the science of medicine.
- d. *To-day*, the annual death rate in London is 24 per thousand; due to the development of the principles of sanitation.

### 3. Where the Present Issue is Fiercest:

a. *Tuberculosis*: According to census report of 1910, the cause of 28.4 per cent of all deaths in United States, *i. e.*: about 175,000 deaths per year. The disease is so slow in developing that it does not impress the imagination like smallpox, and hence the general neglect.

1' Sources of infection: the two chief sources have been found to be:

a' From other human beings: by means of germs, especially in dried *sputum*. To avoid spread of these, the sputum of the patient should always be voided in paper or a special receptacle and destroyed forthwith. To this end, ordinances against spitting on sidewalks should be rigidly enforced.

b' From cattle: through the milk from infected cows, especially where cleanliness has not been carefully exercised in caring for the milk. In case of doubt as to whether the cows have the disease, the only safe course is pasteurization of all the milk used.

2' Factors increasing one's susceptibility to infection:

a' Poor nourishment: weakening the power of resistance. Hence anything will decrease the number of tuberculosis patients which

1'' Improves the food habits.

2'' Lessens the price of wholesome foods.

3'' Raises the quality of wholesome foods.

b' Intemperate habits: diminish the power of the system to develop anti-toxins with which to combat the germs. Hence all efforts toward checking intemperance make for greater protection against tuberculosis.

c' Bad housing: small rooms, especially when dark, damp, or poorly ventilated, are splendid breeding grounds for these germs. Hence the man who fights successfully for sanitary tenement houses and other healthful conditions is a champion against tuberculosis.

b. *Typhoid fever*: caused by entrance of typhoid bacilli into the intestine, where they grow and multiply rapidly and excrete poisons which affect the body tissues. Physicians can do little toward curing this disease, except by way of maintaining the strength of the body so that the patient may have the power to drive off the trouble himself. Causes many deaths each year. About ten per cent of patients die; many others are incapacitated for work for weeks, months, or permanently. Most common in autumn. Being a filth disease it is preventable by proper sanitary precautions.

## 1' Sources of infection:

a' Drinking water, especially where polluted with sewage (faeces being the great medium through which the germs are transmitted). Hence importance of boiling drinking water when any case exists in vicinity.

b' Milk: a very frequent source; a good medium for carrying the germs from dairy to consumer, if there is a case of typhoid near the dairy. Hence need of rigid dairy inspection.

c' Oysters: when eaten raw may be a medium of infection if they have been "floating" near the mouth of a river into which empties the sewage system of some town where there are cases of the disease.

d' Flies: may carry the germs from patient and deposit them upon food. Hence importance of fly extermination, especially from the sick room.

c. *Diphtheria*: also known as "membranous croup," the most dangerous of children's diseases. Highly contagious. Caused by germs that attack membrane of the throat. Most prevalent during school months when children are closely housed. Very often fatal.

1' Sources of infection: any medium common to mouths of patient and playmates, *e. g.*:

a' Discharges from mouth and throat.

b' Air: especially in poorly ventilated rooms, may contain many germs expelled from patient's throat when coughing or speaking loudly.

- c' Pencils: which have been in patient's mouth.
- d' Drinking cups: which have been used by patient. Hence wisdom of abolishing public drinking cup.
- 2' Special means of preventing spread of the disease: *quarantine*: isolating patient from all except physicians and nurses until he has entirely recovered and all of his germs have been destroyed.
- d. *Smallpox*: loathsome and dangerous. Highly contagious.
  - 1' Means of preventing spread:
    - a' Isolation: of all who have, or are about to have, the disease. This is imperative for the sake of the public welfare.
    - b' Vaccination: best safeguard against the possibility of becoming infected and subjected to full measure of disease's dangers; also, only method whereby it is hoped to eliminate ultimately the disease entirely. Therefore, it should be compulsory upon all school children.
- e. *Scarlet fever, measles, whooping cough, tonsilitis*, etc. Because all are highly contagious, and because of their injurious effects, often very serious, it is always best to use all means to prevent them. This calls for
  - 1' Isolation of all who have been exposed until the period during which they can give the disease to others is passed.

#### 4. The Battlefields of Hygiene:

- a. *The home*: where great care should be exercised regarding:
  - 1' The location: including provision for

- a' Plenty of light, through large, well-placed windows, through which the open sky is visible.
  - b' Plenty of air: demanding roominess and remoteness from sources of smoke, vile odors, etc.
  - c' Right sort of neighbors: so far as this is possible, choosing to live among the cleanly and congenial.
- 2' The building: in which the chief cares are
- a' Good ventilation: providing plenty of fresh air without too violent drafts.
  - b' Good heating system: whereby an even temperature can be maintained throughout the house and atmosphere kept at proper humidity.
  - c' Correct plumbing and means of disposing of all litter.
  - d' Cleanliness: at all times and in all parts.
- 3' The furnishings: should be of such sort as will be
- a' Not catchers of dust and dirt.
  - b' Easy to clean with vacuum cleaner or damp cloth.
- b. *The school*: presents, in main, same cares as the home, especially regarding lighting, heating, and ventilating, with additional care regarding
- 1' Drinking fountains.
  - 2' Writing materials.
  - 3' Proper seating.
  - 4' Lavatories.
- c. *The market*: needs to be, so far as possible, free from the things enumerated below. Such markets as are should have our patronage before all others, even though their prices are much higher. It costs

more money to keep up such markets, but they are in no small measure guardians of the public health.

- 1' Decaying fruits, vegetables, etc., which are fertile breeding grounds for many sorts of germs.
- 2' Edible goods exposed to flies, dust, and handling by customers or clerks.
- 3' Stale cereals, stale canned goods, meats, etc., condemned by inspectors.
- 4' Adulterated foods, over-ripe fruits, and bargain counter stuffs.

d. *Streets, alleys, yards.* Here the great need is cleanliness. Remove all rubbish piles, sweep and sprinkle the streets, keep neat and attractive lawns, and you will have gone a long way toward the elimination of flies and deadly germs and toward the provision for personal and for public health.

e. *Sewage systems.* No other material threatens a community with as great disaster as uncared-for sewage; for it is sure to contain countless disease germs. Hence importance of conveying all of it to "filter beds," etc., and there subjecting it to such treatment as will kill all dangerous germs.

f. *Water and ice supplies.* These should not come from brooks, pools, or wells where there is any possible means of pollution. Therefore, especial notice should be taken at all times regarding the relation between location of water supply and the drainage and sewage of the vicinity.

g. *Dairies.* Since milk is to be found as a part of almost every man's diet, and as the most important item of the food of infants and very young children, and since it is also a great medium for the existence and multiplication of disease germs, it

is very fitting that we should have competent and reliable dairy inspectors to demand scrupulous cleanliness and care in handling this food and positive elimination of all unhealthy cows.

## II. GUARDIANS OF THE PUBLIC HEALTH:

1. **Boards of Health:** state and local, whose general duty is to determine the conditions under which the towns and cities can be kept in the best health and to see that the laws and rules relating to public hygiene are enforced.
2. **Commissioners:**
  - a. *Of water works:* to see that the supply of water is both adequate and pure.
  - b. *Sewage commission:* to see to the disposal of sewage in such a way that it becomes permanently harmless.
3. **Inspectors:** to ascertain whether foods on sale are true to what is claimed for them. Their services are most valuable, at present, in decisions concerning wholesomeness of meats and milk; but, as their authority increases, their services must ultimately extend to decisions regarding practically all sorts of food stuffs as well as concerning sanitary and safety devices for all public places and perhaps for private homes too.
4. **Private Individuals:** All hygienic measures ultimately fall back upon the individual for their effectiveness. Hence the value of public instruction in physiology and hygiene.



## CORRELATED READINGS

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### THE ORGANISM OF THE HUMAN BODY

- Advanced Physiology and Hygiene. Conn and Buddington. Chaps. i and ii.  
New Century High School Physiology. Hewes. Chaps. i and ii.  
Human Body and Health (Advanced). A. Davison. Chaps. ii, iii, ii.  
General Physiology and Anatomy. Eddy. Chaps. ii, iii, iv.  
Applied Physiology (Advanced). Overton. Chaps. i, ii, iii.

### FOODS AND FOOD HABITS

- Advanced Physiology and Hygiene. Conn and Buddington. Chap. iii.  
New Century High School Physiology. Hewes. Chaps. v, i.  
Human Body and Health (Advanced). A. Davison. Chap. v.  
General Physiology and Anatomy. Eddy. Chap. v.  
Applied Physiology (Advanced). Overton. Chaps. xii, xiii, xiv.

### FERMENTATION AND DISEASE GERMS

- Advanced Physiology and Hygiene. Conn and Buddington. Chap. iv.  
New Century High School Physiology. Hewes. Chap. xv.  
Human Body and Health. A. Davison. Chap. vi.  
General Physiology and Anatomy. Eddy. Chap. vi.

### DIGESTIVE ORGANS AND DIGESTION

- Advanced Physiology and Hygiene. Conn and Buddington. Chaps. v, vi, vii.  
General Physiology and Hygiene. Eddy. Chaps. vii and viii.  
New Century High School Physiology (High School). Chap. v.  
Human Body and Health (Advanced). A. Davison. Chaps. ix and x.  
Applied Physiology (Advanced). Overton.  
Our Bodies and How We Live. Blaisdell.

### ABSORPTION, ASSIMILATION AND OXIDATION

- Advanced Physiology and Hygiene. Conn and Buddington. Chap. viii.  
General Physiology and Hygiene. Eddy. Chaps. ix and x.  
New Century High School Physiology. Hewes. Chap. v.  
Human Body and Health (Advanced). Davison. Chap. x.  
Applied Physiology (Advanced). Overton.  
Our Bodies and How We Live. Blaisdell.

## THE BLOOD AND THE CIRCULATORY SYSTEM

- Advanced Physiology and Hygiene. Conn and Buddington. Chaps. ix, x and xi.  
 General Physiology and Anatomy. Eddy. Chaps. xi, xii, xiii, xiv.  
 New Century Physiology (High School). Hewes. Chap. viii.  
 Human Body and Health (Advanced). Davison. Chaps. xi and xii.  
 Applied Physiology (Advanced). Overton. Chaps. xviii, xix, xx, xxi.  
 Our Bodies and How We Live. Blaisdell. Chap. vii.

## RESPIRATION

- Advanced Physiology and Hygiene. Conn and Buddington. Chaps. xii and xiii.  
 General Physiology and Anatomy. Eddy. Chaps. xxii, xxiii, xxiv.  
 Our Bodies and How We Live. Blaisdell. Chap. viii.  
 New Century High School Physiology. Hewes. Chap. ix.  
 Biography of Dr. Koch.

## EXCRETION

- Any good elementary biology.  
 General Physiology and Anatomy. Eddy. Chaps. xxiii, xxiv.  
 Advanced Physiology and Hygiene. Conn and Buddington. Chaps. xiv, xv.  
 New Century High School Physiology. Hewes. Chap. x.  
 Applied Physiology (Advanced). Overton. Chaps. xxv, xxvi, xxvii.  
 Life and Health. Blaisdell. Chap. xix.  
 Human Body and Health. Davison. Chap. xvii.

## THE SKELETON

- General Physiology and Anatomy. Eddy. Chaps. xv, xvi, xvii.  
 New Century High School Physiology. Hewes. Chap. iii.  
 Advanced Physiology and Hygiene. Conn and Buddington. Chap. xvi.  
 Applied Physiology. Overton. Chaps. xxxvii, xxxviii.  
 Human Body and Health (Advanced). Davison. Chap. xvii.

## THE MUSCLES

- General Physiology and Anatomy. Eddy. Chaps. xviii, xix.  
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**THE NERVOUS SYSTEM**

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General Physiology and Anatomy. Eddy. Chaps. xxv, xxvi, xxvii.

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**NARCOTICS AND STIMULANTS**

Advanced Physiology and Hygiene. Conn and Buddington. Pp. 59, 62, 108, 164, 329, 330, 333, 335.

General Physiology and Anatomy. Eddy. Pp. 74, 89, 130, 211, 427.

New Century Physiology (High School). Hewes. Chaps. vii and xi.

Human Body and Health (Advanced). Davison. Pp. 37, 68, 75, 201, 256, 257

Heredity. Thomson. Pp. 189, 219, 274.

**SANITATION AND THE PUBLIC HEALTH**

Advanced Physiology and Hygiene. Conn and Buddington. Chap. xxiii.

General Physiology and Anatomy. Eddy. Chap. xxxiii.

New Century Physiology (High School). Hewes. Chap. xvi.

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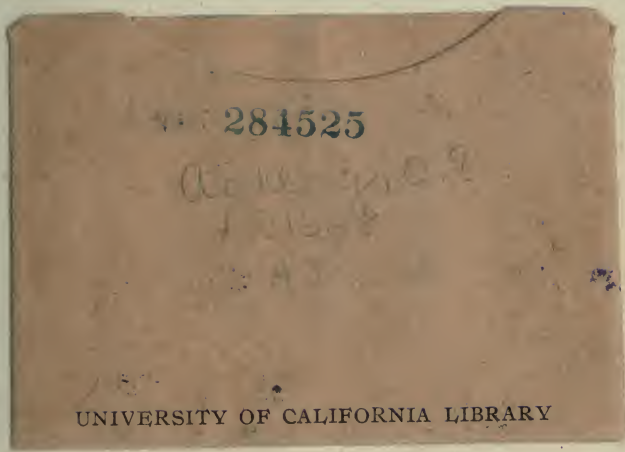
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