

CHAPTER XXVI

EXCRETION AND SEWAGE

435. Getting rid of oxidized and waste substances is *excretion*. All oxidations in the body produce carbonic acid gas and water. In addition, the oxidation of albumin produces a substance called *urea*, which contains the nitrogen of the albumin. These substances together with the minerals or ashes left from the burned cells must continuously be excreted by the lungs, liver, intestine, skin, and kidneys. The kidneys excrete the most harmful of the waste substances.

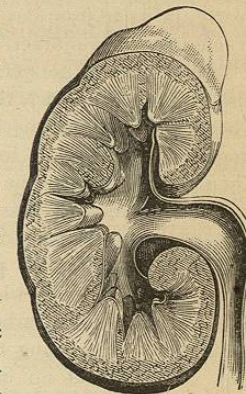
436. Difference between a secretion and an excretion. — In a general way, anything separated from the blood by glands is a *secretion*. But the term strictly is applied only to those substances which, like saliva and gastric juice, are of use to the body. Substances which, like carbonic acid gas and urea, are only waste and harmful products, are true *excretions*.

437. Sweat glands. — Numerous coiled tubes lined with epithelium project into the skin over nearly its whole surface. Each tube is a *sweat gland*, whose epithelium is continually secreting the *sweat*, or *perspiration*. They are very numerous on the forehead, chest, palms of the hands, and soles of the feet. Only a few are found in the upper part of the back.

438. The perspiration. — The perspiration is over 99 per cent water. It contains a small amount of urea and mineral substances. Ordinarily it evaporates so fast that its

presence is not noticed. Nearly a quart of water a day thus passes off from the surface of the body in insensible perspiration. In hot weather and during exercise so much is produced that it accumulates in drops upon the skin.

439. The kidneys. — The main work of excretion is performed by the kidneys. There are two kidneys, one on each side of the backbone, half covered by the two lower ribs. Each kidney is bean-shaped, about four inches in length, by two in breadth, and one in thickness. It is composed of millions of fine tubes made up of epithelial cells; they unite, and finally open into a pocket on the side of the kidney.



Kidney cut across.

440. How the kidneys excrete. — The epithelial cells of the tubes have the power to draw urea and mineral substances from the blood. They also extract a large amount of water in order to wash away the excreted matter. The excretion runs down a tube called the *ureter* to the bladder. About a quart and a half of a fluid called *urine* is thus excreted daily.

441. Kidney disease. — Kidney disease usually takes the form of an aggravated bilious attack. There are headaches, loss of appetite, coated tongue, and great weakness. Usually the urine is diminished, and contains some albumin derived from the blood.

Urea itself is as harmless as carbonic acid gas and is as easily excreted, but when oxidation is incomplete, substances are produced which are as much more harmful than urea as a smoking lamp is more unpleasant than one burning perfectly. When more food is eaten than can be oxidized, poisons are developed from the imperfectly oxidized albumin. Some are leucomaines or substances like them. The kid-

neys try to excrete the poisons, but they become overworked, producing what is called *Bright's disease*. Then the sweat glands excrete more waste matters, and in the emergency often do enough to relieve the kidneys.

442. Relation of the skin and kidneys. — The skin excretes but little urea compared with the kidneys, yet its capacity for excreting water is unlimited. When much water is excreted by the sweat glands, only a little is excreted by the kidneys, and when little perspiration is formed, the kidneys excrete more water. The amount of urea remains nearly the same from day to day, and so the urine will be more colored at one time than another.

The amount of perspiration is governed principally by the temperature, and remains nearly the same whether much or little water is taken. The amount of urine is increased by the water swallowed. A large amount of water tends to wash away the urea more perfectly. Often when one thinks that he has kidney trouble, an increased amount of water swallowed will pass through the kidneys and bring their secretion to a natural appearance.

443. Excretion of poisons swallowed. — When poisons have been swallowed, those which pass by the liver are seized by the kidneys and excreted. Carbolic acid and turpentine are thus excreted by the kidney. In passing through the kidneys these drugs may irritate their cells and set up inflammation. Most drugs, whether they are vegetable or mineral, pass out by the kidneys.

444. Excretion by the liver. — The liver is constantly destroying all kinds of poisons, which it receives not only from the blood of the intestine, but also from the rest of the body. Two bile substances, *glycocholic* and *taurocholic* acids, are probably formed directly from albumin; and while they are excretory products, yet they are elements essential to digestion. Another substance, *bilirubin*, contains most of the waste coloring matter of the blood. When the liver fails to excrete these substances, as in *jaundice*, they pass out by the kidneys and color their secretion yellow.

445. Excretion by the intestine. — Although the intestine absorbs food, yet it also pours out some waste matters.

When the intestine does not expel its contents, symptoms like liver and kidney diseases arise. So the intestine excretes some waste matter. Under certain conditions even the stomach may become an excretory organ, and vomiting may be a life-saving act, just as it often is when poisons are swallowed.

446. Intemperance and kidney disease. — *Alcohol*, by disturbing oxidation and the liver, is especially liable to cause the production of poisons whose excretion severely taxes the kidneys. It alone causes over one half of kidney diseases. Candies, pie, cake, and preserves are all eaten simply for their taste, and usually after a sufficient amount of proper food has been taken. So, in oxidizing this increased amount of food, some must be imperfectly oxidized. Thus poisons are developed and the kidneys are overworked.

Intemperance in sugar eating is extremely common. It produces imperfect oxidation in the same way as alcohol, only its effects are much slower and less noticeable.

447. Sewage. — The excretions of man and animals, together with the dirty water used in washing, is *sewage*. Sewage is composed of substances which are of no use to man, but on the contrary are often very poisonous.

448. Purification of sewage. — Nature is very efficient in changing sewage so that it is no longer harmful. In the upper layers of the soil it is fully oxidized to carbonic acid gas and water and mineral substances. The soil can dispose of a great quantity of sewage and prevent it from polluting the surrounding wells.

In the second place, plants feed upon sewage. They aid in its oxidation and use it as food. Thus plants may form again the substances which were oxidized in man's body so that he may eat the very products which he once excreted.

In the third place, running water washes away sewage, and by means of the oxygen which it always contains it fully oxidizes the excretions.

449. Danger from sewage. — Sewage often is a poison itself, and when much is collected it often develops poisons by its decay. The foul smell of sewage is due to gas called *sewer gas*. While the gas itself is but slightly harmful, yet it is a sign of decay and of lurking sources of danger. Sewage is dangerous, mainly because it may furnish food in which germs of disease may grow. Typhoid fever is often transmitted in this way. These germs may become dry wherever the sewage dries, and may then rise as dust with the sewer gas.

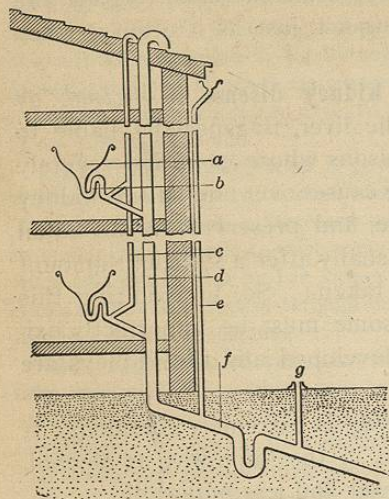


Diagram of the plumbing of a house.

- a* sink or washstand.
b trap, which remains full of water and prevents the entrance of sewer gas.
c air pipe for ventilation and to prevent the water from being sucked out of the trap.
d waste pipe, down which the slops pass into the sewer.
e pipe from the gutter on the roof.
f waste pipe passing under the street.
g ventilation pipe.

hole, from which it slowly filters through the ground.

In more thickly settled places the hole in the ground is often made water-tight, forming a *cesspool*.

451. Sewers. — Towns and cities provide large underground tubes or tunnels, called *sewers*, into which the

450. Disposal of sewage.

— In thinly settled country places nature is able to dispose of the sewage so that it is destroyed wherever it is placed. But in order to be sure to avoid pollution, the simplest contrivance is to conduct the sewage away from the house and into a

sewage runs from each house. The sewage is either emptied into running water and is carried away by the current, or else it is transported to a distance from the city and spread over the soil of a farm, where it becomes plant food. The produce raised upon the farms aids in paying the expense of removing the sewage.

452. Plumbing. — In houses pipes are arranged to carry off the sewage as fast as it is formed in the sinks, wash-bowls, and closets. Since they open into a common sewer of the town, sewer gas can readily enter the houses. To keep it out, each pipe is bent into a loop which remains full of liquid and prevents the entrance of gas.

453. Cleanliness. — No matter how good the natural or artificial drainage may be, if decaying matter is left in cellars it may poison the air. Sinks may become clogged and poison the air, while slops and dirty dishes may be carriers of disease. So cleanliness is of great importance, aside from its mere looks.

454. Choice of a house. — Damp soils are likely to breed disease. In some the subsoil is clay or solid rock and does not permit the sewage to pass off. Land formed by filling in marshes is apt to be damp and malarious, besides affording no natural drainage.

The site for the home should also be such that the barnyard and outhouses can be put so they will drain away from the house and well. Attention to these details of drainage is of far more importance than the natural beauty of a site.

SUMMARY

1. Excretions are waste and poisonous substances expelled from the body. The principal ones are carbonic acid gas, water, urea, and mineral matters.
2. Sweat, or perspiration, is formed in tubes in the skin. It excretes some urea and mineral matters.
3. The kidneys are collections of minute tubes which separate urea, mineral matter, and water from the blood.

4. When, in Bright's disease, or from any other cause, the kidneys cease acting, death by poisoning soon takes place.
5. The skin can aid the kidneys, but cannot take their place.
6. Alcohol causes poisons to develop whose excretion overworks the kidneys.
7. The liver and intestine each excrete a great amount of waste and poisonous substances.
8. The excretions from man remain poisonous until destroyed by the soil, by plants, or by running water.
9. In thickly settled districts it is necessary to carry off the excretions by means of a sewer.

DEMONSTRATIONS

106. Carefully weigh several boys early on a warm day. Have them run about and take violent exercise, eating and drinking nothing, or only known amounts. In a few hours weigh them again. A loss of half a pound or more may be noted.

107. Insensible perspiration may be shown by touching a cold glass to the skin, when moisture will at once condense upon the glass.

108. Secure a specimen of kidney mounted for the microscope. With a power of about 200 diameters show the class how capillaries form a bunch in a pocket at the beginning of each tube, and then pass out to surround the tubes, and finally unite to form the veins. Show them the large size of the cells of the tube.

109. Cut open a pig's or sheep's kidney lengthwise and notice the pocket in its side and the radiating lines of the kidney reaching almost to the surface and marking the course of the tubes.

110. A pot of growing flowers will illustrate nature's method of disposing of sewage. Although manure and dirty water are poured upon the earth, yet they give out no odor, but become fresh and clean and nourish the plant.

111. Show the pupils the traps for sewer gas under the sinks.

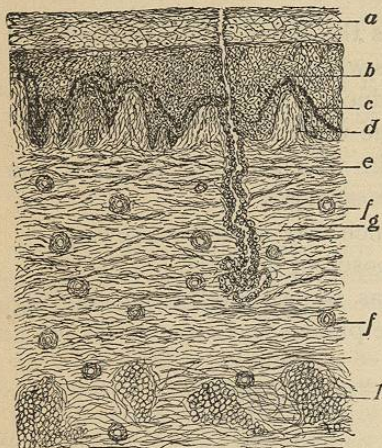
REVIEW TOPICS

1. Explain the difference between a secretion and an excretion.
2. Name the principal excretions and tell how they leave the body.
3. Describe sweat glands and the perspiration as an excretion.
4. Describe the kidneys and their excretion.
5. Discuss how imperfect oxidation may overwork the kidneys.
6. Show how the skin aids the action of the kidneys and how the one acts less when the other is more active.
7. Show how alcohol produces kidney diseases and how sugar acts in the same way.
8. Describe three ways in which nature destroys the excretions of man.
9. Discuss the dangers which may arise from sewage.
10. Tell how sewage is disposed of in cities.
11. Describe how sewer gas is prevented from entering houses through waste pipes.

CHAPTER XXVII

THE SKIN AND BATHING

455. The derma.—The skin is the tough, loose sack which covers the entire body. It is designed to protect the body and to give off perspiration and heat. (See pp. 235, 248.)

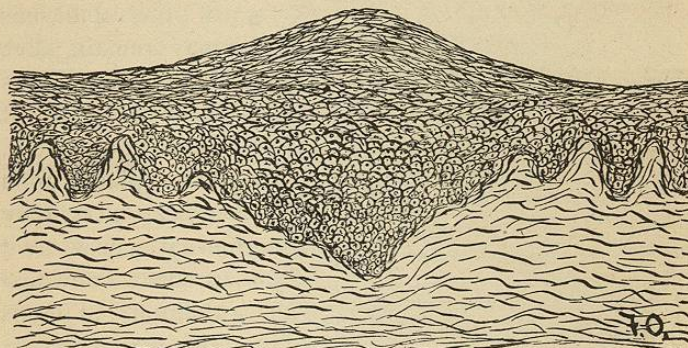


The skin (x 100).

- a* dead layer of epidermis.
- b* growing layer of epidermis.
- c* layer of cells containing the coloring matter of the skin.
- d* papilla.
- e* sweat gland.
- f* small blood tube.
- g* fibers of the derma.
- h* fat cells in the derma.

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456. The epidermis.—The derma is covered with a layer of epithelial cells, called the *epidermis* or *cuticle*. New cells are continually being produced in the deeper layers of the epidermis, while the older cells become matted in a firm mass which is continually being worn away. These cells are directly continuous with the epithelial cells of the mucous membrane and are of the same nature. The epidermis has no nerves and no blood tubes.



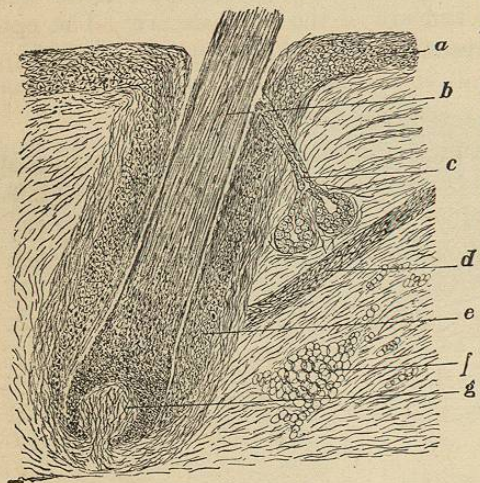
A corn.

457. Upon the palms of the hands and soles of the feet the epidermis forms a very thick layer for the better protection of these much-used parts. When hard labor is performed with the hands, nature causes the protecting epidermis in the exposed parts to form a thick and horny spot called a *callus*. Sometimes pressure and rubbing cause a small area to become thickened so that a point of hardened cells is formed which presses into the deeper parts of the skin. This is a *corn*.

When the skin is vigorously rubbed, or certain drugs are applied, the deeper layers of the epidermis are killed, and water accumulating between them and the outer layers raises a *blister*.

458. Color of the skin.—The deeper layers of the epidermis contain colored granules which give the peculiar color to different races of men. Exposure to the sun's rays produces a darker coloring matter. In some people the coloring matter is deposited in small spots called *freckles*.

459. Skin grafting. — A spot of skin deprived of epithelium is tender and sore. New flesh forms over its surface, while the epithelial cells at its edge produce new ones which spread over the whole surface and complete the healing. If they do not grow, the new flesh sprouts above the skin, forming *proud flesh*.



A hair ($\times 200$).

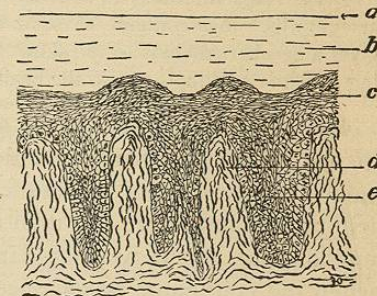
- a epidermis of the skin.
- b hair shaft.
- c sebaceous gland.
- d muscle which makes the hair erect.
- e epidermis of the hair root.
- f fat cells in the derma.
- g papilla from which the hair grows.

The deeper cells of the epidermis may remain alive for some hours after being cut off from the body. When placed upon a clean ulcer, they may grow and produce a new epithelium. This is *skin grafting*.

460. Papillæ. — From the surface of the derma small projections about $\frac{1}{200}$ of an inch in length, called *papillæ*, extend a short distance into the epidermis. They contain nerves of feeling. The papillæ over a small area sometimes become overgrown, so that they project above the skin, forming a *wart*. Rows of papillæ form the fine curved lines upon the balls of the fingers and the palms of the hands. They are most numerous where the sensation of touch is greatest.

461. Hair. — Extending obliquely nearly through the derma are numerous minute tubes lined with epithelium. Their cells become joined together in a tough string, called a *hair*, which projects out of the tube. When the hair is pulled out, the epithelium covering the projection in the tube soon produces another hair. A small muscle is attached to the bottom of each hair root. Cold causes the muscles to contract and to pull the hair tubes to an upright position imparting to the skin a roughness called *goose flesh*. Hair covers almost the entire body.

462. Sebaceous glands. — Near each hair is a gland called a *sebaceous gland*. It secretes a kind of oil, which softens the skin and keeps the hair glossy. The glands are especially numerous down the center of the face. When their mouths are stopped by dirt they often become distended and form small, black spots called *black-heads*, which are often mistaken for small worms.



A nail ($\times 200$).

- a surface of the nail.
- b body of the nail.
- c epithelial cells just before they are welded into a nail.
- d papillæ.
- e growing epithelium.

463. Nails. — The epidermis upon the backs of the last joint of each finger and toe is hardened into a *nail*. The nail is formed at its back part and is pushed onward in its growth. An epithelial cell remains a part of the nail about three months before it is pushed from its root to its end.

464. The complexion. — In health the skin has a velvety appearance, and a rosy color, and is free from spots or scales. Its moisture is

of the proper degree to cause it to feel soft and pliable. Its appearance is changed by ill health. If the stomach and intestine are not in good order, it is almost impossible for the skin to be beautiful. Plain food, fresh air, and exercise make a beautiful skin, and no skin can be beautiful without them. Cold dry air or exposure to the sun's rays often cause it to become red or to blister. These effects are much greater upon those who are unaccustomed to the exposure.

465. Care of the complexion. — Washing the skin with soft water and soap as often as it becomes dirty, and following it by a thorough drying with a soft towel, are the only effective means of beautifying the skin. Paint, powder, and perfumery cannot cause the skin to grow more beautiful. They simply coat its outside, and at the same time stop its sebaceous and sweat glands, so that when it is removed the skin looks worse than before. They act like any other dirt. Many of these preparations contain poisonous minerals such as lead.

Drugs taken internally to beautify the skin act mainly through the arsenic which they contain. Arsenic destroys the blood cells, and so gives a peculiar paleness to the skin. Paleness is only a sign of poisoning which is working harm to the health.

466. Absorbent power of the skin. — Since the outer part of the epidermis is dry and dead and contains no blood tubes or lymphatics, substances rubbed upon the skin will not be absorbed. So man can handle virulent poisons and disease germs without danger. On the other hand, when the epithelium is removed, the exposed blood tubes and lymphatics take up drugs and poisons very readily. Drugs may be absorbed from surgical dressings, and germs of disease may enter through even a minute scratch.

467. Care of the hair. — The hair of man, like that of animals, is soft and glossy in health, but often dry and rough during disease. Daily brushing to remove the dirt, and to distribute the oily secretion of the sebaceous glands, will keep the hair in the best condition. All that is necessary beyond this is frequent washing with soft water. The secretion of the sebaceous glands is sufficient to oil the hair and scalp. There is no substance which will cause hair to grow, neither will any

stop its growth. When hair is shaved off, it soon regains its former length and then ceases to grow. Shaving seems to have some effect in causing the hair to grow coarser, but it does not add to the number of separate hairs.

468. The beard. — At about the age of sixteen the hair upon a boy's face begins to grow larger and coarser, and if let alone becomes a full beard in the course of two or three years. A shaved beard is not so silky as one that has never been cut.

A beard gives to a young man an appearance of age and experience and is popularly taken for a sign of mental and physical strength. As a matter of fact the presence or absence of a beard has nothing to do with a person's experience or knowledge.

469. Care of the nails. — Biting the nails makes their edges ragged, besides making the ends of the fingers sore. The nails themselves are not poisonous, but underneath their projecting ends germs of disease may be mixed with the dirt which gathers there. Naturally the nail adheres to the finger nearly down to its end, but is often kept raised and sore by too persistent cleaning. The edge of the semicircle of flesh surrounding the root of the nail is naturally soft and slightly raised so that it looks like a fine silken braid. Sometimes it becomes hard and cracks, especially upon cold, dry days. Cutting away the hard edge down to its soft margin in the flesh prevents the extension of the cracks. A tiny sliver of the edge of flesh around the nail torn back into the flesh forms a *hangnail*. The hangnail should be cut off close to the flesh. It is best prevented by gently pushing the skin back from the nail. Tight shoes bind the toes together, curving the great toe nail into the flesh, causing an *ingrowing* toe nail. Broad shoes are the best preventive of the trouble.

470. Bathing. — A noticeable odor of perspiration about any part of the body is a sign of uncleanliness, and is the best indication of the need of a bath. Even in cold weather a bath is needed at least once a week, while in the summer it may be necessary to bathe daily. Soap and hot water soften the epithelium, and if the skin is then rubbed vigorously, a large amount may be rolled into small balls, which are often supposed to be dirt. When much epithelium is removed in this way, the body is more sensitive to the cold,

the perspiration passes off with greater ease, and the skin is made tender.

471. Hot baths. — The heat of a bath in which the body is kept warm from the time it enters the water until it is dry dilates the blood tubes of the skin, so that the blood accumulates upon the surface. Thus the internal organs contain less than their natural supply of blood, and the body is apt to feel weak and drowsy. After mental labor a hot bath may cause the blood to leave the brain and so bring about sleep. When a cold is coming on, a hot bath may attract blood away from the throat and bronchi so that the inflammation is cut short. The proper time for a hot bath is at night, just before retiring, so that the circulation may become natural before morning. A hot bath requires the use of a warm room, and of a tub sufficiently large to admit most of the body at once, for evaporation of the warm water causes a cold feeling on coming out of the bath. It should always be followed by rest or sleep.

472. Cold baths. — When a cold bath is taken, the blood tubes of the skin at first contract and give a cold feeling; but they soon dilate. With the dilatation there comes an increased flow of blood throughout the whole body, so that there is a feeling of warmth and vigor in marked contrast with the drowsiness of the hot bath. The invigorating effects of a bath are called its *reaction*. If a cold bath is long continued, there comes on a second contraction of the arteries, so that the blood is forced within the body, producing a feeling of coldness and weakness from which the body is a long time in recovering. This second contraction of the blood vessels is called the *secondary reaction*. The bath should be stopped at the first appearance of a chill.

473. An easy way of bathing. — A cold bath requires nothing more than some water and a towel. A simple wetting of the body with the hands, followed by rubbing with a soft towel, produces all the effects of an elaborate bath tub. Such a bath can be taken in two minutes upon rising and is very invigorating and refreshing.

474. Turkish baths. — A Turkish bath is a combination of hot and cold baths in which the body at first is made to perspire in a hot bath while being rubbed. The body is then suddenly deluged with cold water and rubbed dry. At night the bath is refreshing, but the removal of epithelium and the excessive perspiration make the bather liable to take cold.

475. Sea bathing. — Running water carries off the heat of the body, and thus produces a greater effect than still water. The motion of the waves makes sea bathing exhilarating, and the salt in the water seems to have some stimulating effect.

476. Bathing in fevers. — A cold bath always lowers the temperature of a feverish person, and if properly given, greatly adds to his comfort. It also stimulates the skin to greater activity so that it aids the kidneys in their work of excretion. A good way of bathing a feverish person is to uncover only an arm, and wet it with lukewarm water. Then gently rub it with the bare hands until it is dry. The evaporation rapidly produces an agreeable coldness, while the rubbing keeps up the circulation and prevents taking cold. Then cover it and go over the other arm, and then the legs, and the body in the same way. Finish by washing the face and brushing the teeth. It is proper to give such baths several times a day if the fever is high.

SUMMARY

1. The skin consists of a thick network of connective tissue, called the *derma*, covered with several layers of epithelium, called the *epidermis*.
2. A hair is formed by the welding together of epithelium in a minute tube in the skin.
3. Sebaceous glands pour an oily substance upon the hair roots to soften the skin and hair.

4. At the backs of the ends of the fingers and toes the epithelium is thickened and hardened to form the nails.
5. Digestive disturbances are the principal causes of a poor complexion.
6. Paints and powders irritate the skin and have the same effect as dirt.
7. Daily brushing the hair and frequently washing it with soap and water are the best means of keeping it soft and glossy.
8. Nails should be smoothly trimmed, and gently cleaned.
9. The skin should be washed often enough to prevent an odor of perspiration.
10. The heat of hot baths dilates the arteries of the skin so that blood leaves the internal organs and brain and produces a feeling of rest and drowsiness.
11. A cold bath contracts the arteries of the skin. But they soon dilate and produce a feeling of warmth and exhilaration, called the *reaction*.
12. If a cold bath is continued, the arteries again contract, producing chilliness and a feeling of exhaustion.

DEMONSTRATIONS

112. Examine a specimen of skin with a microscope. Notice the network of connective tissue in the derma, and the numerous arteries and veins. Notice its projections of papillæ and their covering of epithelium. Notice that the epithelial cells in the deepest layers are large and round, and the outermost layers are flat and shriveled and can scarcely be recognized. Notice a faint line of colored granules in the third or fourth layer of cells. In a negro the colored layer is very distinct. The specimen will also probably show one or two winding sweat glands.

113. The skin specimen will probably show a few hairs, but one specially prepared will be better. Notice the deep tubelike depression

in which the hair rests, and the little knob embraced by the hair at its bottom. Notice the whitish cells of the sebaceous glands reaching off from the side toward which the hair points. Underneath the gland will likely be seen the faint outlines of the small muscle which causes the hair to stand on end.

114. A specimen of nail under the microscope will appear almost transparent, but the papillæ of the skin and the young epithelial cells beneath it will show well.

115. Wash a boy's arm. Then apply a cloth wet in hot water for a few minutes and show how the softened epithelium can be rubbed off. Explain that it is not dirt, but the protection of the arm.

REVIEW TOPICS

1. Describe the skin, its derma, epidermis, subcutaneous tissue, and coloring matter.
2. Describe the modifications of epidermis in a callous spot and a corn.
3. Describe freckles; a blister; an ulcer.
4. Describe the papillæ.
5. Describe a hair, sebaceous glands, and blackheads.
6. Describe the nails.
7. Give the causes and treatment of a bad complexion, and the effects of paints and powders and drugs.
8. Give simple directions for the care of the hair.
9. Give simple directions for the care of the nails.
10. Give a general rule when to bathe for cleanliness.
11. State the effects of a hot bath, and when to take it.
12. State the effects of a cold bath, and give a simple and easy way of taking one.
13. Describe a Turkish bath, and give reasons for not soaking and rubbing the skin to an excessive degree.
14. Give an easy way of bathing a feverish person.