

6. Show how bacteria are destroyed in the body by white blood cells and by the blood plasma.
7. Describe an *antitoxin* and tell how it is used in treating diphtheria.
8. Describe vaccination.
9. Show how bacteria are destroyed by sunlight; by the air; by running water; and by the soil.
10. Show how man destroys bacteria by cleanliness; by heat; and by antiseptics.
11. Show how a surgeon destroys germs before and after a surgical operation.
12. Give some hints about the care of a sick room; and about cleansing it after an infectious disease.
13. Describe the disease tuberculosis, or consumption.
14. Give the duties of a board of health.

NOTE. -- For a more extended discussion of bacteria and disease, see "The Story of the Bacteria," by T. Mitchell Prudden, M.D.

## CHAPTER XLI

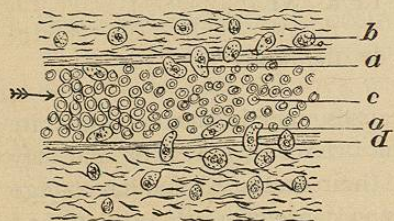
### REPAIR OF INJURIES

**694. Injuries.** — Many causes outside the body operate upon its cells to injure them. Excessive heat or cold may impair their vitality or cause their death. A sudden change from heat to cold is a common cause of injury. Blows and cuts may kill whole armies of cells. Above all, bacteria may cause injury and disease. In a few hours, the injured part shows a change, which is apparently due to an increase of the injury, but which is really caused by nature's attempt to repair the part.

**695. Congestion.** — After an injury has been received the first step in its repair is to dilate the arteries so as to permit more blood to flow through the part. Then more plasma will penetrate into the lymph spaces. This produces redness and some swelling and is called *congestion*. Congestion is a sign of attempted repair. This alone may be sufficient to heal the injured part.

**696. Inflammation.** — If the injury is greater, there is a change in the behavior of the white blood cells. Ordinarily they tend to flow more in the outer part of the blood stream, but when the arteries enlarge as a result of injury they adhere to the sides of the smallest blood tubes and some pass entirely through their walls and lodge in the lymph spaces. There they envelop and digest the injured parts and carry them away with the lymph. The lymph and blood cells have great power of absorbing blood and

dead cells, or even such substances as stitches left in the body by a surgeon. The excess of white blood cells causes more swelling, and some pain. This is an aggravated form of congestion, and is called *inflammation*. Some of the white



Beginning of inflammation ( $\times 400$ ).

- a white blood cells adhering to the wall of a capillary and passing through it.
- b white blood cells which have passed outside of the capillary in order to repair an injury.
- c red blood cells passing through the capillary.
- d wall of capillary.

blood cells grow in place of the removed cells and so fill in the gap. Each cell becomes long and branched and finally develops into a connective tissue cell. If the new cells are in great amount, they have a different appearance from the original cells and are then called a *scar*.

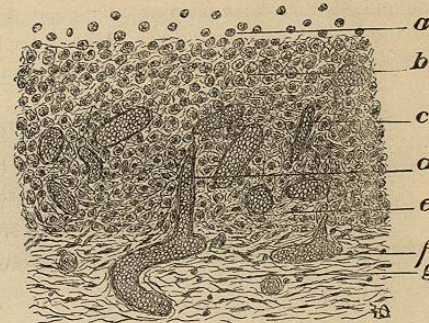
#### 697. Repair of cuts.—

When a cut is made in a tissue, the same process

takes place, but in addition new blood tubes sprout from each side of the wound and interlace in the middle. The white blood cells grow about the new tubes and become connective tissue and so bind the edges of the cut together.

When the skin is injured, the white blood cells form new tissue upon the surface while the epithelium spreads over it from the edges, stopping the growth and completing the healing process. Sometimes the new connective tissue grows faster than the epithelium and forms soft tufts, which project above the healthy flesh. These tufts are called *proud flesh*. If they are scraped off, or cauterized, the epithelium is enabled to cover the wound, and to complete the healing.

698. Injuries due to bacteria.—If bacteria cause the injury to the cells or if they enter and grow after the injury is done, the blood cells must fight them as well as repair the damage. Sometimes they cannot do both at once. Then the white blood cells and plasma leave the blood tubes to a still greater degree and lay siege to the bacteria until they completely fill the lymph spaces. They even stop up the blood tubes, producing great swelling and pain. White blood cells and bacteria are now tightly wedged among the injured tissues with no chance for escape and with no nourishment. Then the whole injured part becomes soft and finally bursts and runs out as a creamy matter called *pus*.



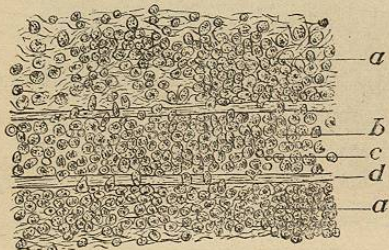
The repair of a wound ( $\times 200$ ).

- a new white blood cells upon the surface of a raw spot.
- b growing white blood cells.
- c new capillary.
- d new branch from a capillary.
- e older white blood cells which are becoming elongated and branched like connective tissue cells.
- f old capillary sending out a new branch.
- g old connective tissue.

Thus nature sacrifices a part of the body in order to get rid of the bacteria which threaten to overcome the whole body. Then the white blood cells grow and repair the wound as in clean wounds. A mass of pus in the body is called an *abscess*. Every abscess or collection of pus is caused by bacteria.

If bacteria grow upon an open cut, the white blood cells must devote part of their energies to fighting them, and so healing goes on slowly,

while the dead cells, or pus and plasma, run off in a continuous stream. So bacteria hinder the repair of wounds, and prevent their edges from growing together directly. Then the cut must slowly heal from its bottom. When a wound begins to be tender and to discharge, it is said that one has *taken cold* in it. Taking cold in a wound means that bacteria are growing in it. Their toxins may poison the whole body and produce a severe fever, which may cause death. Surgeons now exclude bacteria from the wounds which they make. The white blood cells then have nothing to do but repair the cut, and every part of the wound heals at once. Healing applications do good mainly by destroying germs which may come near the wound.



The second stage of inflammation ( $\times 200$ ).

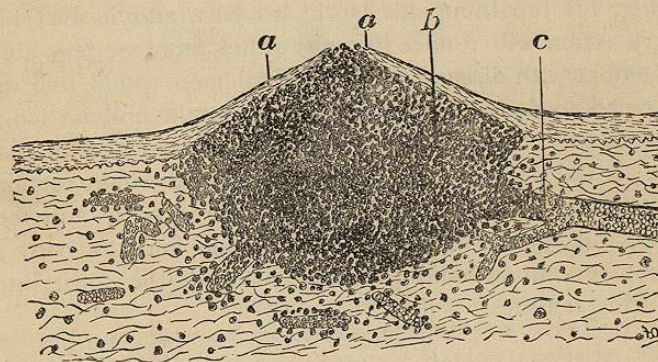
- a white blood cells which have left the capillary.
- b white blood cells which nearly block the capillary.
- c a few red blood cells which still circulate.
- d wall of the capillary.

the germs will be removed, and the white blood cells will grow unhindered.

When an abscess is forming, the heat of a poultice dilates the blood vessels, and so hastens the softening process. Thus it "brings the abscess to a head" and hastens the discharge of the pus. Since the pus will form anyhow, it is always better to open the abscess and let out the matter at once. This can be done without pain by using cocaine.

**700. Taking cold upon the lungs.**—When a mucous membrane is injured, as by exposure to cold, there will be the same changes in its blood tubes as in a wound

of the flesh. Then the membrane will be red and tender and possibly swollen. Owing to the thinness of the membrane and of its epithelium, the plasma and white blood cells will come to the surface. The matter may collect until it is coughed up and expelled. The nose and throat are the most often affected, but in severe cases it extends to the trachea and lungs. When the matter fills the air sacs of a part of the lung, the disease is called *pneumonia*.



The third stage of inflammation, or the formation of an abscess ( $\times 50$ ).

- a epithelium of the skin softened and bursting.
- b white blood cells which have packed the tissues full and shut out nourishment.
- c blood tube stopped by white blood cells.

In order to take cold there must be an injury to the cells, and bacteria must grow upon the injured spot. It often happens that the cells are exposed to injury, and no cold is contracted, for germs do not happen to grow, while on the other hand the exposure may be slight, and yet may enable germs to produce a severe cold.

In colds and in an abscess, the pus and discharged substances are not foul matters which are circulating in the blood, and which should be expelled, but consist of the strong blood cells which have died fighting for the defense of the body, and of plasma, which is an efficient protection against the germs. Both being dead and charged with the toxins of the bacteria, they should be expelled from the body.

When a cold is first coming on, a hot bath and hot drinks and hot bed clothing, together with a liver stimulant, may cause the skin and liver to excrete enough toxins to enable the white blood cells to overcome the bacteria.

**701. A long life.** — Although in former times man was often conquered by bacteria of disease and even now is continually assailed, yet now he knows more about his tiny foes and is able to protect himself. He knows that his eating, his breathing, his work, his rest, and in fact his every action will render his cells either more or less able to combat with disease germs. If all men would live up to their knowledge, germs of disease would find no lodgment in the body, while there would be no cause of disease in the body itself. Then man's mind would remain with his body far beyond the allotted three score and ten years, and, during all its long stay, would find the body a willing servant to build the ideal plans of the spirit into enduring realities.

#### SUMMARY

1. An injury to the cells of the body causes the arteries to dilate and bring more blood to the part.
2. Over a sore spot the white blood cells form new connective tissue while the epithelium of the healthy skin spreads over the new tissue, stopping its growth and completing the healing process.
3. When bacteria are growing in an injured spot, the white blood cells attack them, but are often killed themselves and pass off as creamy matter called *pus*.
4. If the white blood cells cannot overcome the bacteria, they hem them in until they and the tissues starve and run out as pus.

5. The changes which take place about an injured part cause it to become red, painful, swollen, and warmer than usual.
6. If wounds and all other injuries were protected against bacteria, they would heal at once without discharging pus or other matter.
7. In injuries to mucous membranes, the white blood cells and plasma pass through the thin tissues to the surface and are discharged at once.
8. Taking cold means an injury due to bacteria.
9. The matter discharged from an abscess or from a "cold" is composed of the best cells of the body which have died in its defense.

#### DEMONSTRATIONS

175. Scratch the skin upon the lower part of the arm. Notice that a red line develops in a moment. Explain that the scratch injured the cells and partly paralyzed the blood vessels, and that the redness is due to more blood in the part, which has come to repair the damage and to protect the rest of the body.

176. A pimple upon the face will illustrate the different stages of inflammation. Explain that a pimple may be caused by a prick too small to be noticed, but which has introduced some bacteria beneath the skin. Explain that the redness is due to the blood which has come to repair the damage. Explain that the white spot upon the top of the pimple is the softened area through which bacteria and dead cells will finally pass out, and that the pus is composed of white blood cells which have died fighting to protect the body against the bacteria.

177. Place a tiny drop of matter pressed from a pimple or a cut or a scratch upon a microscope slide and examine it with a power of 400 diameters. Notice that it is composed of white blood cells, containing nuclei. Examine also a drop of mucus from the nose and notice that it consists largely of the same kind of cells.

178. Obtain a prepared microscopic specimen from a wound in the process of healing. Show that the newly formed tissue consists of

round blood cells upon its surface, and that in the deeper layers the cells grow larger and become branched. Explain that the deeper layers are the older and that their cells are white blood cells which are growing to become connective tissue.

## REVIEW TOPICS

1. Explain in order what happens in an injured part of the body, describing the increased flow of blood, and the action of the white blood cells.
2. Explain the healing of a cut.
3. Explain how a raw spot of skin becomes healed, and what part the epithelium takes in the process.
4. Explain how bacteria in an injured part retard healing.
5. Explain how white blood cells overcome the bacteria.
6. Explain the formation of an *abscess*.
7. Explain taking cold in a wound, and in a mucous membrane.
8. Give the signs of inflammation and its use.
9. Tell what composes the matter discharged from an abscess and from the nose and throat during a cold.
10. Show how to treat a wound in which one has taken cold.
11. Explain how to treat a cold of the air passages.

## GLOSSARY.

**Ab-do'men** (Lat. *abdomen*, belly), the cavity of the body which contains the stomach, intestine, liver, pancreas, and spleen.

**Ab'scess** (Lat. *abs*, away, and *cedere*, to move), a collection of dead creamy matter in the flesh of a living person.

**Ab-sorp'tion** (Lat. *ab*, away, and *sorbere*, to soak in), taking a substance into the tissues of the body, without change in its composition.

**Ac-com-mo-da'tion** (Lat. *ad*, to, *con*, with, and *modus*, measure), adjusting the lens of the eye to the proper shape to cause the image of an object to fall upon the retina.

**A'cid** (Lat. *acere*, to sour), any sour, irritating substance, which will corrode other substances.

**A'con-ite** (Gr. *akoniton*, the plant commonly called monkshood), an extremely poisonous plant. It is used to lower fevers. In overdoses it produces extreme weakness of the whole body.

**Ad'e-noid vegetations** (Gr. *aden*, gland, and *eidos*, form), collections of soft, grape-like bodies growing in the upper part of the pharynx. They are common in children.

**A-dul'ter-ate** (Lat. *ad*, to, and *alter*, another), to make impure by an admixture of an inferior substance.

**Al-bu'min** (Lat. *albus*, white, because it generally turns white when heated), a term applied to a class of substances, some form of which is the essential part of every living cell. It is composed of the elements carbon, hydrogen, nitrogen, oxygen, and sulphur. The form of albumin which is found in the white of an egg is spelled *albumen*.

**Al'co-hol** (Ar. *al-kohl*, a powder of antimony used in painting the eyebrows), on account of its extreme fineness the name came to be applied to the product formed by repeatedly distilling wine, for this was supposed to be the real "spirits" of the wine.