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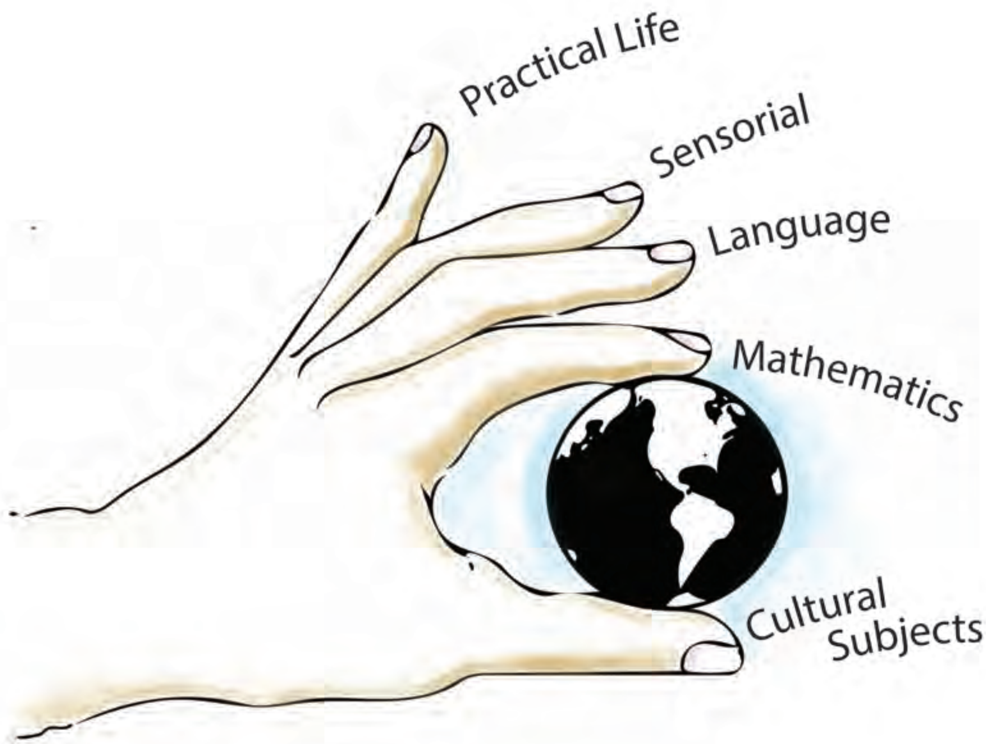

Biology

Elementary

Lesson Preparation Materials

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Mitosis

Cells are enclosed bya **cell membrane** to contain the **cytoplasm** and the **nucleus.** The nucleus is surrounded bya **nuclear membrane.**

1

Cells of living organisms reproduce by **mitosis,** the duplication bydivision of a single cell. When cells fail to divide, no growth occurs. This is known as atrophy. Cancer is characterized byuncontrolled cell division.

2

Interphase is the period between successive divisions of the cell. During the interphase, changes in the cell nucleus allow for the duplication and division of DNA. The two pairs of **centrioles** have duplicated.

3

During the next phase known as the **prophase,** each of the 46 pairs of **chromatids** is connected by a **centromere.** Each chromatid has the equivalent DNA of a chromosome. At the end of the prophase, the nuclear membrane dissolves and the **nucleolus** within the nucleus disappears. The nucleolus had contained genetic material. The centrioles project **asters of microtubules** and move toward the opposite poles of the dividing cell.

4

The **metaphase** follows the prophase. The strands of microtubules or spindle fibers span the cell center from one pair of centrioles to the other. The 46 pairs of chromatids and their centromeres group on the microtubules at the center of the cell, during the metaphase.

5

The next phase is known as the **anaphase.** The centromeres divide. Each is attached to one of the two chromatids so that they are no longer paired. Now there are 46 chromosomes being drawn to each side of the dividing cell by their centromere. As soon as the new chromosomes arrive at each side of the cell, anaphase ends.

6

In the final **telophase,** the cytoplasm cleaves or separates to form two new cells. In each cell, a nuclear membrane is formed and a nucleolus develops within the nucleus. The centromeres disappear and the chromosomes disperse. The interphase begins for the two new cells.

7

The daughter cells remain in **interphase** until cell division.

8

interphase

early anaphase

early prophase

late anaphase

late prophase

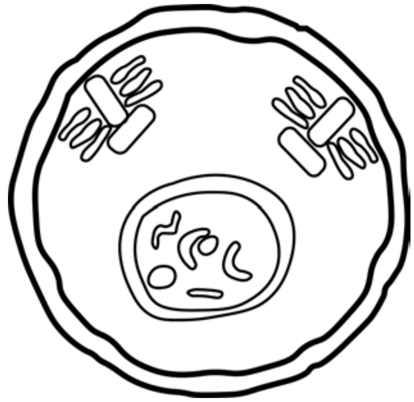
telephase

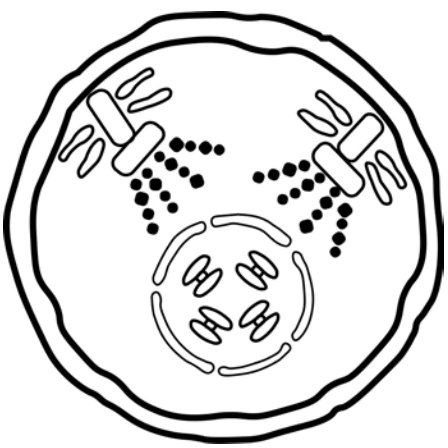
early metaphase

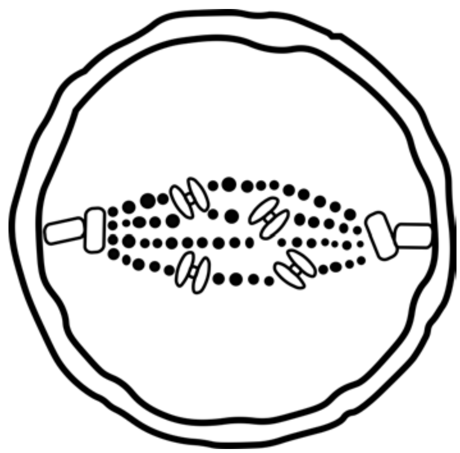
interphase

late metaphase

Mitosis





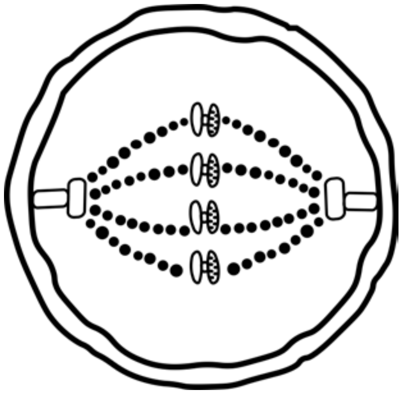


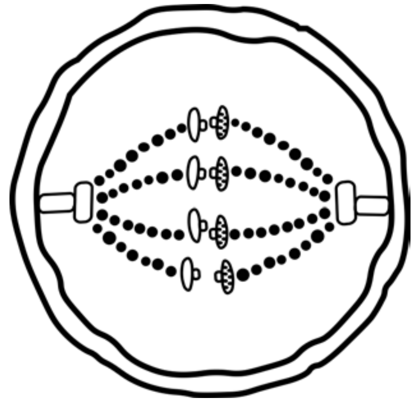
interphase **mother cell**

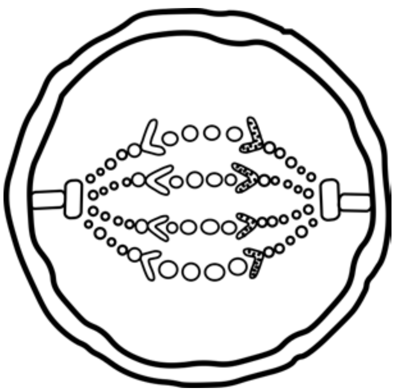
prophase **dispersed chromatin**

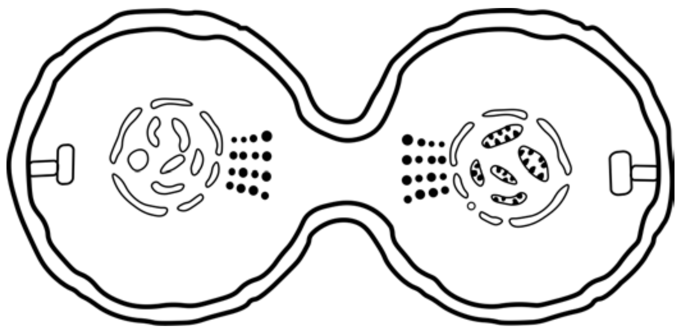
prophase **centrioles**

mataphase **strands of microtubules**







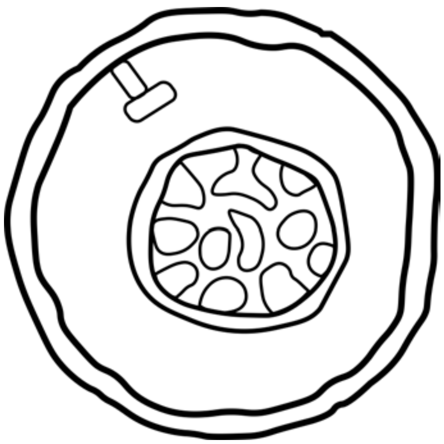


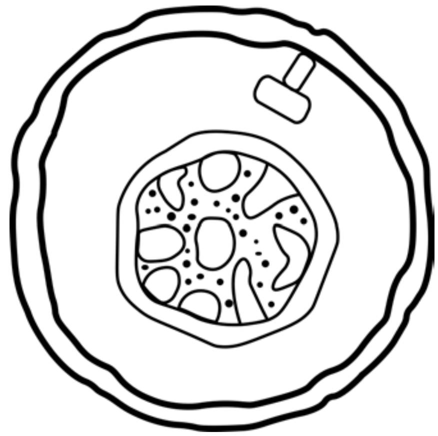
metaphase centromeres group on spindle fibers

anaphase centromeres divide

anaphase
chromosomes drawn to poles

telephase
cytoplasm begins to cleave





interphase
daughter cells

Nitrogen Cycle

Nitrogen is a gas that makes up 78% of air. Every cell of every living organism contains nitrogen. All living organisms require nitrogen but cannot use it in its gaseous form. Nitrogen must be combined with other elements to be utilized. This is known as nitrogen fixation.

1

The nitrogen cycle is the process whereby nitrogen is fixed from its gaseous form to compounds which are used by living organisms. The cycle takes place through the atmosphere, soil, water, plants and animals. Nitrogen (N_2) is taken from air in the soil and converted to ammonia (NH_3). This is done by nitrogen-fixing bacteria and algae. Most of the ammonia is absorbed by plants but some escapes into the air.

2

Nitrogen can be fixed by the roots of plants of the pea family known as legumes. Farmers raise legumes, then plow under the mature plants to provide nitrogen which fertilizes the soil.

3

Lightning converts the nitrogen in the atmosphere into an oxide of nitrogen. The heat of the lightning stroke causes nitrogen to burn by combining with oxygen. By the time it reaches the ground as acid rain, it is a nitrate. This form of nitrogen compound can be used by living organisms.

4

Nitrogen is available from dead plants, dead animals and manure. Bacteria and fungi decompose this material. Ammonia (NH_3} is produced from the nitrogen compounds in the dead organisms and manure. Plants are able to produce necessary food by absorbing ammonia.

5

Not all of the ammonia is absorbed by plants. Some is converted into nitrates by nitrifying bacteria. Some forms of bacteria convert ammonia into nitrite compounds (NO_2-}. Other forms of bacteria convert nitrites into nitrates (NO_3-}. Plants can absorb nitrates. Animals eat plants for their source of nitrogen.

6

Nitrogen is returned to air by the process of denitrification. Nitrates in the soil are converted to nitrogen and nitrous oxide (N_2O} by denitrifying bacteria. Some nitrogen compounds are washed into rivers, lakes and other waterways.

7

The supply of fixed nitrogen has been increasing since about 1850. The burning of fossil fuels such as oil and coal forms compounds of nitrogen and oxygen like nitric oxide. This causes smog and acid rain. Commercially produced nitrogen fixed fertilizers add fixed nitrogen to the environment. Along with the growing of legumes, about 140 million tons of fixed nitrogen are added each year. This is more than the fixed nitrogen produced from natural sources. Human activity now dominates one of the most important natural cycles of Earth.

Dicotyledons

There are two cotyledons or seed leaves.

1

Leaf has reticulate veins and usually has a petiole. Margins are often toothed.

2

Stems grow by producing successive cylinders of xylem tissue.

3

Flowers have four or five petals and sepals or multiples of four or five.

4

Pollen grains usually are tricolpate or having three furrows.

5

The endosperm contains reserve food within the seed coat which is digested by the embryo during germination.

6

Examples:

beans,

squash

7

Monocotyledons

There is one cotyledon or seed leaf.

1

The mature leaf has parallel veins, an entire margin and usually no petiole.

2

Stems do not have xylem, only vascular strands.

3

Flower parts are in multiples of three and sepals are often petal-like.

4

Pollen grains are monocolpate or having one furrow.

5

The endosperm contains reserve food within the seed coat which is digested by the embryo during germination.

6

The shield-shaped body next to the endosperm envelops the cotyledon and the plumule in monocotyledons.

7

Examples:

corn,

lilies,

orchards palm trees

8

Polycotyledons

There are more than two cotyledons and these are arranged in a whorl.

1

Leaves usually are scale-like or needle shaped. Each is replaced when one drops so that the plant is evergreen.

2

Beneath the thin bark, the cambium actively produces rapid growth. Usually the bark contains resin to protect it from fungi.

3

There are no flowers.

4

Pollen grains are winged.

5

Seeds are uncovered or naked in gymnosperms and most are produced in cones.

6

Examples:

pine,

fir and

cycad trees

7

Characteristics of Angiosperms	Characteristics of Gymnosperms
fibrous roots	tap roots
soft herbaceous stem tissue	woody stems or trunks
flowers as reproductive units	single primary axis branching (excurrent)
veined leaves	needle or scale like leaves
diffuse mode of branching (deliquescent)	strobilus or cone as reproductive unit
monocotyledonenous or dicotyledoneous seeds	polycotyledoneous seeds

Important Orders of Dicotyledons

Ranales:	magnolia, buttercup, tulip tree, lotus
Rosales:	rose, strawberry, blackberry, apple, cherry, legumes, plane
Papaverales: (Rhoeadales)	tree poppy, cabbage
Geraniales:	citrus fruit, flax, rubber
Umbellales:	carrot, dogwood, English ivy
Rubiales:	honeysuckle, coffee
Campanulales:	bellflowers, asters
Caryophyllales:	primrose, buckwheat
Ericales:	rhododendron, blueberry, cranberry
Gentianales:	olive, privet, milkweed, gentian
Polemoniales:	morning-glory, potato, tobacco
Lamiales:	mint, tea, lantana
Scrophulariales:	snapdragon, bladderwort, acanthus

Internal Parts of the Leaf

waxy cuticle	xylem
upper epidermis	phloem
palisade tissue	lower epidermis
mesophyll	stomata
veins	guard cells
bundle sheath	chlorophyll
chloroplast	respiration
photosynthesis	carotenoid
xanthophyll	

the glossy, waterproof outer coat of the leaf

nearly transparent layer of cells on surface of a leaf

cells just beneath the upper epidermis containing chloroplasts which make food for the plant

spongy area of middle leaf with fewer chloroplasts than in the palisade area where water, carbon dioxide and oxygen diffuse into and out of these cells into air spaces in the leaf

tiny tubes located in the mesophyll which distribute water and food throughout the leaf

cells surrounding the vein or vascular bundle

upper part of vein which conducts water and minerals to the leaf

lower part of vein which conducts food materials away from the leaf single layer of cells on the bottom of the leaf

microscopic openings in the lower epidermis through which water evaporates and oxygen and carbon dioxide diffuse

chloroplast-containing cells which surround the stomata and regulate its opening and closing

green pigment in chloroplasts which absorb sunlight to carry out the process of photosynthesis

cells which contain chlorophyll where water taken up by the plant is split into hydrogen and oxygen, where the hydrogen combines with carbon dioxide from air to produce sugar and give off oxygen

process in which plant leaves produce food (fructose or gluclose) from carbon dioxide and water using energy from the sun through the conversion of light energy to chemical energy

the reverse of photosynthesis whereby food (sugar) is assimilated by combining it with oxygen which produces carbon dioxide, water and energy for growth

yellow to red pigments in plants which carry out photosynthesis

yellow pigment appearing
with chlorophyll in plants

Internal Parts of the Leaf

waxy cuticle
the glossy, waterproof outer coat of the leaf
upper epidermis
nearly transparent layer of cells on surface of a leaf
palisade tissue
cells just beneath the upper epidermis containing chloroplasts which make food for the plant
mesophyll
spongy area of middle leaf with fewer chloroplasts than in the palisade area where water, carbon dioxide and oxygen diffuse into and out of these cells into air spaces in the leaf
veins
tiny tubes located in the mesophyll which distribute water and food throughout the leaf
bundle sheath
cells surrounding the vein or vascular bundle
xylem
upper part of vein which conducts water and minerals to the leaf
phloem
lower part of vein which conducts food materials away from the leaf
lower epidermis
single layer of cells on the bottom of the leaf
stomata
microscopic openings in the lower epidermis through which water evaporates and oxygen and carbon dioxide diffuse
guard cells
chloroplast-containing cells which surround the stomata and regulate its opening and closing
chlorophyll
green pigment in chloroplasts which absorb sunlight to carry out the process of photosynthesis
chloroplast
cells which contain chlorophyll where water taken up by the plant is split into hydrogen and oxygen, where the hydrogen combines with carbon dioxide from air to produce sugar and give off oxygen
photosynthesis
process in which plant leaves produce food (fructose or gluclose) from carbon dioxide and water using energy from the sun through the conversion of light energy to chemical energy

$$6\ CO_2 + 12H_2O \xrightarrow[\text{chlorophyll}]{\text{sunlight}} C_6H_{12}O_6 + 6\ O_2 + 6\ H_2O$$

respiration
the reverse of photosynthesis whereby food (sugar) is assimilated by combining it with oxygen which produces carbon dioxide, water and energy for growth

$C_6H_{12}O_6 + 16\ O_2 \rightarrow 6\ CO_2 + 6\ H_2O + 673{,}000$ calories

carotenoid
yellow to red pigments in plants which carry out photosynthesis
xanthophyll
yellow pigment appearing with chlorophyll in plants

Evolution of Plants

Over 440 million years ago, plants were the first form of life to leave water and colonize the land. Animal life on land would not have been possible without this.

1

The first land plants came from fresh water although all life originally began in the oceans. Small, simple plants like the algae of today made adaptations to survive out of water. They had to give up continuous access to water and cope with exposure to air, gravity and atmospheric pressure.

2

Small water plants have rapid life cycles. They have high mutation rates. Those able to survive for short periods without water but exposed to air were the basis for the development of land plants.

3

The advantages gained by plants leaving a water habitat for land were two. More sunlight is available on land than in water. The need for oxygen and carbon dioxide is more easily met on land. It takes longer for these gases to enter plant cells in water than on land.

4

Beginning about 439 million years ago in the Silurian Period, a waxy coating developed to cover the external surface of the plant cell. This is known as **cuticle.**

5

Pores called **stomata** developed. These openings in the cuticle allow carbon dioxide to pass into the plant for photosynthesis and oxygen to be expelled.

6

Guard cells formed around the stomata. These could change the size of the opening and regulate the amount of water vapor leaving the plant.

7

Plant **spores** evolved. These further reduced water loss and provided a tougher outer covering.

8

About 410 million years ago, some plants became more complex by developing **vascular tissues.** These allowed water and sap to be conducted throughout the plant. Plants could increase in size and height as they developed an extensive root system, strong stems and a canopy of leaves.

9

During the Devonian Period, every plant group known today except flowering plants had evolved. This occurred within a 50 million year time span.

10

About 125 million years ago during the Cretaceous Period, angiosperms or flowering plants appeared.

11

Domestication of Plants

Early humans gathered fruit, nuts, berries, leaves, roots, stems and flowers of plants which were found growing wild in the environment. Some plant parts were eaten, some were used as medicines and some were used for making cloth. All of the present day domesticated plants arose from wild plants. Many of the domesticated plants not only taste different but also look very different from their wild state.

1

There is evidence of the domestication of cereal grains and legumes by 9000 B.C.E. in the Middle East. This food was plentiful and edible in the wild state. Most of these plants did not require genetic changes to be cultivated as crops. They were self-pollenating, easily grown and reached maturity for harvest in a few months. Their seeds could be stored to provide food at a later time and to plant during the next growing season.

2

Early plant gatherers liked wild plants with fleshy fruit containing few seeds. Examples are pumpkins and squash. The largest berries and fruits with the best taste were preferred. Therefore, it was the seeds of these that were cultivated.

3

Fortunately, seeds of many edible fruits are so bad-tasting that they are spit out. If animals chewed and ate the seeds, then there would be no way to save and cultivate them. Many seeds are not digested in the intestinal tract and are eliminated. Some seeds cannot germinate unless they have passed through an animal's digestive system. For example, aardvarks in Africa eat a kind of melon whose seeds germinate only after passing through the intestinal tract of the aardvark.

4

In what is now Turkey, domestication of long stemmed flax plants occurred about 7000 B.C., making it one of the oldest crops. Linen fiber was produced from the stems and was woven into cloth. Linen is still in use today.

5

Early humans also sought oily fruit such as olives from which to extract oil. There is evidence that cultivation of trees which produced larger and oiler olives began about 4000 8.C. in the regions around the Mediterranean Sea. Other seeds cultivated for their oil were poppy, sesame, mustard and flax.

6

Domestication of dates, figs, pomegranates and grapes began about 4000 B.C. They could be grown from seeds or from cuttings taken from mature plants. Plants grown from cuttings will be identical to the plant from which the cutting was taken. It takes about three years to produce a crop.

7

About 3000 B.C., cultivation of another plant, cotton, began in what is now Pakistan. Cotton fibers continue to be used in producing textiles. Oil is extracted from cotton seed. It is used in food manufacture. The meal remaining after oil extraction is used for animal food.

8

Genetic change was essential for the domestication of peas. The pods of most wild peas explode once the seeds (peas) inside the pod are mature. This ensures that many of the peas will become embedded in the ground where they are able to germinate and produce more plants. Some of the plants naturally mutated so that the gene causing the pods to explode was not present. These unexploded pods made peas available for humans to eat. They saved some of the seeds (peas) for planting and so the mutant pea plants became domesticated.

9

Usually, bad-tasting plant parts were avoided. Now it is known that many of these were poisonous in their wild form. Some of these wild poisonous plants have been modified by mutation. For example, almonds in their wild form contain amygdalin which breaks down to form cyanide in the digestive tract. Cyanide is a deadly poison. A mutation in a single gene in a few almond trees prevented the formation of amygdalin. An early human who happened to taste an almond from one of those trees would have found it not bitter and non-poisonous. These are the seeds that would have been planted and cultivated to produce trees with edible almonds. The planting of almond orchards began about 3000 B.C.E.

10

Other foods whose ancestors were poisonous or bitter are egg plants, potatoes and lima beans. The present day varieties resulted from occasional mutations which occurred naturally and were discovered by early humans through the chance tasting of the mutation.

11

The planting of orchards for raising apples, cherries, pears and plums did not develop until Roman times. It takes too long to raise a tree from a seed and the variations in fruit quality are too great. Propagation from cuttings is not possible. Grafting is the best way. The technique was discovered in China but the Romans wrote books describing the process and rules. A scion, which is a bud, branch or cutting from one plant, is attached to the stock which provides the root system and perhaps part of the stem. The scion determines the quality and type of fruit which will be produced.

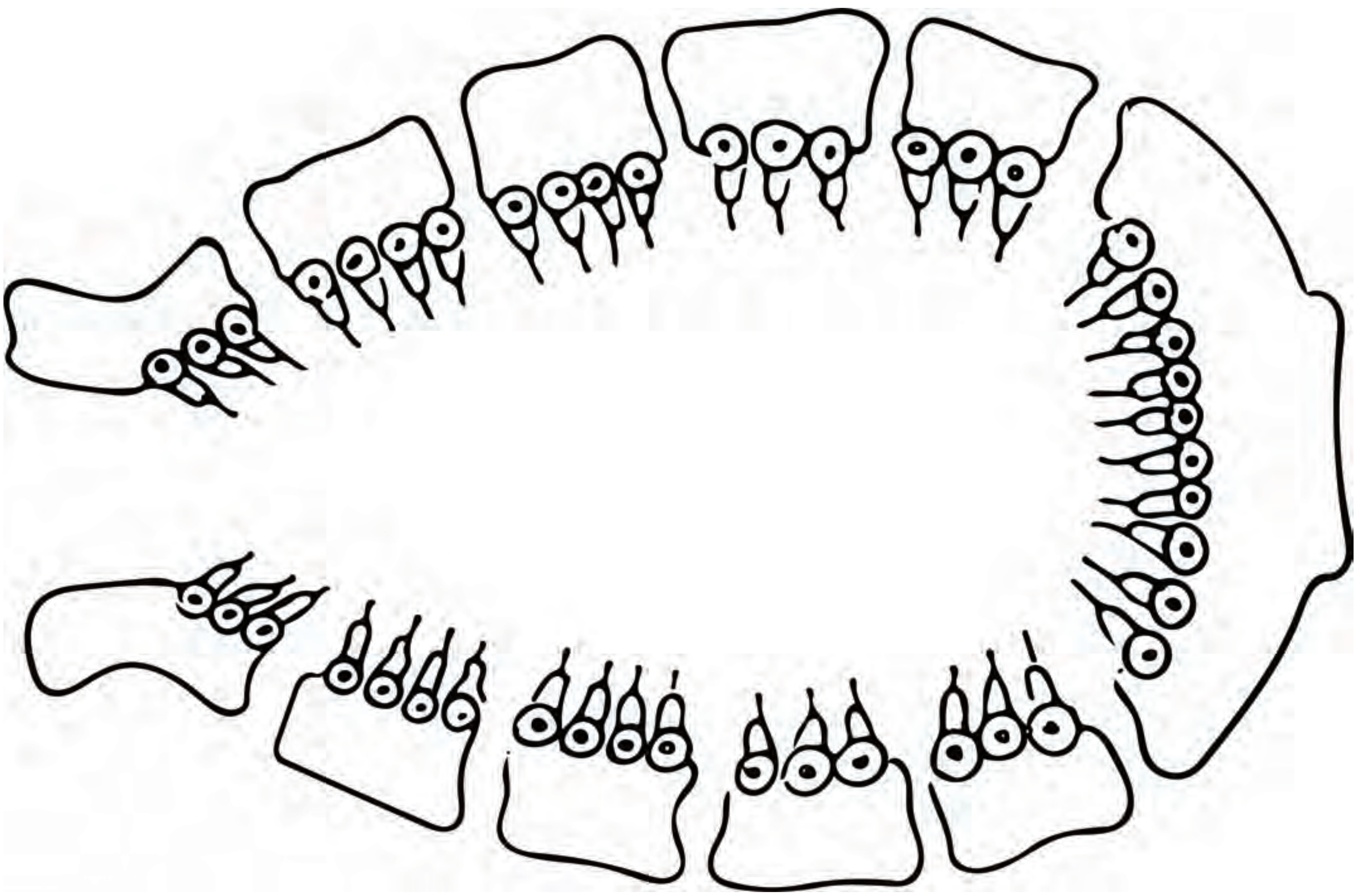
12

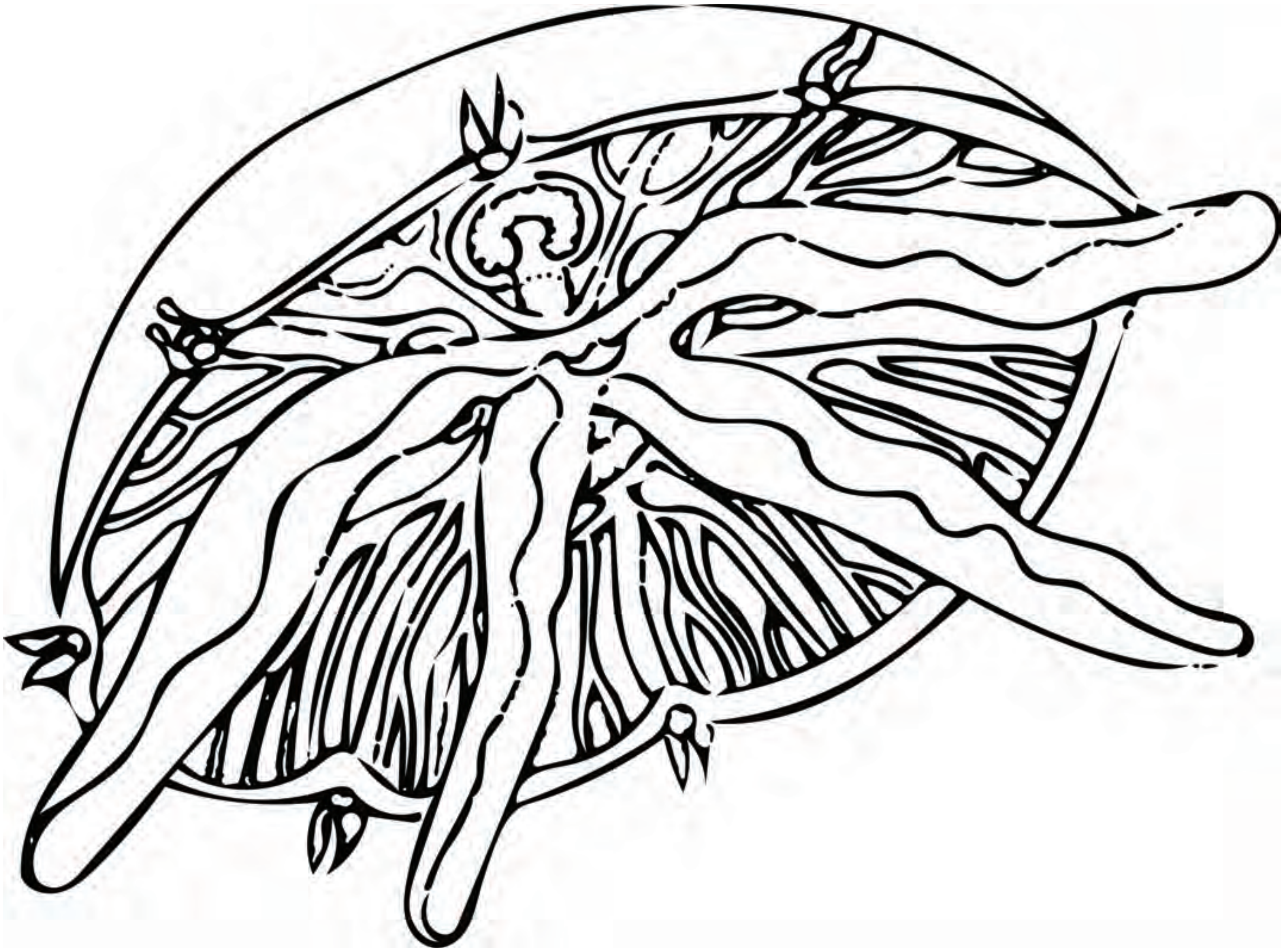
There are many wild plants which have defied domestication such as oak trees. They produce acorns which are nutritious but have a bitter taste. Tannin causes the taste. To remove tannin, acorns must be ground and leached. Many genes are responsible for the production of tannin. Planting an acorn low in tannin would not produce a tree bearing low tannin acorns.

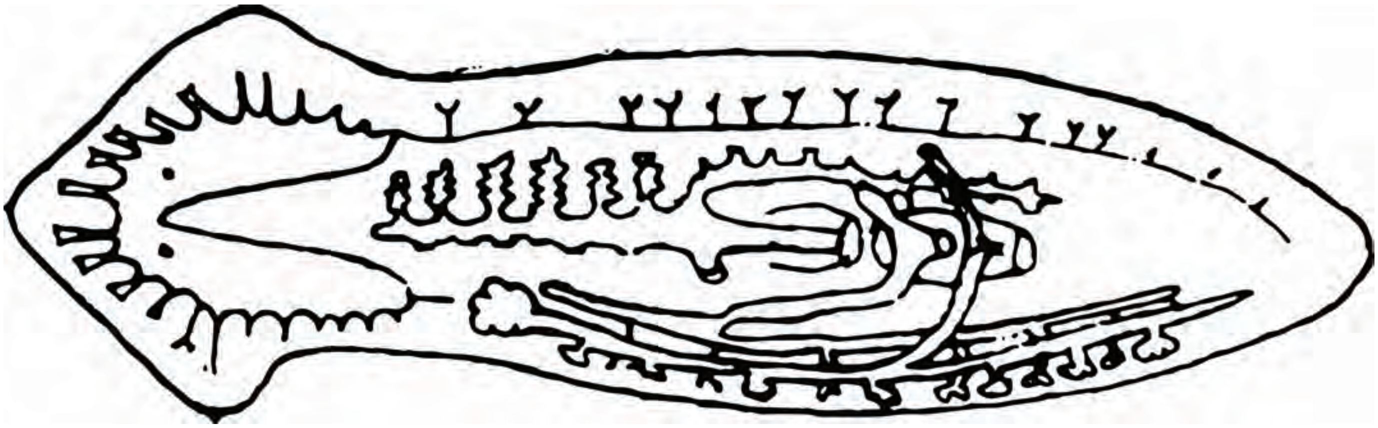
13

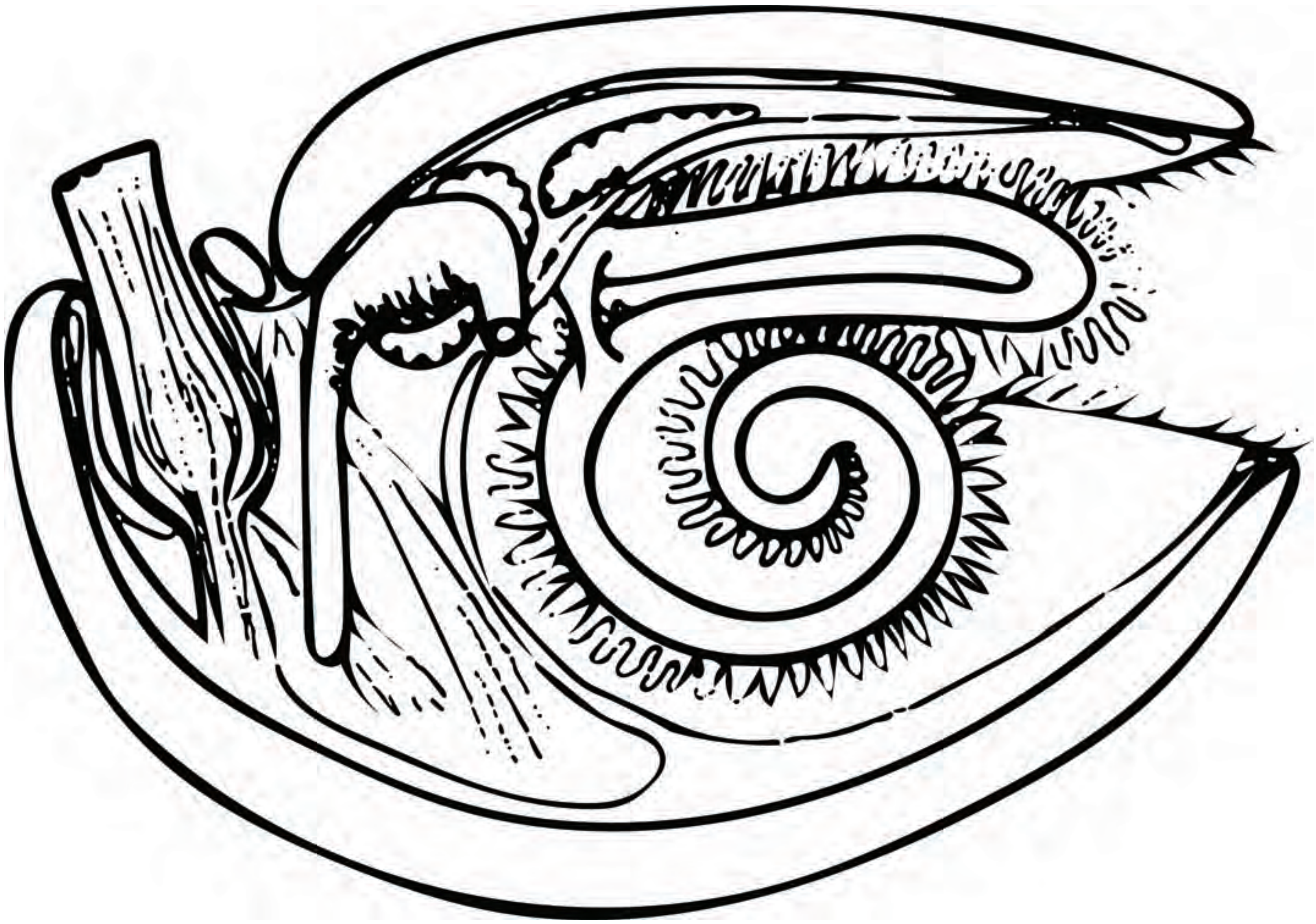
Today scientists can genetically engineer many plants to produce seedless fruit, bigger fruit, fruit that ships and keeps well. The differences between ancient wild plants and modern plants all came about through natural variations in the wild plant.

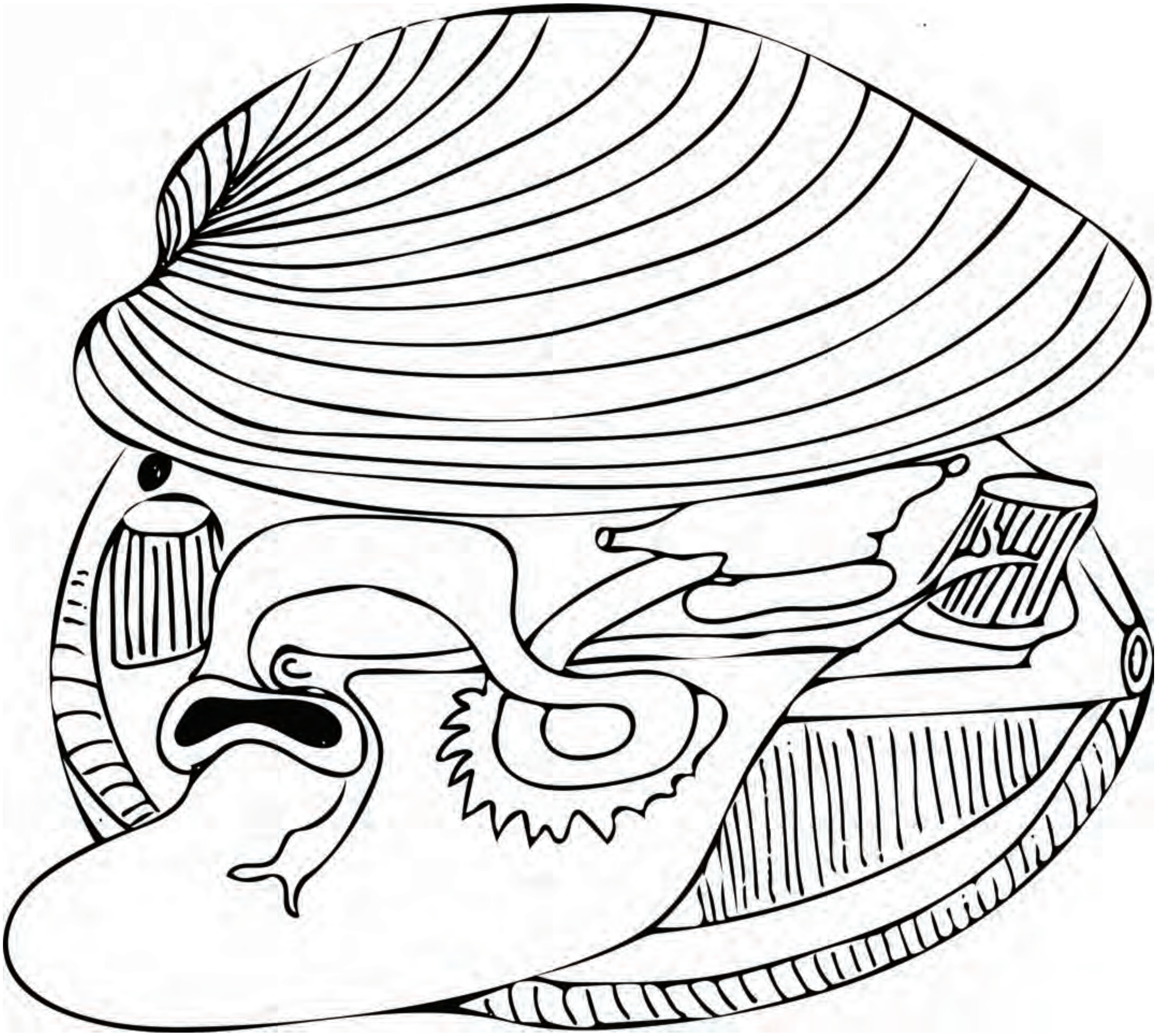
14

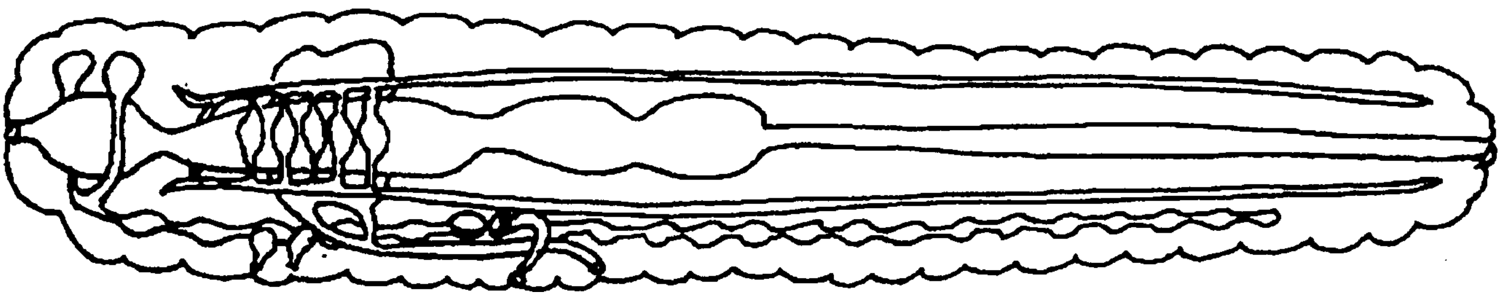


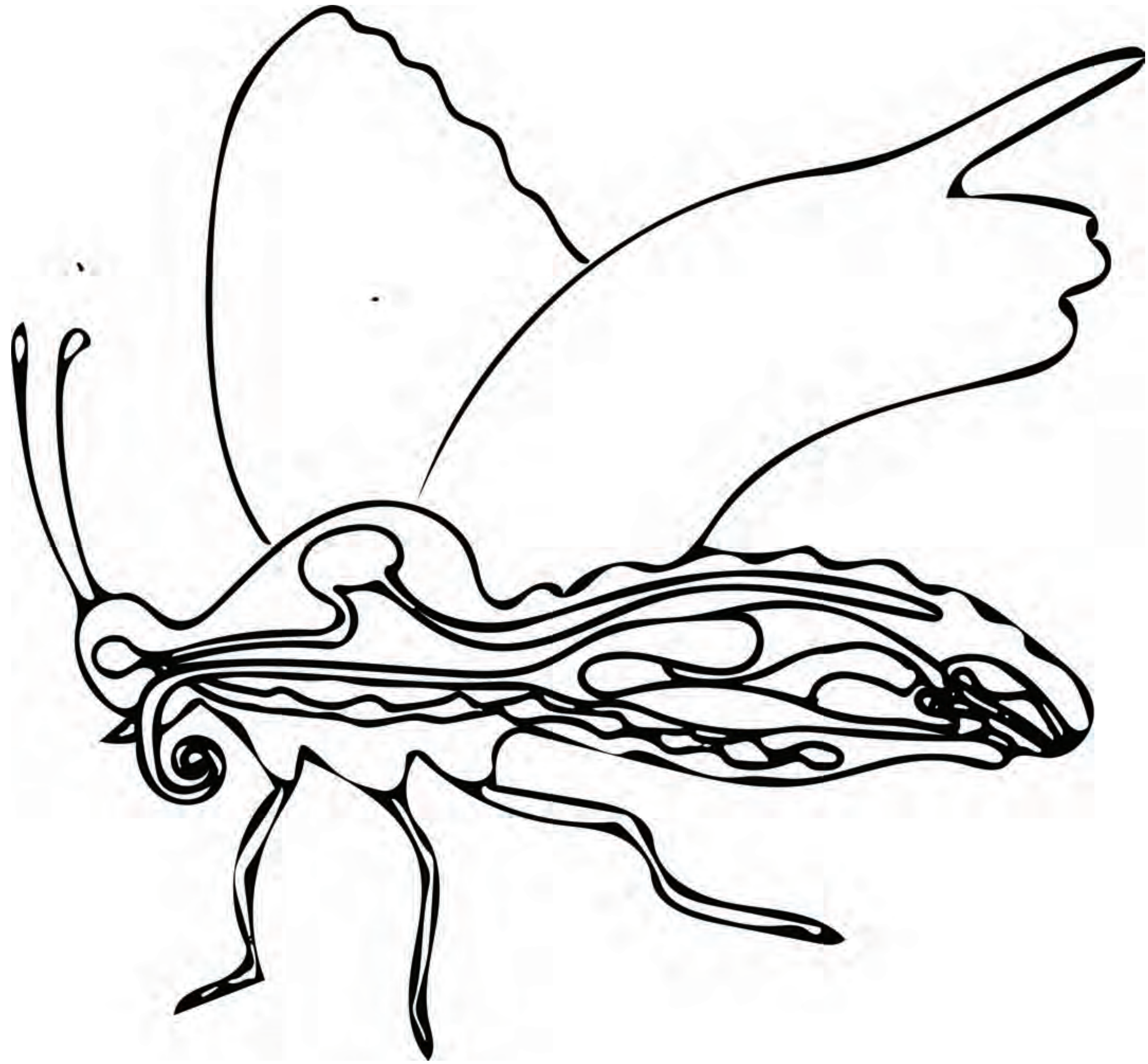


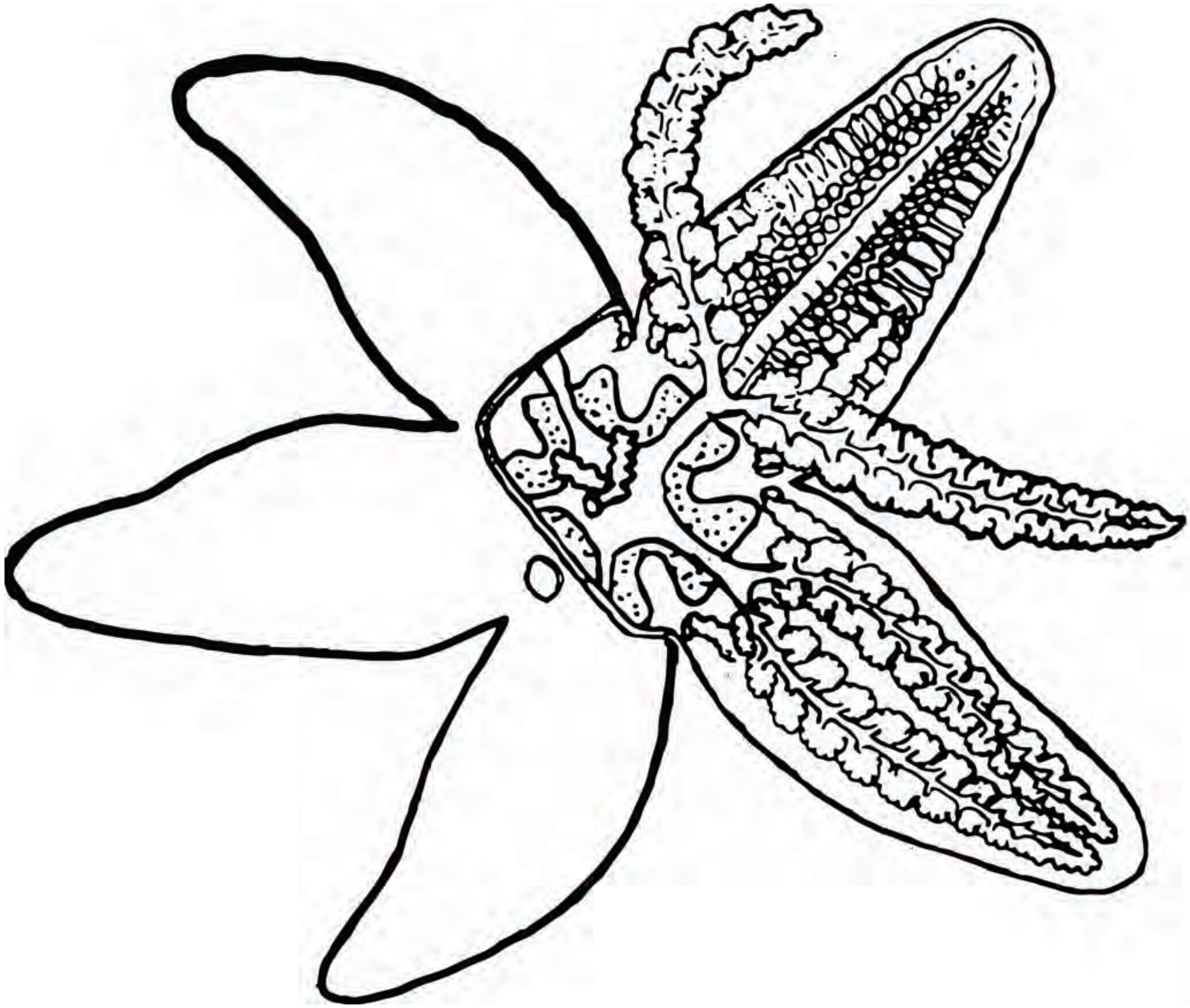


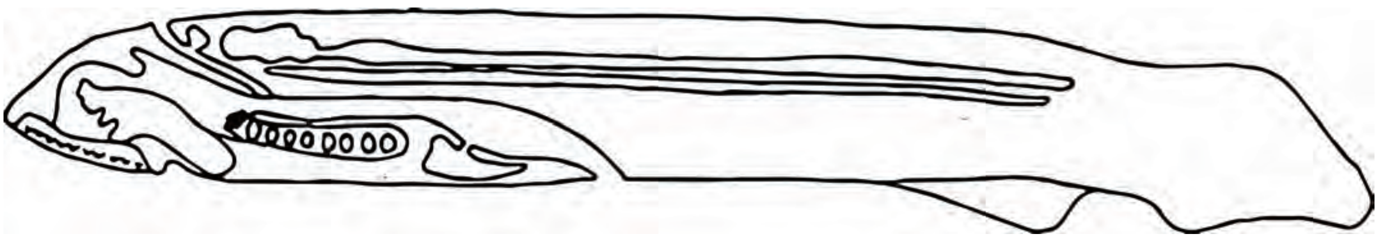


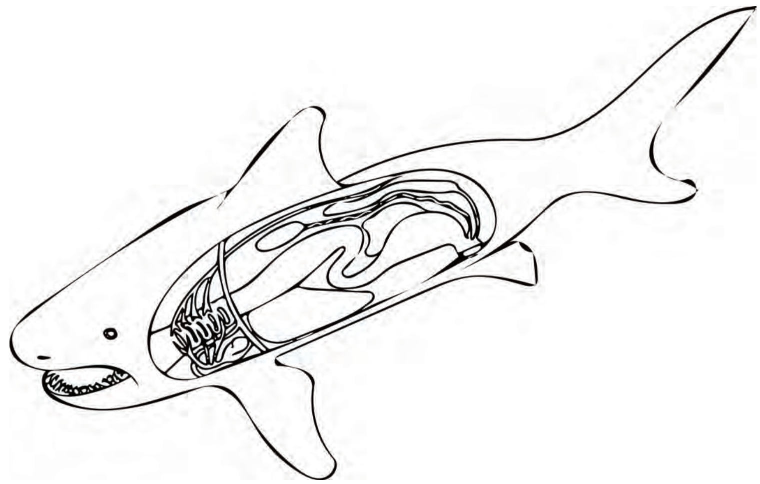


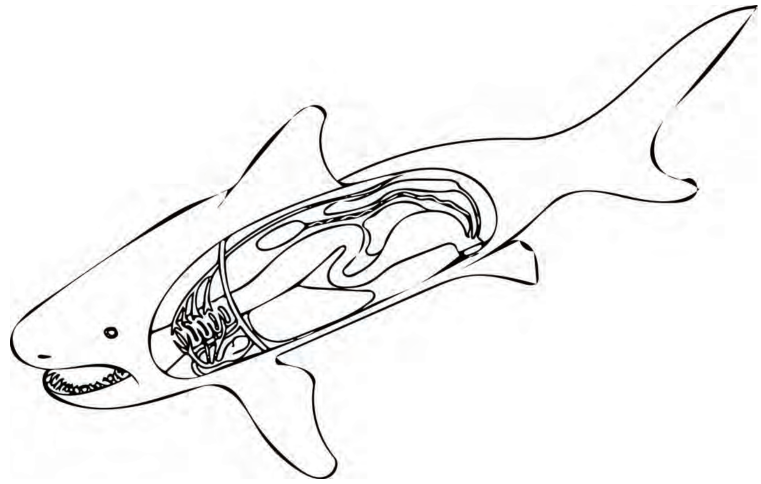


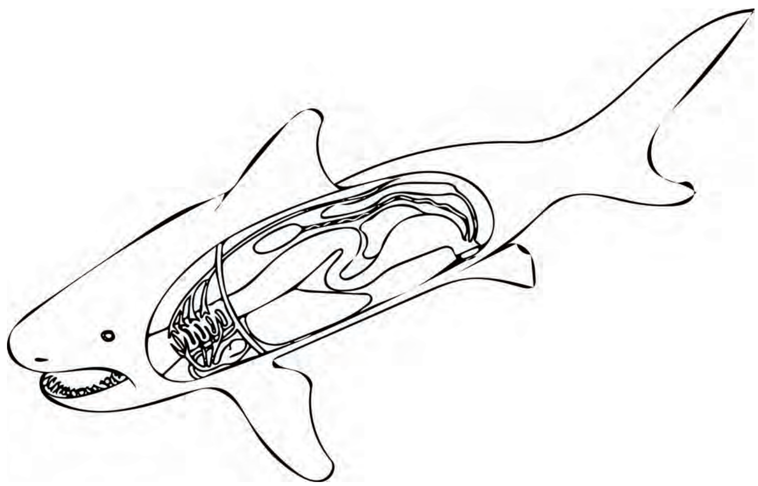


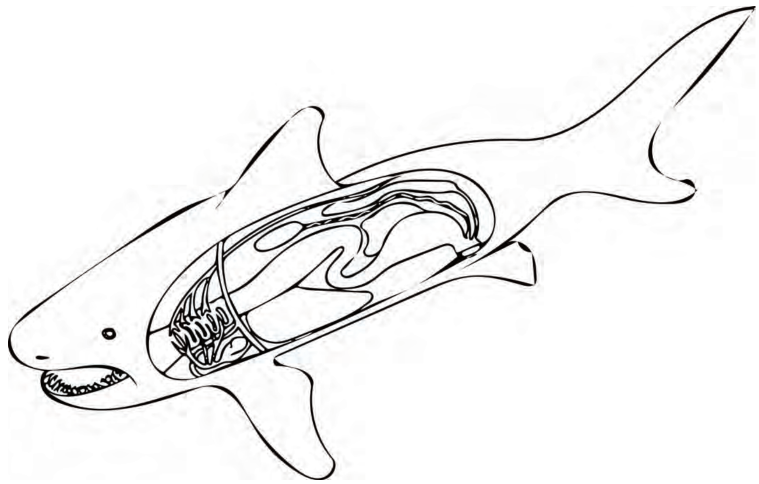


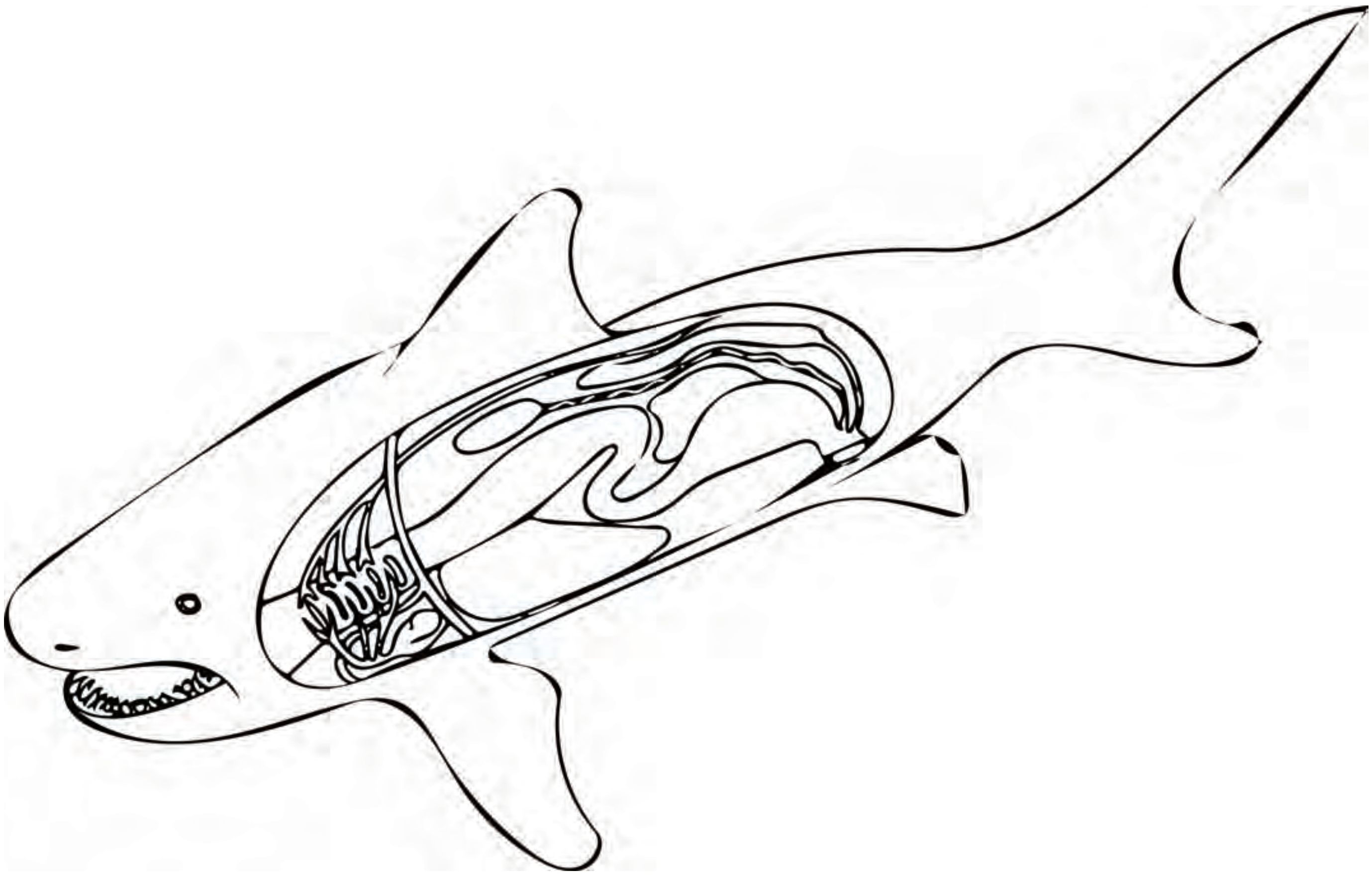


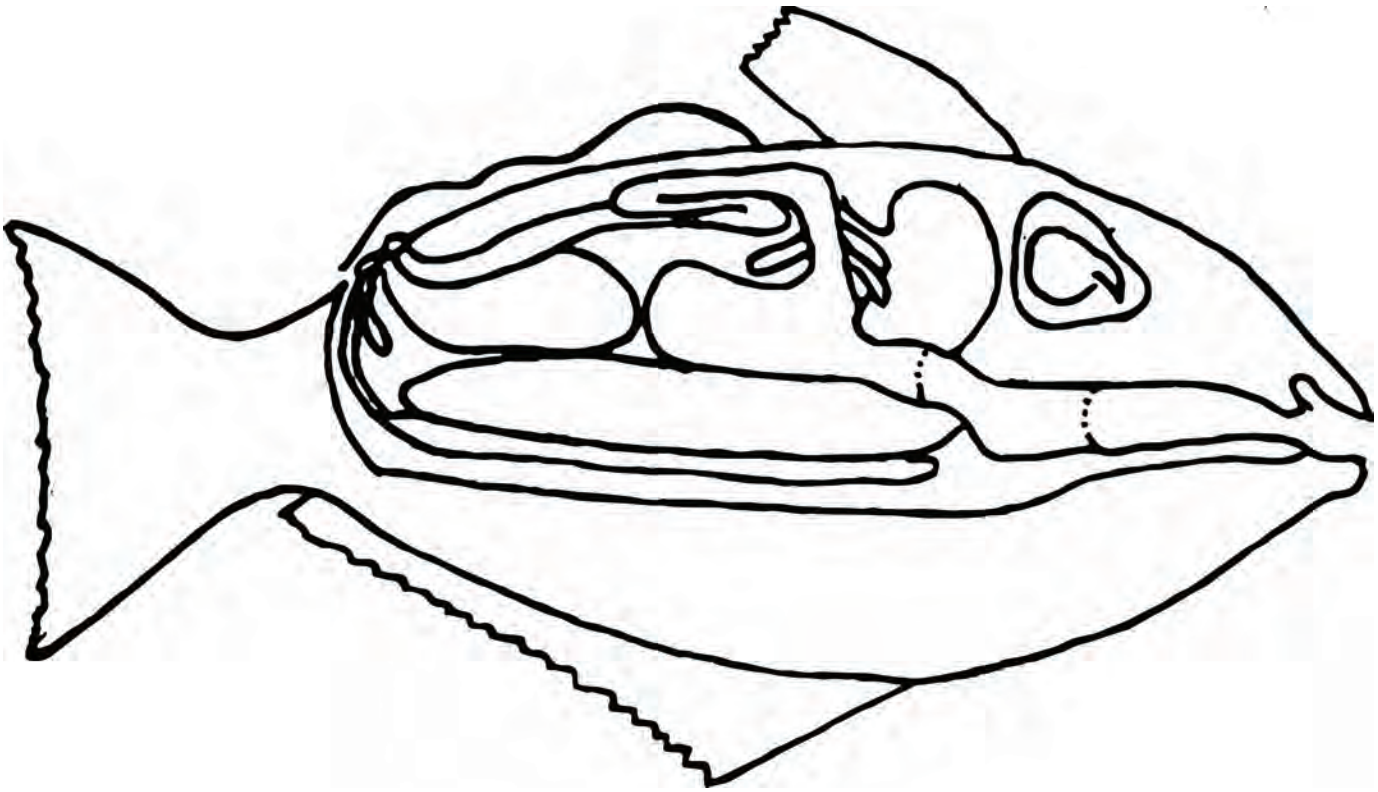


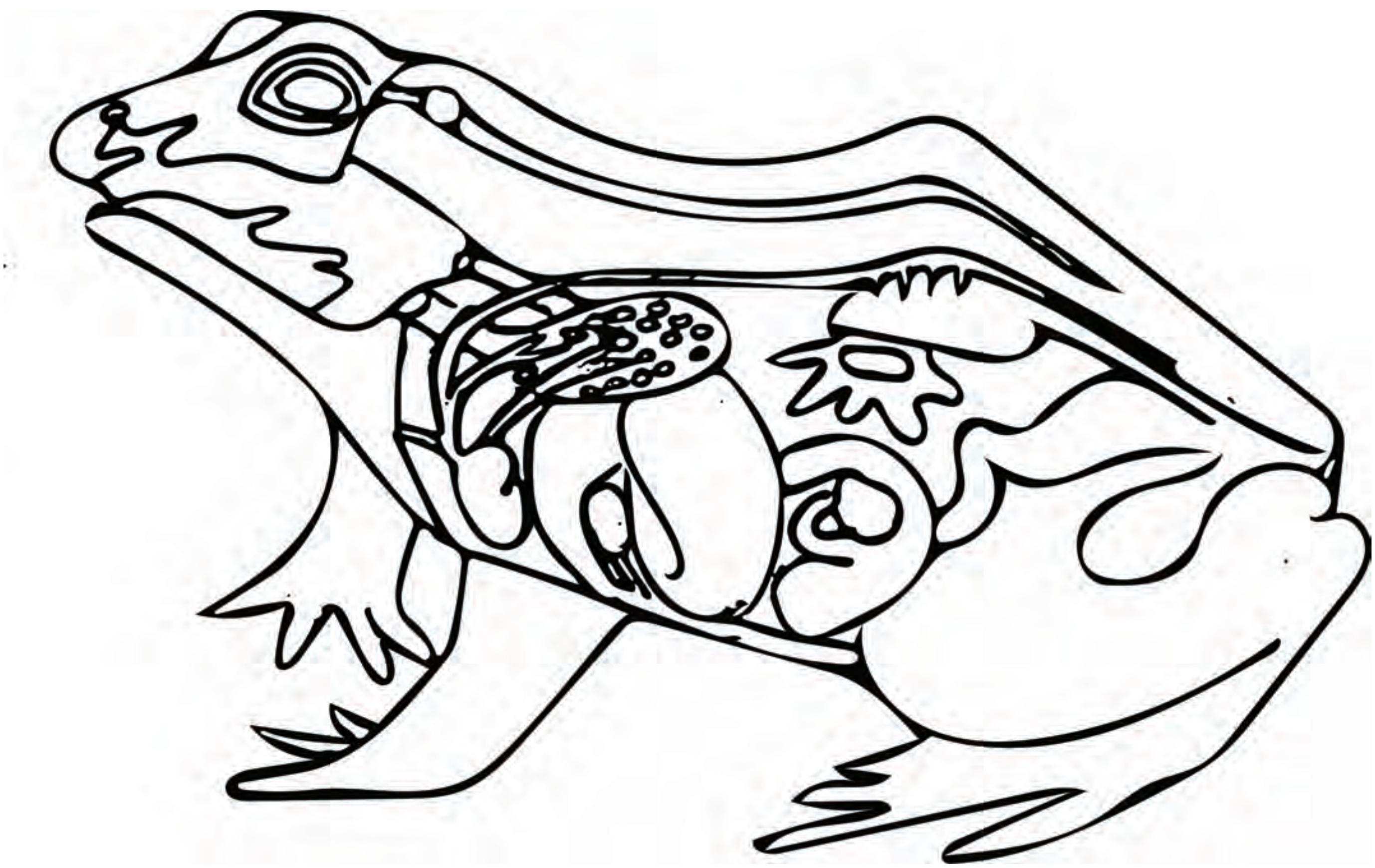


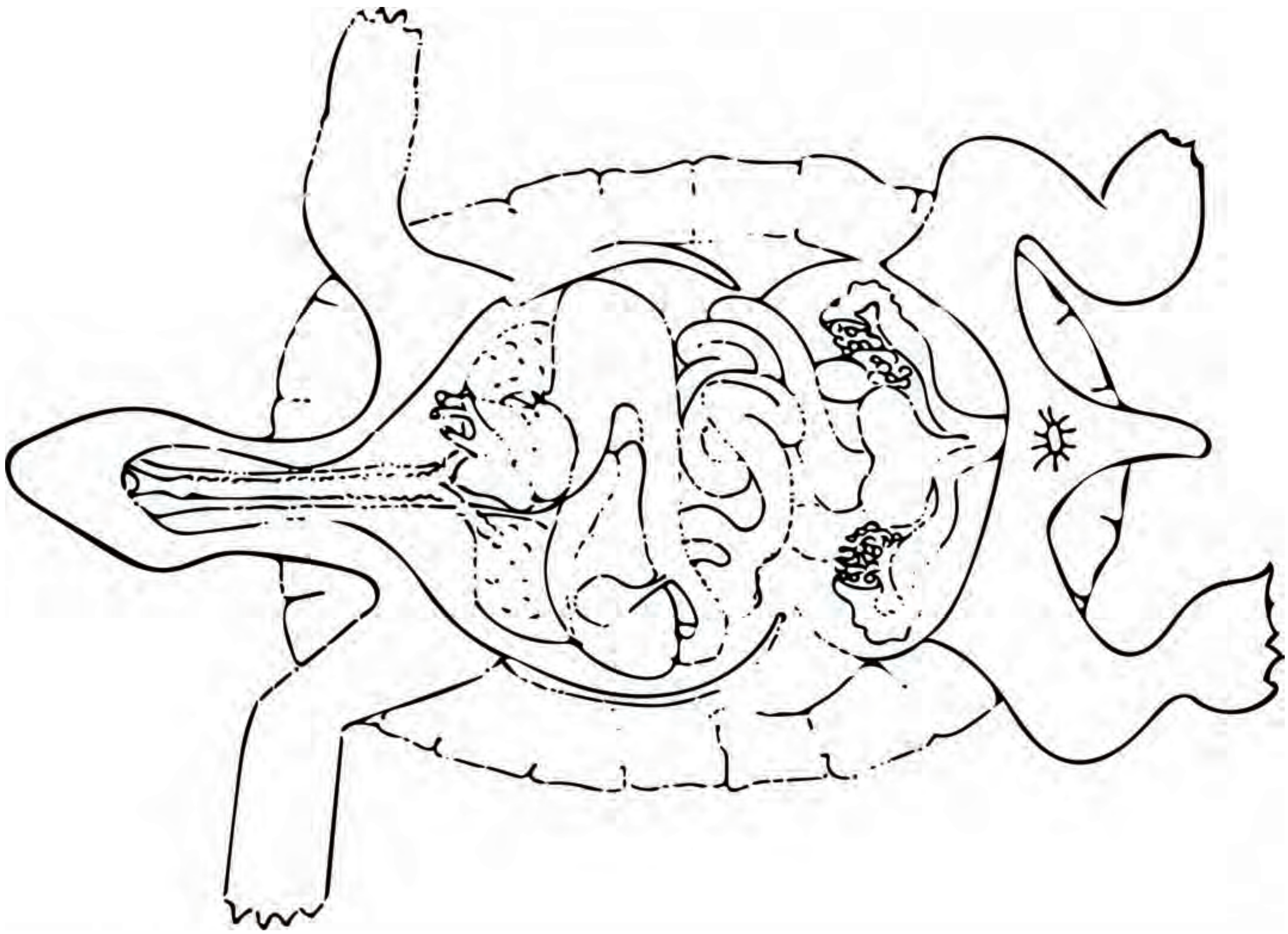


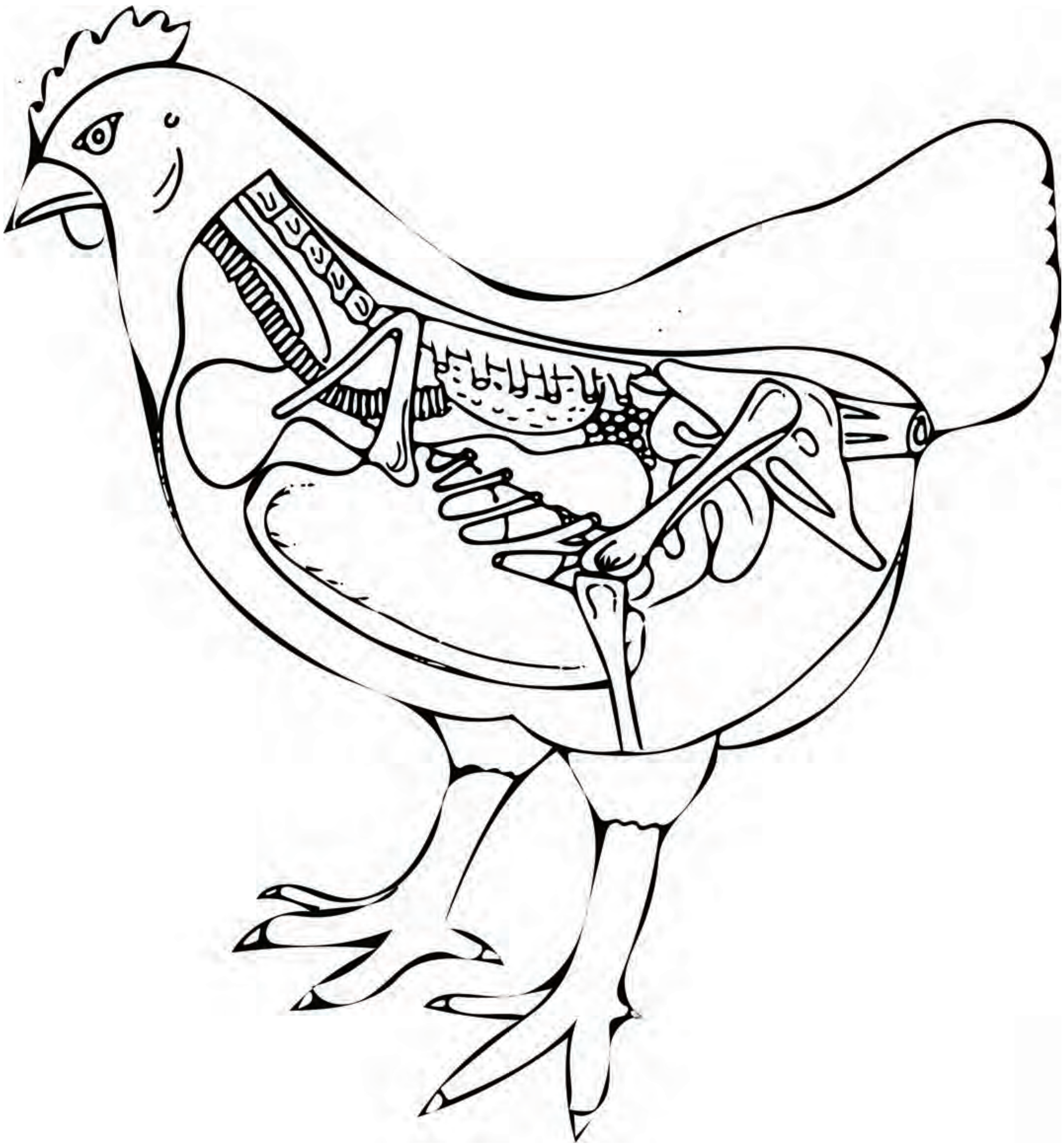


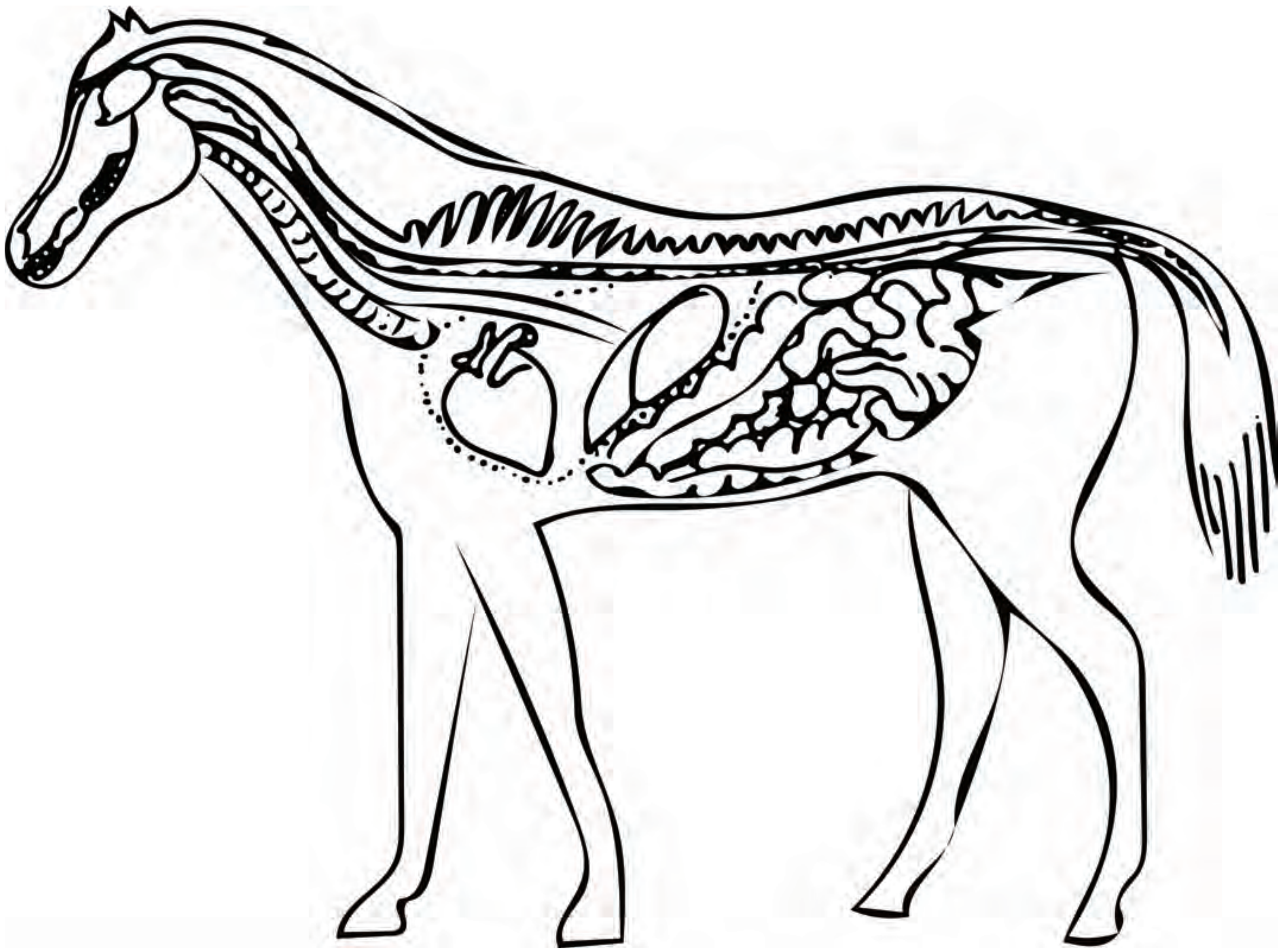


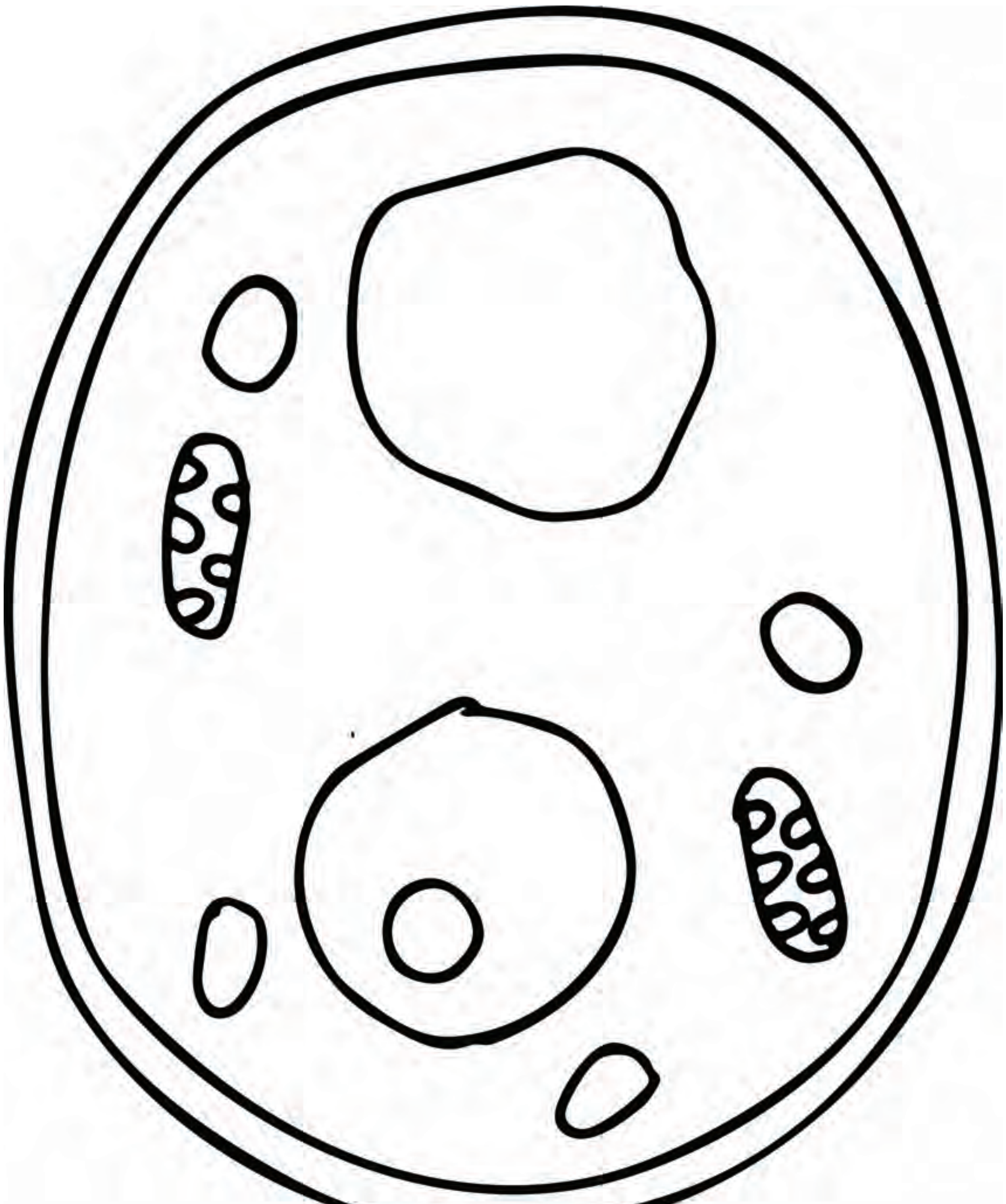


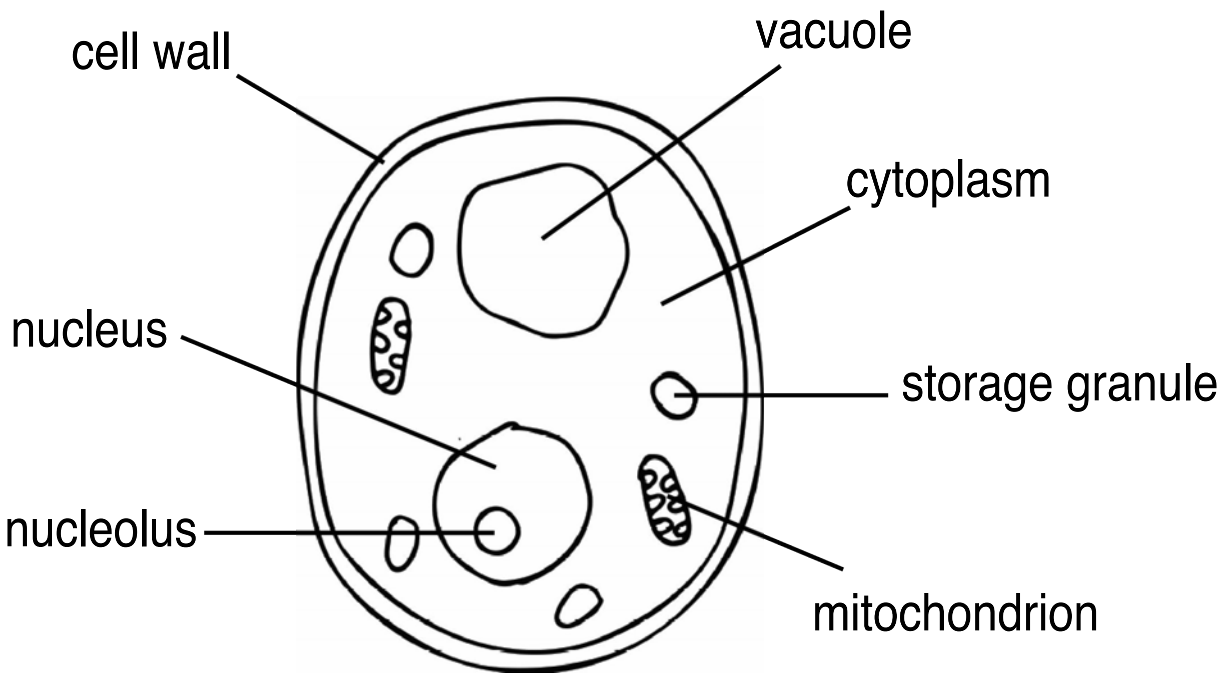












Parts of the Fungal Cell

Parts of the Fungal Cell

cytoplasm

nucleus

nucleolus

mitochondrion

storage granule

vacuole

The Skeletal System

The **skeleton** is the internal structure which gives form to the body. It includes **bone, cartilage** and **ligaments.** Bone is the hardest of all the body's living tissue. Bones protect vital parts such as the brain and organs within the chest cavity. Movement of the body is possible through the action of skeletal muscles which are attached to bones and by the joints between bones. Bones form blood cells and are a source of calcium ions for the body's use.

In infants, the skeletal system is composed of **cartilage,** a tough, rubbery, nonliving substance. The infant's skeleton is very flexible and not easily broken. This allows for the rapid growth in early life. Throughout cartilage are bone cells or **osteoblasts.** These form rings of mostly calcium phosphate around themselves. The bone cells form centers of deposit or **lacunae.** Cartilage is gradually replaced to form rigid bone except at the ends of bones. Cartilage allows bones to move smoothly where there are two adjoining bones or joints such as the knee, elbow or hip.

Bones of the head are separate structures in infancy but fuse with age.

There are several types of joints in the skeletal system. The **dovetail joint** is the type found in the skull where once separate bones fused with age. **Gliding joints** are located in the wrists and spine. **Ball and socket joints** are located at the shoulders. **Hinged joints** are located at the elbows. A **pivot joint** is located where the first cervical vertebra, the **atlas,** connects with the second cervical vertebra, the **axis.**

4

Bones are porous and may contain cavities filled with a soft substance, **marrow.** The cells which secrete bone mineral are supplied by blood vessels and nerves which pass through the **Haversian canals.** These are long tubular spaces within the bone.

5

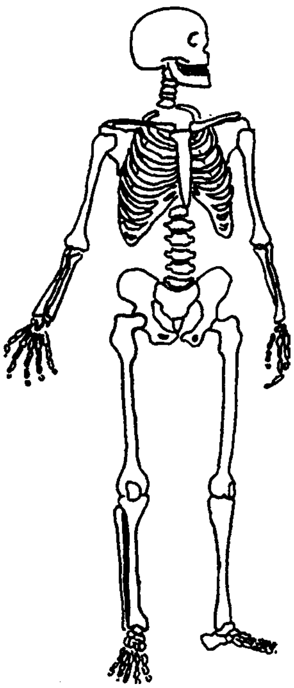
Covering the bone surface is a thin layer of tissue known as **periosteum.** This contains osteoblasts which deposit mineral matter especially where the bone has been broken. Because the rate of bone deposit becomes slower with aging, regeneration of bone slows in older people. The quantity of minerals in aging bones increases, causing brittleness so that fractures from falls become more common in older people.

6

Ligaments hold bones together at joints. Ligaments are composed of tough, pliable connective tissue fibers that do not expand or contract.

Bones may be flat, short, long or irregular in shape. The long bones give height to the body.

7



spinal column

coccyx

scapula

ulna

cranium

phalanges

mandible

radius

sacrum

metacarpals

vertebra

carpals

clavicle

fibula

sternum

tibia

pelvis

tarsals

costae (ribs)

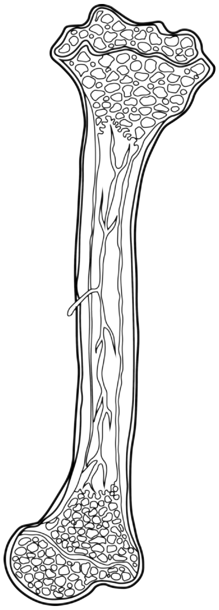
metatarsals

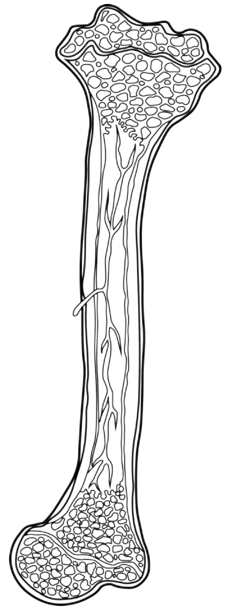
patella

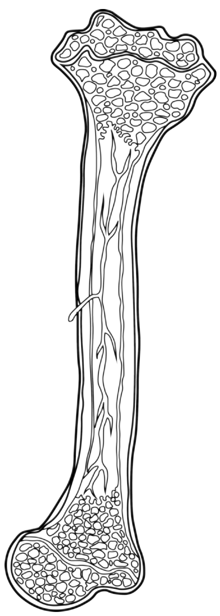
femur

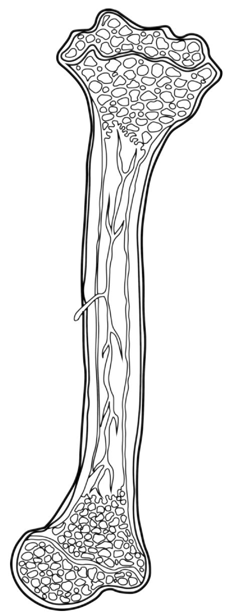
phalanges

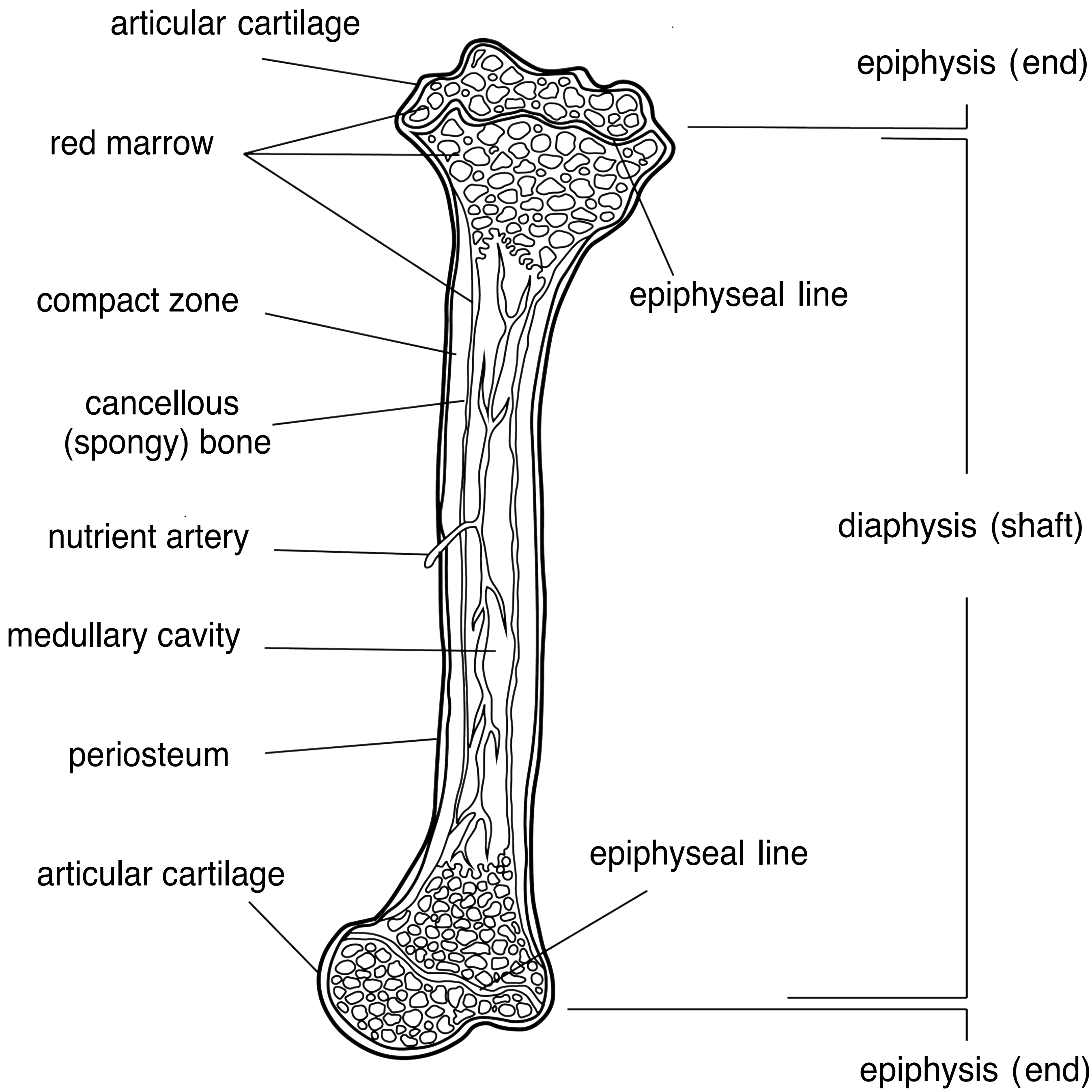
humerus










articular cartilage
red marrow
compact zone
cancellous
(spongy) bone
nutrient artery
medullary cavity
periosteum
articular cartilage
epiphysis (end)
epiphyseal line
diaphysis (shaft)
epiphyseal line
epiphysis (end)

heart

septum

epicardium

pericardium

endocardium

right auricle or atrium

superior vena cava

inferior vena cava

tricuspid valve

right ventricle

left auricle or atrium

mitral valve

semilunar valve

pulmonic valve

aortic valve

pulmonary veins

pulmonary artery

left ventricle

aorta

coronary arteries

organ whose walls and septum are composed of **cardiac muscle** or **myocardium** which contracts rhythmically to pump blood throughout the body

that part of the heart muscle which divides the left and right sides of the heart

membrane covering the heart's exterior surface

membrane surrounding the epicardium

membrane lining the four interior chambers of the heart

upper chamber of the heart into which venous blood from the head, neck and arms is conveyed by the **superior vena cava** and venous blood from the lower parts of the body is conveyed by the **inferior vena cava**

one of the body's largest veins which conveys blood from the head, neck and arms to the right auricle

one of the body's largest veins which conveys blood from the lower parts of the body to the right auricle three flaps of tissue at the bottom of the right auricle which prevent blood from flowing back when it is pumped through the opening from the right auricle to the right ventricle

lower chamber of the heart into which blood is pumped from the right auricle

upper chamber of the heart into which venous blood from the lungs is conveyed by the **pulmonary vein**

two flaps of tissue at the bottom of the left auricle or atrium which prevent blood from flowing back when it is pumped through the opening from the left auricle to the left ventricle

three half moon shaped flaps of tissue composing the **pulmonic valve** and the **aortic valve**

semilunar valve which prevents blood from flowing back into the **pulmonary artery** when the right ventricle contracts

semilunar valve which prevents blood from flowing back into the **aorta** when the left ventricle contracts

blood vessels which transport blood from the lungs to the left auricle or atrium blood vessel which transports blood from the right ventricle to the lungs

lower chamber of the heart which pumps oxygenated blood into the aorta and the coronary arteries

the body's largest artery which receives oxygenated blood from the left ventricle and branches in the **aortic arch** to distribute blood throughout the body by the **innominate artery, the carotid artery and the left subclavian artery**

blood vessels branching from the aorta to transport blood from the left ventricle to supply the heart muscle itself

The Heart

heart
organ whose walls and septum are composed of cardiac muscle or myocardium which contracts rhythmically to pump blood throughout the body

septum
that part of the heart muscle which divides the left and right sides of the heart

epicardium
membrane covering the heart's exterior surface

pericardium
membrane surrounding the epicardium

endocardium
membrane lining the tour interior chambers of the heart

right auricle or atrium
upper chamber of the heart into which venous blood from the head, neck and arms is conveyed by the superior vena cava and venous blood from the lower parts of the body is conveyed by the Inferior vena cava

superior vena cava
one of the body's largest veins which conveys blood from the head, neck and arms to the right auricle

inferior vena cava
one of the body's largest veins which conveys blood from the lower parts of the body to the right auricle

tricuspid valve
three flaps of tissue at the bottom of the right auricle which prevent blood from flowing back when it is pumped through the opening from the right auricle to the right ventricle

right ventricle
lower chamber of the heart into which blood is pumped from the right auricle

left auricle or atrium
upper chamber of the heart into which venous blood from the lungs is conveyed by the pulmonary vein

mitral valve
two flaps of tissue at the bottom of the left auricle or atrium which prevent blood from flowing back when it is pumped through the opening from the left auricle to the left ventricle

semilunar valve
three half moon shaped flaps of tissue composing the pulmonlc valve and the aortic valve

pulmonic valve
semilunar valve which prevents blood from flowing back into the pulmonary artery when the right ventricle contracts

aortic valve
semilunar valve which prevents blood from flowing back into the aorta when **the left ventricle contracts**

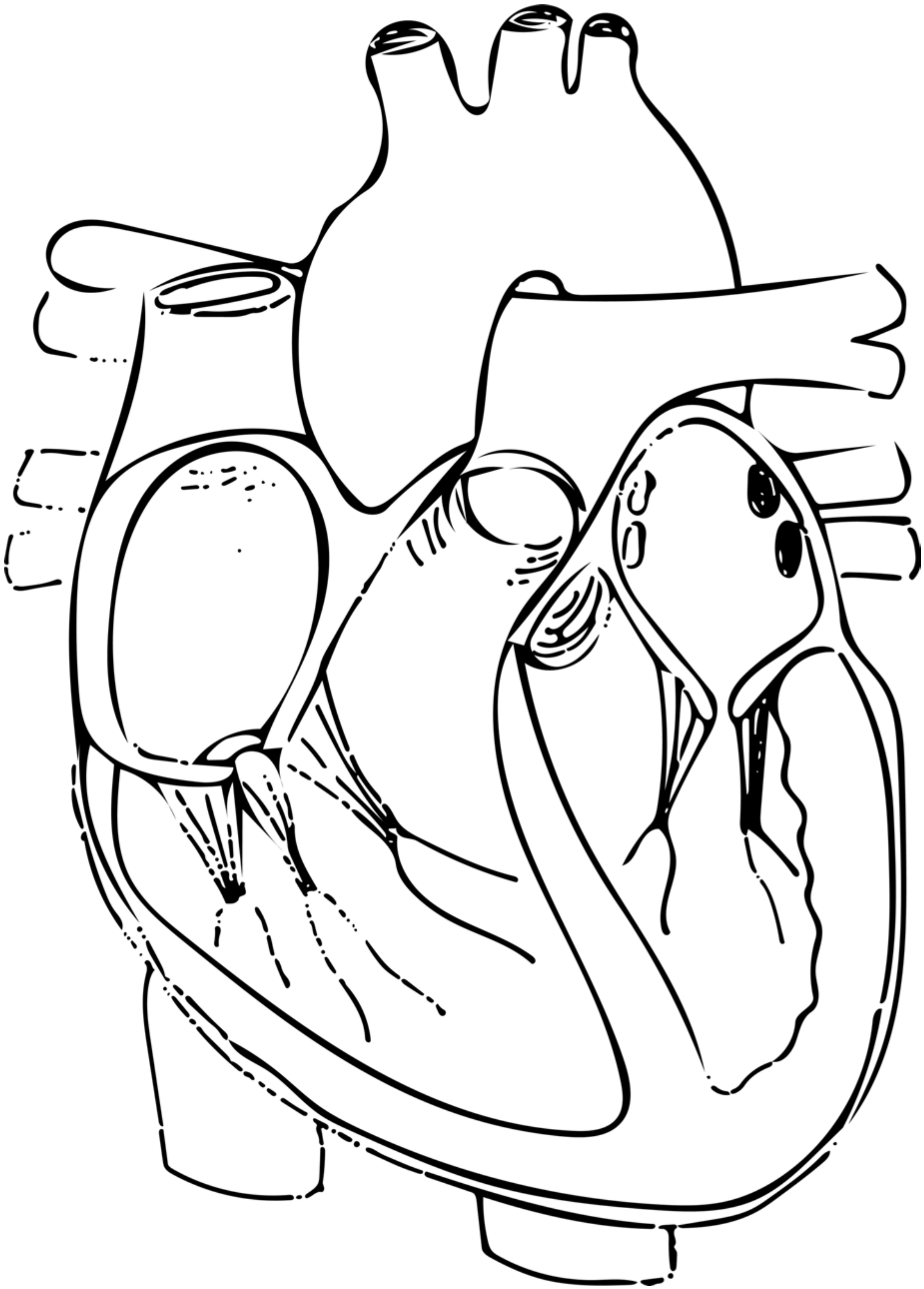
pulmonary veins
blood vessels which transport blood from the lungs to the left auricle or atrium

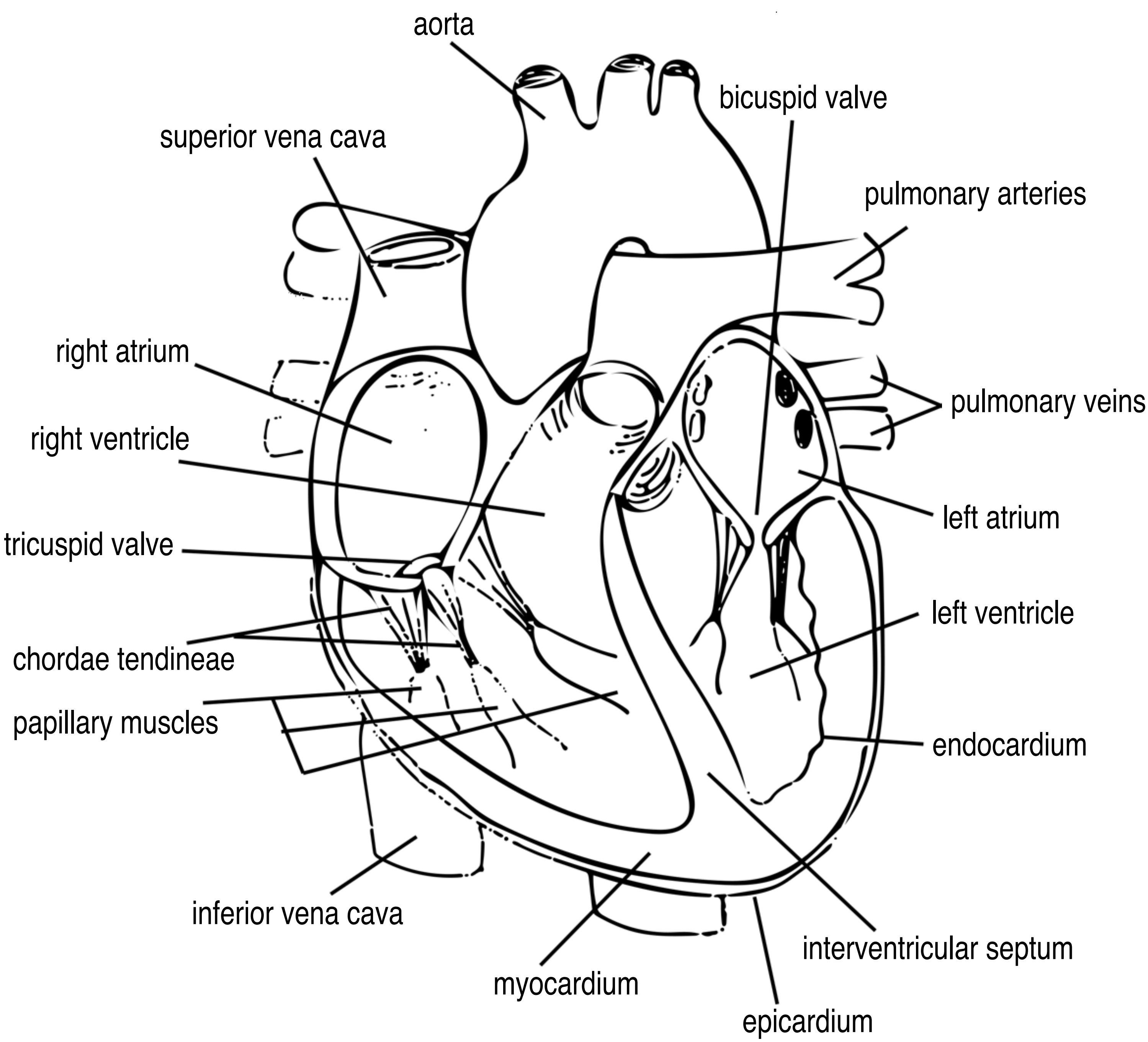
pulmonary artery
blood vessel which transports blood from the right ventricle to the lungs

left ventricle
lower chamber of the heart which pumps oxygenated blood into the aorta and the coronary arteries

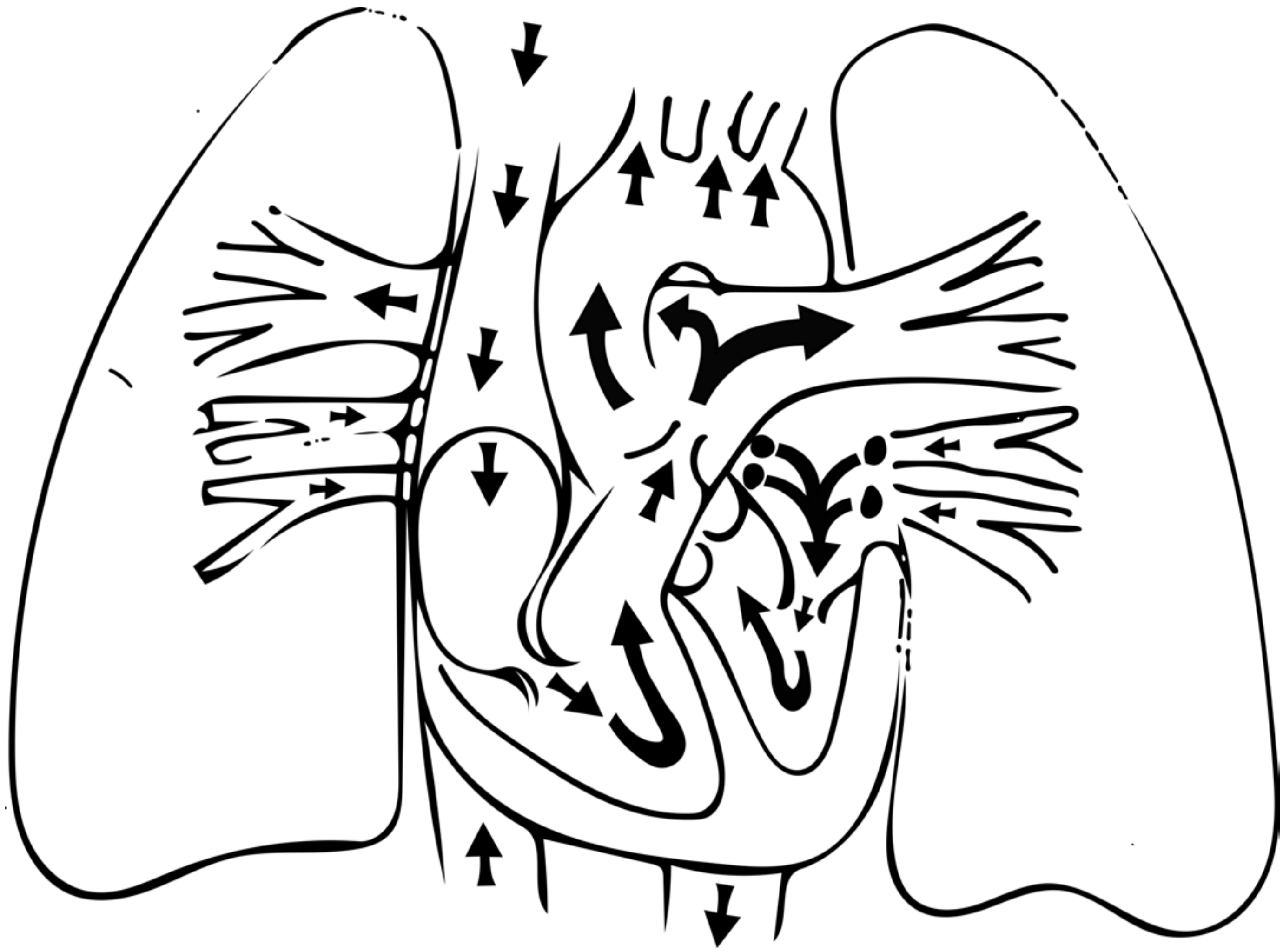
aorta
the body's largest artery which receives oxygenated blood from the left ventricle and branches in the aortic arch to distribute blood throughout the body by the Innomlnate artery, the carotid artery and the left subclavlan artery

coronary arteries
blood vessels branching from the aorta to transport blood from the left ventricle to supply the heart muscle itself





Parts of the Heart



Direction of Flow

Blood Composition

Plasma
Blood is composed of about 55 % plasma, the fluid which contains blood cells also known as **formed elements** as well as the other components. Plasma itself has a composition of 91% water, 7% proteins, 1% inorganic salts and 1% other materials.

Plasma proteins are globulin, albumin and fibrogen. These are important in regulating blood pressure, excreting urine, forming antibodies to produce immunities and clotting of blood. If plasma proteins are separated from plasma, blood serum remains.

Albumin controls the flow of plasma between cells and capillaries. Nutrients bind to albumin to be transported to tissues of the body. Globulin proteins, antibodies produced by B cells and T cells, combat infection. Fibrogen is responsible for blood clotting.

The endocrine glands produce hormones which enter the plasma. As a hormone reaches the specific part of the body it regulates, it acts as a chemical stimulant to that body part, such as the thyroid gland.

4

Erythrocytes

The most numerous blood cells are **red corpuscles** or erythrocytes. There are about five million in one cubic millimeter of blood. They are disc shaped with edges thicker than their centers. The red color of blood comes from a compound of iron and protein, known as **hemoglobin,** in the erythrocytes. Oxygen is transported to the body's cells by hemoglobin which then removes carbon dioxide from the cells.

5

Erythrocytes contain **enzymes,** chemicals which allow cells to function effectively. A red corpuscle lives about 120 days.

6

Erythrocytes are formed from **stem cells** in the **marrow** at the center of the large bones. Stem cells develop into **precursor cells.** These form erythrocytes, **leukocytes** and **thrombocytes.** Although there are nuclei in the erthrocytes as they form in bone marrow, the nuclei are not present when mature erythrocytes enter the blood. Blood cells enter the blood stream from the bone marrow through cavities in the marrow known as **sinuses.**

7

Worn out erythrocytes are removed from the blood by the liver and the spleen. The liver produces a digestive fluid, **bile,** from the coloring matter of old red corpuscles. The balance between old and new erythrocytes is maintained by a process known as **homeostasis.** Too little hemoglobin results in anemia.

8

Erythrocyte production in bone marrow is stimulated by a hormone, **erythropoietin,** secreted by the kidneys.

9

Thrombocytes
There are about 300,000 of these very small disc like blood cells per cubic millimeter of blood. Within bone marrow, thrombocytes develop into large **precursor cells** known as **megakaryocytes.** These fragment into **platelets** which then enter the blood stream. They live about ten days. They produce **thromboplastin** when a blood vessel is cut. This substance reacts with **fibrogen,** a blood protein, to cause clotting to stop the flow of blood. A scab is formed to seal the opening.

10

Usually blood does not clot within the blood stream. When it does occur in a blood vessel, it is known as **thrombosis.** **Coronary thrombosis** is the formation of a clot within the heart so that oxygen cannot reach parts of the heart muscle. The damage causes a heart attack. When a clot occurs in the brain, **cerebral thrombosis** results and insufficient oxygen may cause paralysis or death.

11

Leukocytes

There are between 5,000 and 9,000 leukocytes or **white blood corpuscles** per cubic millimeter of blood. They tend to be round and colorless, having several sizes.

12

One of the types of leukocytes is the **neutrophil, a phagocyte** formed in bone marrow. They move by their own power and can enter intercellular spaces. They are attracted to areas of the body where bacteria or foreign matter have invaded tissue. Neutrophils surround and digest the invading bacteria. This process is known as **phagocytosis.** Neutrophils live only until they perform phagocytosis. Where large numbers of neutrophils accumulate, pus is formed. The greatest number of phagocytes are neutrophils. An increase in the number of neutrophils may indicate the presence of infection somewhere in the body.

13

Monocytes are another type of phagocyte which migrate to infected areas of the body. Here they mature and become **macrophages** which kill germs. They produce antibodies and may destroy cancer-causing cells.

14

Rare phagocytes, **eosinophils,** defend the body against parasites.

15

Basophils are another group of rare white blood cells. Their function is uncertain.

16

Lymphocytes are another type of leukocyte. They are formed in lymphoid tissue such as lymph nodes and tonsils.

17

8-cell lymphocytes mature in lymph nodes and the spleen. When foreign substances, termed **antigens,** enter the body, they stimulate lymphocytes to produce **antibodies.** These are **globulin protein** compounds. They either destroy or render harmless invading substances such as bacteria or viruses.

18

T-cell lymphocytes move to the thymus gland to mature, then travel to the lymph nodes. T-cell lymphocytes produce substances which control 8-cell activity and which activate monocytes.

19

Blood Sugar

The level of sugar in the blood is regulated by **insulin,** a hormone secreted by the **pancreas** in glands known as the **Islets of Langerhans.** When there is not enough insulin produced, the blood sugar level rises. The body's cells cannot utilize the sugar without insulin. The absence of insulin causes a disease known as **Diabetes mellitus.** Insulin must be taken by mouth or injected into the blood stream to enable the body to process sugar.

After eating, the carbohydrates consumed are converted to **glucose** for absorption in the digestive tract or are stored in the liver as **glycogen,** an animal starch. To maintain a constant level of blood sugar, an enzyme is produced in the liver which converts the stored glycogen to glucose which is released into the blood as needed.

Blood Types

There are two major classifications of blood groups, the ABO and the Rh.

1

ABO human blood types are classified according to presence or absence of red cell antigens, A and B. It is essential to know blood type when a blood transfusion is needed. If the wrong blood group is used, the transfused red cells are destroyed by the blood of the person receiving the transfusion. A cross-match is conducted before transfusions to determine compatibility of the blood to be transfused with the blood of the recipient.

2

There are four main blood types: A, B, AB and **0.** **Type A** blood cells have only antigen A and the plasma contains anti-8 antibodies. **Type** B blood cells have only antigen B and the plasma contains anti-A antibodies. Type AB blood cells have both antigens A and B and the plasma contains neither anti-A or anti-8 antibodies. **Type 0** blood cells have neither antigen A or antigen B. Type O blood is the most common, type A is next most common, few people have type B and type AB is the most rare blood type.

3

The Rh factor was named for the rhesus monkeys in which this factor was discovered in 1940. Rh blood types are classified according to the presence or absence of the Rh factor on red corpuscles. When Rh antigens are present, blood is Rh positive. When Rh antigens are absent, blood is Rh negative. The Rh factor is inherited.

4

Red corpuscles with the Rh factor present will agglutinate or clump when the anti-Rh antibody is introduced by blood transfusion. Anti-Rh antibodies are not naturally occurring in blood. They are produced when an Rh negative person receives Rh positive blood. One transfusion may not cause serious problems. A second transfusion of Rh positive blood will cause agglutination when the anti-Rh antibodies attack the Rh positive red corpuscles.

5

If the child of an Rh negative mother and an Rh positive father inherits the Rh positive factor, the mother produces anti-Rh after the baby has been born. This can be prevented by injecting the mother with anti-Rh serum. The serum destroys the baby's cells in the mother's blood before her body has time to produce its own anti-Rh.

6

If a mother has a second Rh positive baby without receiving the anti-Rh serum, the anti-Rh factor in her blood will destroy the red corpuscles of the unborn child. This condition is known as erythroblastosis fetalis or Rh disease. It causes anemia, brain damage and even death of the baby. If the baby born with Rh disease has all of its blood replaced immediately after birth, the effects of the disease may be diminished or eliminated.

7

Blood Flow

Blood is pumped by the heart from its ventricles through the arteries to all parts of the body. Arterial blood transports oxygen and dissolved nutrients to all the body's cells so that they can function.

1

From the arteries, blood passes into smaller tubes known as arterioles which divide into even smaller tubes or capillaries to convey blood away from the heart . There are about 2,000 capillaries in one cubic millimeter of human skin.

2

It is through these very thin capillary walls that oxygen and nutrients from digested food pass to nourish cells.

3

Carbon dioxide and other waste products of cetl activity as well as lymph drained from tissues pass back into capillaries to be collected by the venules.

4

Venules lead into larger blood vessels known as veins which transport blood back to the auricles or atria of the heart.

5

Blood maintains the body's temperature and fights infection. It transports oxygen and nutrients to cells, carbon dioxide and wastes from cells and chemicals such as hormones which regulate bodily functions. Blood has the ability to stop its flow by clotting when a blood vessel is damaged.

6

Adults have about five quarts of blood while a child weighing eighty pounds has about half of that and an eight pound infant has about eight and one half ounces, slightly over one cup. Adults who live at high altitudes where there is less oxygen have about two more quarts of blood to provide the essential amount of oxygen to the body.

7

Blood Transfusion

Blood can be taken from one person to be given to another. Transfusions are necessary during surgery if a large amount of blood has been lost. Those who have lost more than a quart of blood due to injury or accident require transfusions. When bone marrow does not produce a sufficient quantity of blood cells, blood transfusions supply the needed cells.

1

Blood may be donated to blood banks. It is stored in sterile bags with chemicals to prevent clotting and to preserve it. Under refrigeration, whole blood will keep tor up to 49 days. Most blood is separated into red corpuscles, plasma and other components before freezing each part for storage up to several years. Blood is tested for infectious diseases such as hepatitis and AIDS before storage.

2

Blood Testing

Screening Tests

A blood count is a screening test given to determine the number of red and white blood cells as well as the quantity of hemoglobin in a small sample of blood.

1

A **hematocrit** compares the quantity of red corpuscles with other components of the blood sample. This test can indicate defects in the production of blood cells.

2

Blood may be analyzed for **glucose.** A high level of this sugar may indicate diabetes due to a lack of sufficient insulin.

3

Blood may be analyzed for **urea.** A high level indicates that the kidneys are failing to filter such waste from the blood.

4

Blood may be analyzed for **cholesterol.** A high level of this crystalline substance indicates an increased risk for heart disease if arteries become clogged with cholesterol.

5

Diagnostic Tests

Blood may be tested to determine the cause of **anemia,** a disease in which there is a very low red corpuscle count. If anemia is due to a lack of iron, the cells are very small. If it is due to a lack of vitamin B_{12}, the cells are very large.

6

Blood may be tested to determine the proportion of white blood cells of each type. **Leukemia** is indicated by a very high number of these cells. An inability to overcome infection is indicated by a low neutrophil count.

7

Blood may be tested for bleeding disorders. A **platelet count** and **a clotting test** are given especially before surgery.

Blood Disorders

Low levels of hemoglobin prevent sufficient oxygen from reaching tissues. This is known as **anemia,** which may be caused by k>w production of red corpuscles in bone marrow. The condition may result from dietary deficiency, disease or infection. Anemia may result from loss of blood due to injury. Anemia also results from **excessive hemolysis** or red cell destruction due to certain chemicals, infectious bacteria or fungi, abnormal antibodies and inherited diseases such as sickle cell anemia and thalassemia.

A disease, **leukemia** or blood cancer, affects several types of leukocytes. There is a rapid increase of immature white cells in the blood. Chemical and radiation treatments have been developed to cure this disease.

Leukopenia is a condition in which there are few white corpuscles as a result of infections, certain drugs and diseases. When there is a low number of neutrophils, it is known as **neutropenia.** This causes the body to be unable to overcome bacterial infections.

Fertile soil contains microorganisms. Bacteria, fungi, algae and protozoa live in soil. They decompose plant and animal materials to make humus. They aid in the dissolving of minerals. Bacteria and algae change nitrogen from the air to a form that plant can use. Fungi help keep soil in small particles.

4

The gray, infertile soil of tropical forests has a thin layer of humus. The sub-soil is fine clay. Plants grow with difficulty in this soil.

5

Hemophilia is an inherited condition in which the body lacks the clotting factors needed to prevent bleeding. Injections of these factors are given to treat this disorder.

6

Thrombocytopenia is a disorder which causes excessive bleeding due to a very low number of platelets. This may be caused by certain drugs or infections.

7

Septicemia or blood poisoning results from infectious bacteria orfungi entering the blood stream.

8

Malaria results from a parasite introduced into the body. The bite of a female anopheles mosquito transmits protozoans known as Plasmodia into the blood stream. The Plasmodia migrate to the liver, reproduce, then invade red corpuscles, causing them to rupture.

9

Mononucleosis results from a virus which infects the blood's B cells.

10

AIDS results from a virus which infects the blood's T cells, preventing the immune system from functioning to overcome infection.

11

Blood Pressure

As the heart pumps blood throughout the circulatory system, there is pressure not only from the pumping action, but also from the elasticity of the walls of the arteries and the resistance of arterioles.

1

Blood pressure is measured in the arteries by a sphygmomanometer. This instrument consists of a numbered dial with a blood pressure "cuff", an inflatable bag, which is wrapped tightly around the upper arm. Air is pumped into the cuff by squeezing a bulb several times. This tightens the cuff and closes the arteries. The cuff is allowed to deflate. The person taking the blood pressure listens with a stethoscope to the blood as it again passes through the arteries at the inner side of the elbow and reads the dial. This gives the systolic pressure. The diastolic pressure reading is taken when the sounds of flow turbulence disappear.

2

Systolic pressure is the pressure of blood within the arteries when the heart muscle is contracting. Diastolic pressure is the pressure of the blood when the heart has relaxed to fill with blood.

3

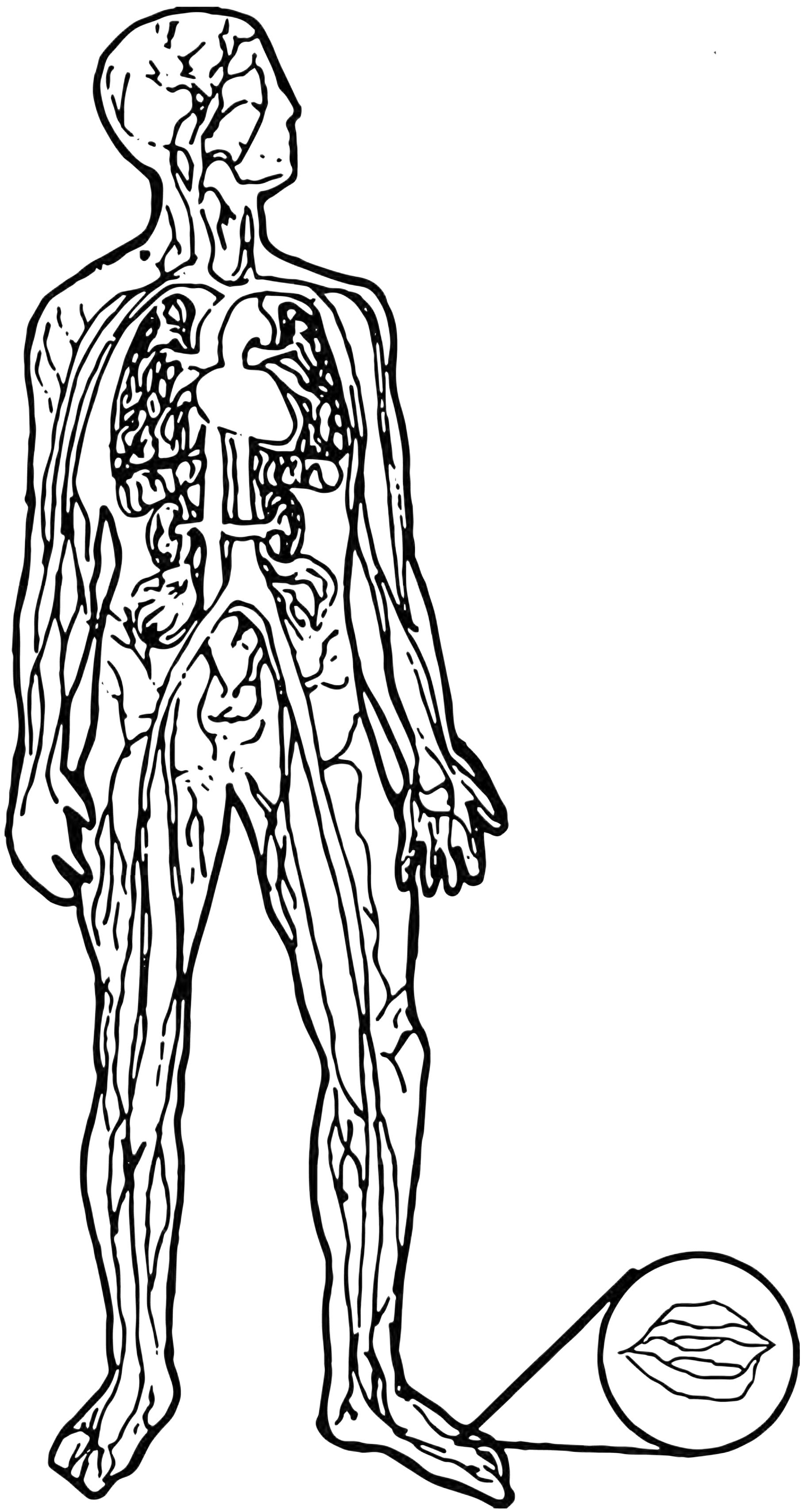
Blood pressure is written as one number representing the systolic pressure reading over a second number representing the diastolic pressure reading. In a normal young adult, blood pressure is about 120/80. By age fifty, 150/90 is considered normal. Blood pressure tends to increase with age because the arteries lose their elasticity. Blood pressure can be elevated from physical activity and emotional stress. Hypertension is the term used to indicate higher than normal pressure.

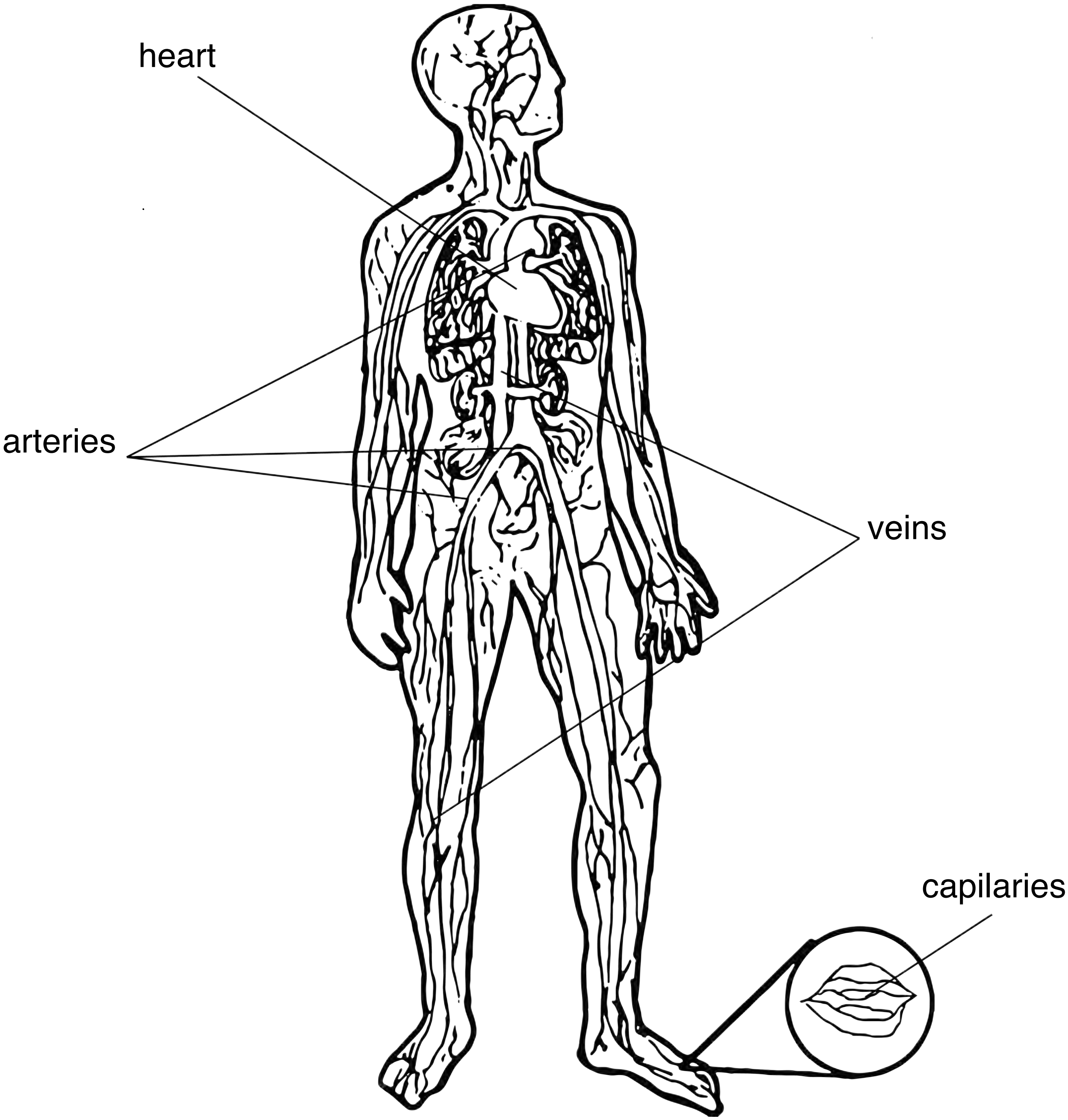
4

5

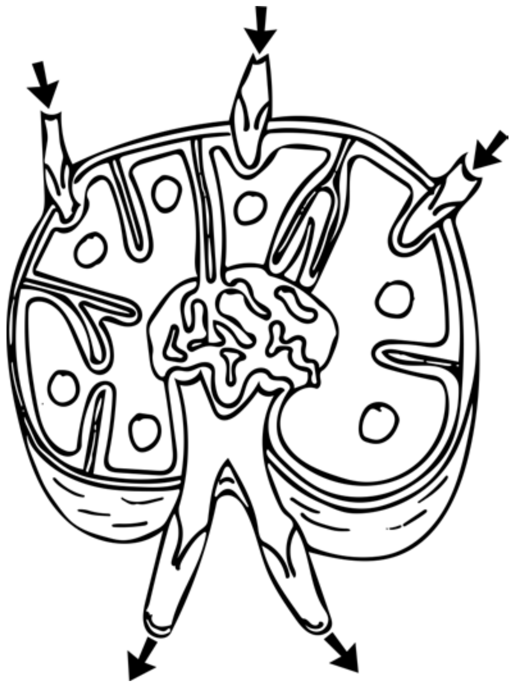
6

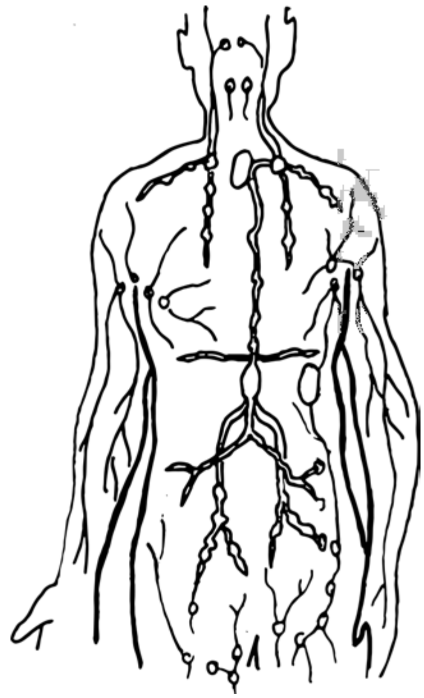
7

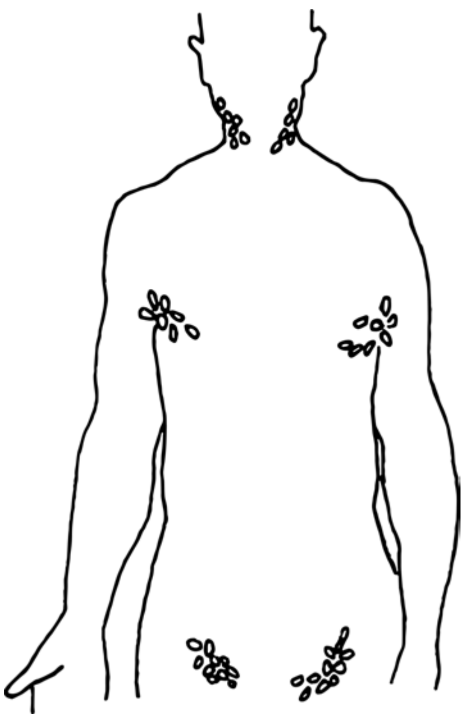


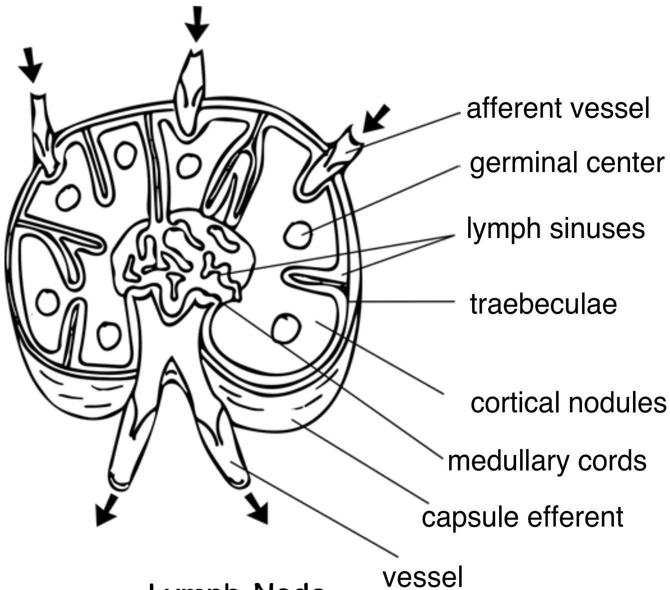


Circulatory System

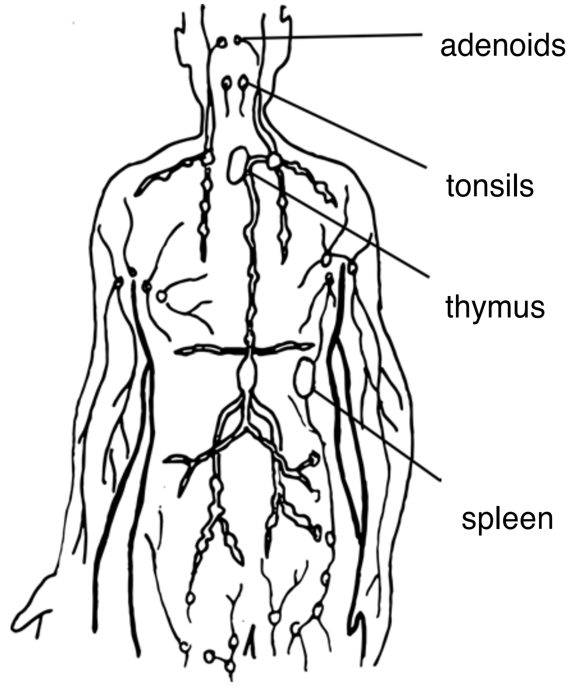




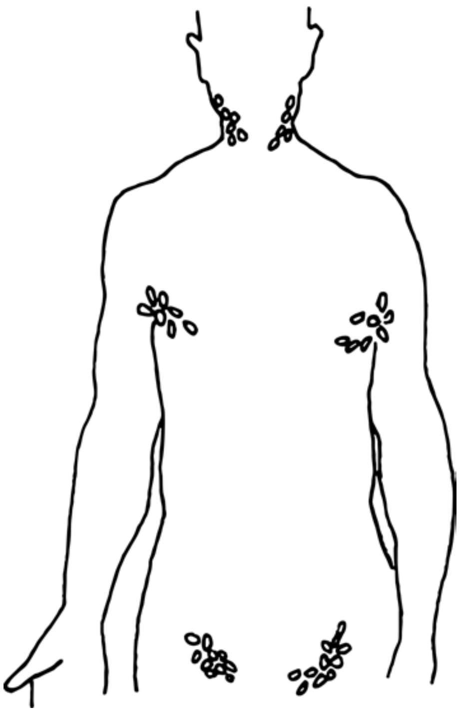




Lymph Node



Lymphatic System



Lymph Nodes

afferent vessels

lymph sinuses

reticular fibers

trabeculae

cortical nodules (nodules of the cortex)

germinal centers

capsule

medulla

medullary cords

efferent vessels

lymphatic organs

hemolymphatic organ

blood vessels

veins

capillaries

small tubes through which lymph enters the lymph sinuses within lymph nodes

maze of spaces within a net of fine reticular fibers through which lymph percolates

fibers which are net-like in appearance

connective tissue fibers which support the sinuses in the lymph node

tightly fitted lymphocyte cells surrounding the lymph sinuses which produce antibodies

center of cortical nodules with less density where lymphocytes multiply

fibrous covering enclosing the lymph node

inner part of the lymph node consisting of lymph sinuses surrounded by medullary cords macrophages which "strain" the lymph by absorbing microorganisms such as bacteria

tubes through which filtered lymph leaves the lymph node

tonsils, adenoids and the **thymus gland** where **antibodies** are formed to combat infections

the **spleen** which contains **macrophages** to engulf parts of disintegrating red blood cells and which produces lymphocytes, plasma cells and antibodies and stores erythrocytes

tubes which transport blood throughout the body, composed of three layers: the inner layer or **tunica interna or intima,** an elastic membrane; the middle layer or **tunica media,** composed of smooth muscle cells and elastic fiber in a circular arrangement; the outer layer or **tunica externa** or **adventitia,** composed of connective tissue and elastic fibers arranged along the length of the arteries

blood vessels with thinner walls and larger diameters than arteries but composed of the same three layers as arteries

smallest blood vessels of the arterial blood-vascular system composed of **endothelium** forming capillary walls only one cell thick with an average diameter of 8/1000 millimeter and length of usually not more than 1 millimeter

The Circulatory System Definitions

circulatory system
system which conveys fluids within the body by means of the **blood-vascular** and the **lymphatic** systems

blood -vascular system
that part of the circulatory system composed of various sizes of continuous tubes or blood vessels which convey blood throughout the body

heart
muscular organ which pumps blood throughout the body, located in the chest cavity slightly to the left of center

arterial blood-vascular system
that part of the circulatory system composed of **arteries** which divide into smaller tubes known as **arterioles** which divide into even smaller tubes or **capillaries** to convey blood away from the heart

venous blood-vascular system
that part of the circulatory system composed of small tubes known as **venules** which collect blood from the capillaries and lead to larger tubes or **veins** which convey blood back to the heart

arterial pulmonary division
that part of the arterial blood vascular system which conveys blood to the lungs

systemic pulmonary division
that part of the arterial blood vascular system which conveys blood to all parts of the body except the lungs

venous pulmonary division
that part of the venous blood vascular system which conveys blood from the lungs

venous systemic division
that part of the venous blood vascular system which conveys blood from all parts of the body except the lungs

hepatic portal system
that part of the venous blood vascular system which conveys blood from the digestive tract and the spleen through sinusoids in the liver before returning it to the heart

sinusoid
cavity through which blood passes

renal portal system
that part of the venous blood vascular system present only in the human embryo which conveys blood from the posterior part of the embryo through its kidneys before returning it to the embryonic heart

hypophysio-portal system
that part of the venous blood vascular system associated with the blood vessels of the pituitary gland

lymphatic system
that part of the circulatory system composed of lymph capillaries and lymphatic vessels
which convey lymph throughout the body
lymph capillaries
very fine tubes which drain tissue spaces and lead into lymphatic vessels

lymphatic vessels
small tubes which transport lymph throughout the body by movements within the body such as these of the blood vessels to which they are adjacent

lymph
fluid similar to blood plasma without red corpuscles and with a lower protein content

lymph nodes
small bean-shaped masses of connective tissue fibers containing lymphocytes, fixed macrophages and plasma cells located in groups near veins at intervals in the lymphatic vessels

afferent vessels
small tubes through which lymph enters the lymph sinuses within lymph nodes

lymph sinuses
maze of spaces within a net of fine reticular fibers through which lymph percolates

reticular fibers
fibers which are net-like in appearance

trabeculae
connective tissue fibers which support the sinuses in the lymph node

cortical nodules (nodules of the cortex)
tightly fitted lymphocyte cells surrounding the lymph sinuses which produce antibodies

germinal centers
center of cortical nodules with less density where lymphocytes multiply

capsule
fibrous covering enclosing the lymph node

medulla
inner part of the lymph node consisting of lymph sinuses surrounded by medullary cords

medullary cords
macrophages which "strain" the lymph by absorbing microorganisms such as bacteria

efferent vessels
tubes through which filtered lymph leaves the lymph node

lymphatic organs
tonsils, adenoids and the thymus gland where antibodies are formed to combat infections

hemolymphatic organ
the spleen which contains macrophages to engulf parts of disintegrating red blood cells and which produces lymphocytes, plasma cells and antibodies and stores erythrocytes

blood vessels
tubes which transport blood throughout the body, composed of three layers: the inner layer or tunica interna or intima, an elastic membrane; the middle layer or tunica media, composed of smooth muscle cells and elastic fiber in a circular arrangement;
the outer layer or tunica **externa** or adventitia, composed of connective tissue and elastic fibers arranged along the length of the arteries

veins
blood vessels with thinner walls and larger diameters than arteries but composed of

the same three layers as arteries

capillaries
smallest blood vessels of the arterial blood-vascular system composed of **endothelium** forming capillary walls only one cell thick with an average diameter of 8/1000 millimeter and length of usually not more than 1 millimeter

Parts of the Brain

The brain consists of two **cerebral hemispheres** The hemispheres are not equal in function. The left hemisphere is involved with linguistic functions, mathematics and logic. The right hemisphere in involved with spatial relationships, musical ability, facial recognition, expression of emotion, complex visual patterns and nonverbal relationships.

Impulses from sensory and motor neurons cross to opposite sides of the central nervous system on the way to and from the brain. Sensory receptors from the left side of the body send impulses to the right side of the cortex. Motor impulses arising in the right cortex cause muscular activity on the left side of the body.

The central nervous system is enclosed by three membranes known as **meninges.** The outer layer is a tough fibrous membrane, the **dura mater,** which protects the brain. The middle layer is a thin membrane, the **arachnoid membrane,** which is involved with maintenance of cerebrospinal fluid. The inner layer or **pia mater** is filled with blood vessels to nourish the brain and lies close on the surface of the nervous tissue it covers.

The **outer cerebral cortex** is composed of unmyelinated nerves tissue (gray matter). Visible on the brain's surface are **fissures** (deep groves), **gyri** (raised places) and **sulci** (furrows). Myelinated nerve tissue (white matter) lies beneath the upper gray matter. Motor areas of the cortex are served by **basal nuclei.** There are paired **lateral ventricles.** The cranial bones that cover the cortex give its areas their names. These are: **frontal, parietal, temporal, occipital, insula** and **limbic.**

4

The ventricles within the brain are continuous with the central canal of the spinal cord.

All contain cerebrospinal fluid which is similar to lymph. This fluid is continuously secreted by brain tissue, the **choroid plexuses,** and reabsorbed by veins.

5

Functions of the cortex have been determined through experiments and clinical data. Memory (storage of experience) and association (exchange of impulses with other brain areas) involve all of the cortex.

6

The brain is divided into **lobes:** frontal, parietal, temporal and occipital. Each has definite functions. The anterior part of the parietal lobe is the site for voluntary muscle control. The posterior part of the parietal lobe is the site for sensory coordination. The occipital lobes are the site for vision. Parts of the temporal lobe are the sites for hearing and speech. **Broca's area** in the frontal lobe directs the muscular movements needed for speaking a word. When reading, the **angular gyrus** converts the visual image of the word to its associated sounds. This area also formulates the spoken sentence.

7

The **frontal lobe** is the site of intellectual functions:

reasoning, abstract thinking, aggressive behavior, sexual behavior, smell, speech, lar:,guage, initiation of movement.

The **central sulcus** roughly marks the boundary between the motor areas at the back of the brain and the sensory areas at the front.

8

In the **parietal lobe** lies the ability to recognize specific sensory stimuli, to use symbols in communication (language), to develop ideas with the corresponding motor responses to utilize them.

9

One area of the parietal lobe, the **postcentral gyrus,** receives impulses concerning pain, touch, taste, pressure, temperature and body position from the entire body. Consciousness of sensory stimulation arises in this area.

10

Smell, language, emotional behavior, visceral reactions concerned with self-preservation and reception of impulses related to hearing are centered in the **temporal lobe.** In addition to an auditory area for hearing sound, there is an auditory association area, **Wernicke's area,** in the left hemisphere where awareness and discrimination of sound are processed to interpret the meanings of sound patterns of speech.

11

The reception of visual impulses from the optic nerve occurs in the **occipital lobe.** Visual discrimination and awareness take place in this part of the brain.

12

The main path of interhemispheric communication between the left and right hemispheres is the **corpus callosum.** Located above the lateral ventricles, it is the largest tract of nerve fibers in the brain, containing over 200 million.

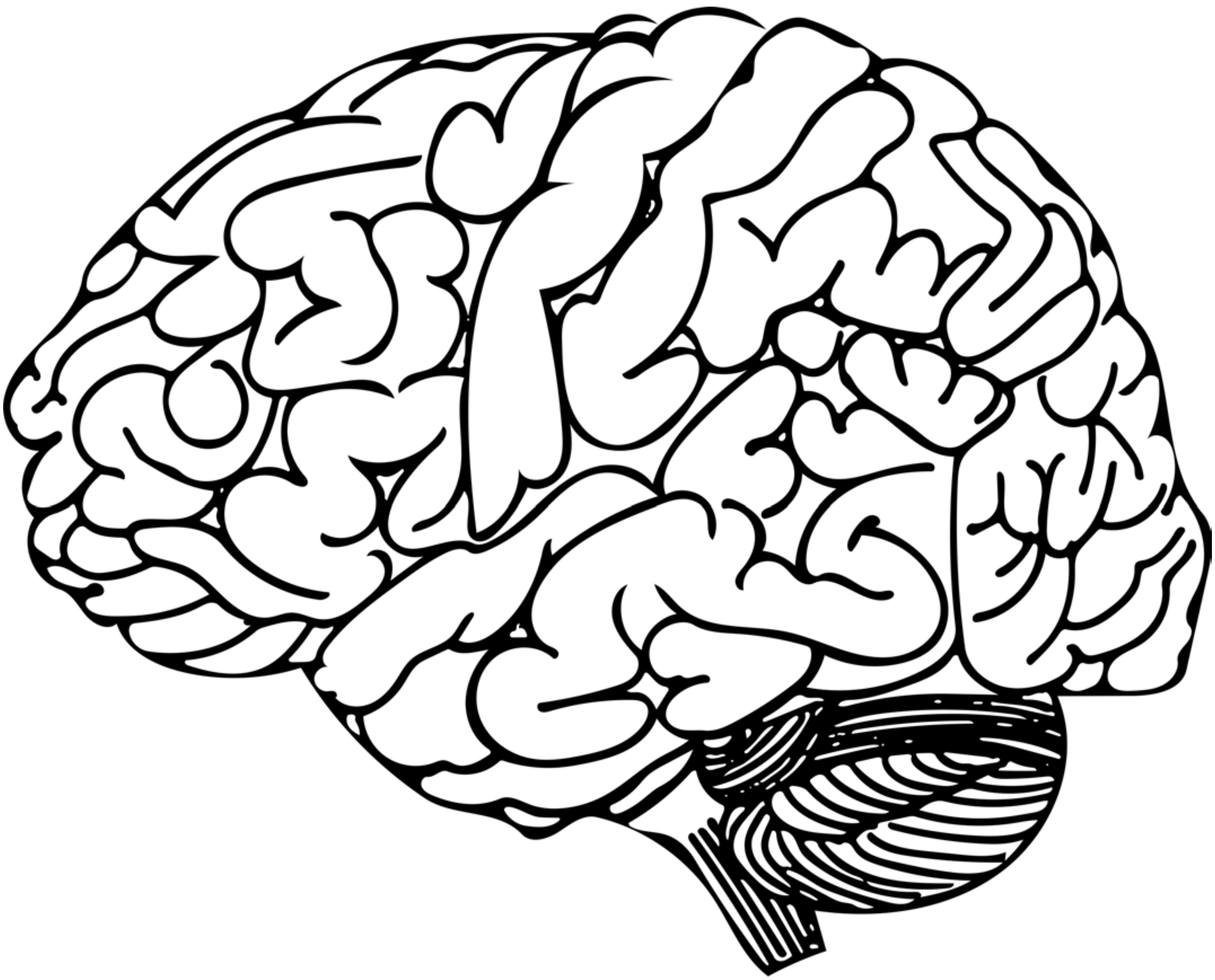
13

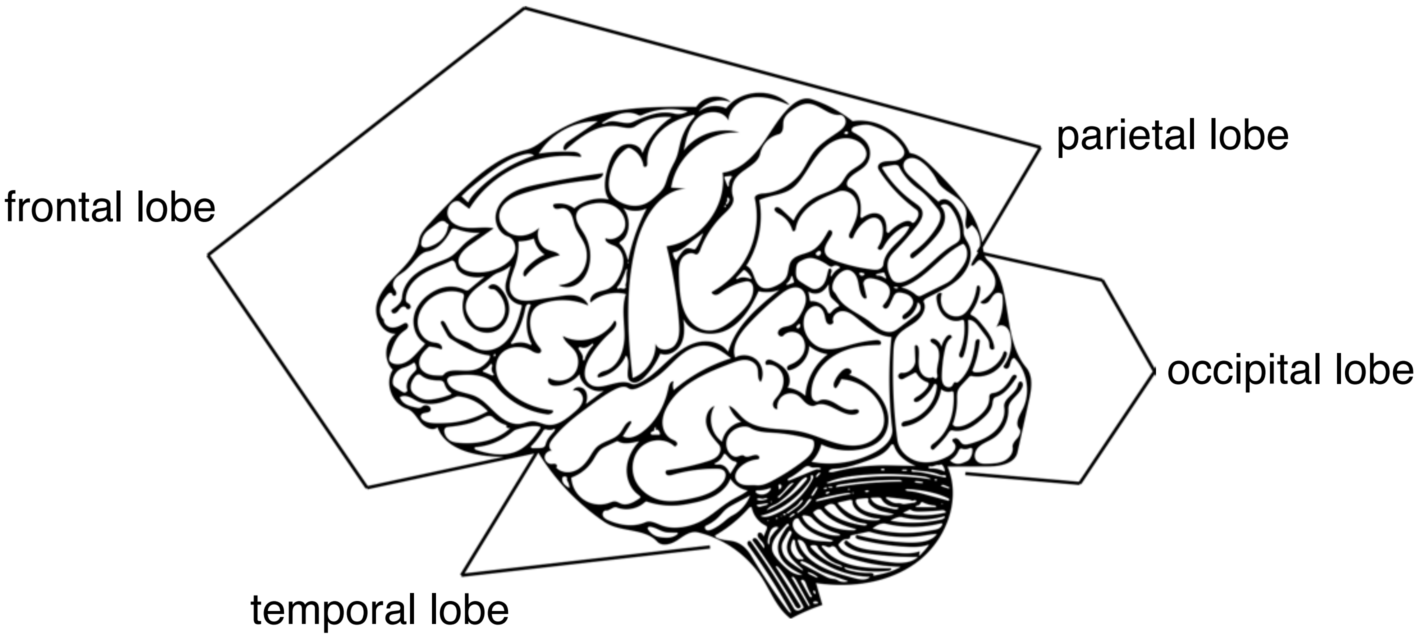
The **pons** connects hemispheres of cerebellum and also links the **cerebellum** and **cerebrum.**

14

The **basal nuclei or ganglia** are masses of gray mater at the base of the hemispheres. They are involved with autonomic reflexes. They lie on either side of the **diencephalon.** This is composed of the **thalamus, hypothalamus** and **epithalamus or pineal gland.** These structures are involved with integration of sensory experiences leading to appropriate motor responses and regulation of the conscious state. The pineal gland is thought to secrete a hormone, melatonin, which inhibits gonad activity and is related to the natural cycles of body functions.

15





Parts of the Brain

Physiology

Learning

Learning is the process by which behavior is changed as a result of practice or experience. Behavior is any response that an organism makes to its environment. It can take the form of thoughts, emotions and actions as well as responses of glands and muscles.

1

Early studies of learning involved **stimulus-response** relationships. The stimulus can be any object or situation which involves a sense organ. Following the presentation of the stimulus is a response. The stimulus **elicits a** response. It is possible to elicit a similar response by presenting a new stimulus at the same time as the original stimulus. This is known as **classical conditioning or respondent learning. A** Russian scientist, Ivan Pavlov, conducted the first classical conditioning experiments by sounding a tone when food was given to a dog. Eventually, the dog salivated when the tone was sounded even though no food was present. It is possible to develop a **conditioned response** to lights, sounds or electric shock.

2

Instrumental conditioning or **operant conditioning** involves a learned response on the environment which produces some effect. B. F. Skinner, an American psychologist, trained rats to push a lever to obtain food. Children learn that crying will get attention. Crying is the learned response and attention is the effect.

3

Multiple-response learning begins with a sequence of simple steps involving stimuli. Simple steps are combined later to produce more complex behavior patterns. Learning to play a musical instrument is an example. In the laboratory, rats are observed finding their way through a maze to be rewarded with food at the end. Many choices are possible and the more often the rat goes through the maze, the quicker it will learn the correct path.

4

Insight learning involves the solving of a problem by understanding relationships among parts of the problem. Insight may occur unexpectedly after many attempts to arrive at a solution.

5

Learning theories can be categorized according to stimulus-response relationships, cognition or understanding of concepts and ideas, or humanistic approaches involving creative expression.

6

One kind of learning is called **declarative.** It consists of learning facts about people, places and things. It involves making associations which take place through interconnections of neural pathways. Declarative learning is processed in the part of the brain known as the hippocampus.

7

A second kind of learning is called **procedural.** It involves learning motor skills and using perceptual strategies. Specific sensory and motor systems are associated with each skill.

8

Many factors are involved in the learning process. The learner is not ready to learn until the nervous system has reached the optimum stage of development. Motivation or the desire to learn influences the learning process. Extrinsic motivation involves external rewards. Intrinsic motivation results from the reward of satisfaction gained in the process of learning. Transfer of learning from a previously mastered task to a new one can make learning easier if the stimuli and the response of the tasks are similar.

9

Conditions for optimum learning are: working for short periods of time spaced widely apart rather than cramming the learning into one long period, known as **Massed Practice;** having actual experience in performing an activity rather than watching another person do it.; getting immediate feed-back on the accuracy and quality of the performance; practicing the most difficult parts of a task separately and repeatedly before incorporating them into the total activity; relating the task to previously learned experiences to make it more meaningful through **transfer of learning;** making parts of the learning task distinctive; establishing good study habits through being able to concentrate and complete tasks.

10

Physiology

Membrane Theory of Nerve Conduction

Nerve cells are covered with **membranes** which have very tiny openings known as **pores.** These are opened or closed by means of **protein molecules.** When not in use, sodium ion concentration in the neuron is low.

1

Potassium and negative organic ion concentration is greater in the cell than in its surroundings. This causes the inside of the neuron to be more negative than its surroundings.and the membrane to be **polarized.** The **resting potential is** the difference in voltage across the membrane.

2

The membrane's porosity and resting potential is changed when a stimulus is applied to a neuron. The stimulus can be chemical, electrical or mechanical. It causes the membrane's pores to open, thus allowing sodium ions to enter the neuron. This makes the interior of the cell positive in charge or **depolarized.**

3

The beginning of a nerve impulse requires a stimulus of a certain intensity, known as **threshold voltage.** This stimulus depolarizes the neuron and it **fires.** No matter how strong the stimulus, the impulses from any particular neuron have the same duration and size. This is the **all-or-nothing phenomenon** since the neuron always fires at its maximum strength or not at all. The intensity of the stimulus is perceived by the brain through the frequency of the impulses and the quantity of neurons stimulated.

4

A solution capable of conducting an electric charge fills the interior of the axon. When one area of an axon is depolarized, it spreads through the solution along the axon. This is known as the **action potential.**

5

The impulse moves continuously along unmyelinated axons. On myelinated axons, the impulse jumps from one **node of Ranvier** to the next. These nodes are places along the axon where there are interruptions in the myelin sheath.

6

As a nerve impulse arrives at the end of an axon, a chemical known as a neurotransmitter is released into the synaptic cleft. This chemical crosses the synapse to reach the dendrite of the next neuron. Pores of the nerve membrane open so that ions pass through them. The resulting voltage change is known as the postsynaptic potential. This can be excitatory which spreads to the axon of another cell, producing another action potential. The postsynaptic potential also can be inhibitory, preventing the axon from producing another action potential. Transmission of nerve impulses across a synapse does not always occur.

7

Physiology

Parts of Neurons

The mammalian nervous system is composed of millions of nerve cells or **neurons.**

These neurons are arranged in long, thin bundles known as **nerves.**

1

The **neuron body** is shaped like a sphere 1/1000 of an inch or 0.025 millimeters in diameter. This body receives and sends nerve impulses, makes proteins and uses energy to maintain itself.

2

The neuron body has an **axon** extending in one direction. An axon is about 1/25 of an inch or 1 millimeter long. It is the "output" extension. It terminates in tiny branches. There are enough branches in one neuron to contact up to 1,000 other neurons.

3

Some axons are enclosed in a **myelin sheath.** Myelin is a fatty white tissue formed by Schwann cells which surround the axons in the peripheral nervous system. Myelin is formed by cells known as **glia** in the central nervous system. Myelinated axons compose the **white matter** of the nervous system.

Unmyelinated axons appear gray in color because they are not covered by white myelin. These compose the **gray matter** of the nervous system.

Dendrites which are shorter than and twice as thick as the axon extend from the other parts of the cell. They also terminate in branches. Usually there are six main dendrites, each about 1 /50 of an inch or 0.5 millimeter long. They receive impulses from axons.

Axons and dendrites do not touch. Between the axon of one cell and the dendrite of another is an extremely small space called the **synaptic cleft.**

Electrical impulses are transmitted from the axon of one neuron to the dendrite of another across the **synapse.**

Chemicals known as **neurotransmitters** allow the electrical impulse to move across the synapse.

A single neuron can send and receive thousands of impulses each second. There are about 100 billion neurons in the human brain. Memory of experiences is spread over a large neural network of more than a million neurons.

8

The more the brain is used, the more extensive the dendrites become. More synapses are developed as well. The more synapses between cells, the more circuits there are to process information. More synapses allow more information to be learned, understood and recalled.

9

Brains with more synapses use less energy than others. Glucose is the fuel of the brain.

10

Sensory organs (eyes, ears, nose, mouth, fingertips) receive stimuli from the environment through specialized neurons or **receptors.** These stimuli are changed into rhythmic patterns of electrical **impulses** passing along the neurons. A chemical process is the basis for the electrical impulse.

11

A brain circuit is formed as the electrical impulses link neurons into a chain or pathway. The next time the same stimulus is experienced, the electrical impulses travel quickly through the same circuit. Short-term memory lasts only a few days. Long-term memory may last a lifetime. New memories are laid down in the hippocampus which makes recall of recent events possible. Long-term memory is stored in the neocortex.

12

For the first eighteen years of life, the brain is developing its basic circuitry. Experiences develop new circuits and synapses. After adolescence, these pathways are strengthened and interconnections are enhanced. The network of circuits stops forming.

13

Different parts of the brain are involved in different activities. Scientists are "mapping" brain function. They scan the brain using MRI (magnetic resonance imaging), CAT (computer-assisted tomography) and PET (positron emission tomography) which measure blood flow in the brain. Active parts of the brain show greater blood flow than inactive parts.

14

Physiology

Neurons and Neural Circuits

There are four types of neurons: sensory, association, autonomic motor and somatic motor.

1

Sensory neurons transmit information in the form of nerve impulses from receptors in the sense organs to **association neurons** in the brain and spinal cord. The brain analyzes the nerve impulse message it receives.

2

Neural impulses are transmitted from the brain by **somatic motor neurons** to appropriate body parts such as muscles. **Effectors** in those organs react to the brain's message and action takes place. The speed of a neural impulse is from 3 to 300 feet per second.

3

Transmission of impulses by **autonomic motor neurons** involve two neurons with the synapse site located in the cell body of the second neuron. These collections of cell bodies outside the central nervous system are known as ganglia. Autonomic motor neurons control smooth muscle and glands of the viscera as well as the heart muscle.

4

From repeated past experiences, **neural circuits** are established among neurons.

A **reflex** is a simple neural circuit. It is transmitted from the location of the stimulus through the spinal cord and connects a receptor and an effector without passing through the brain.

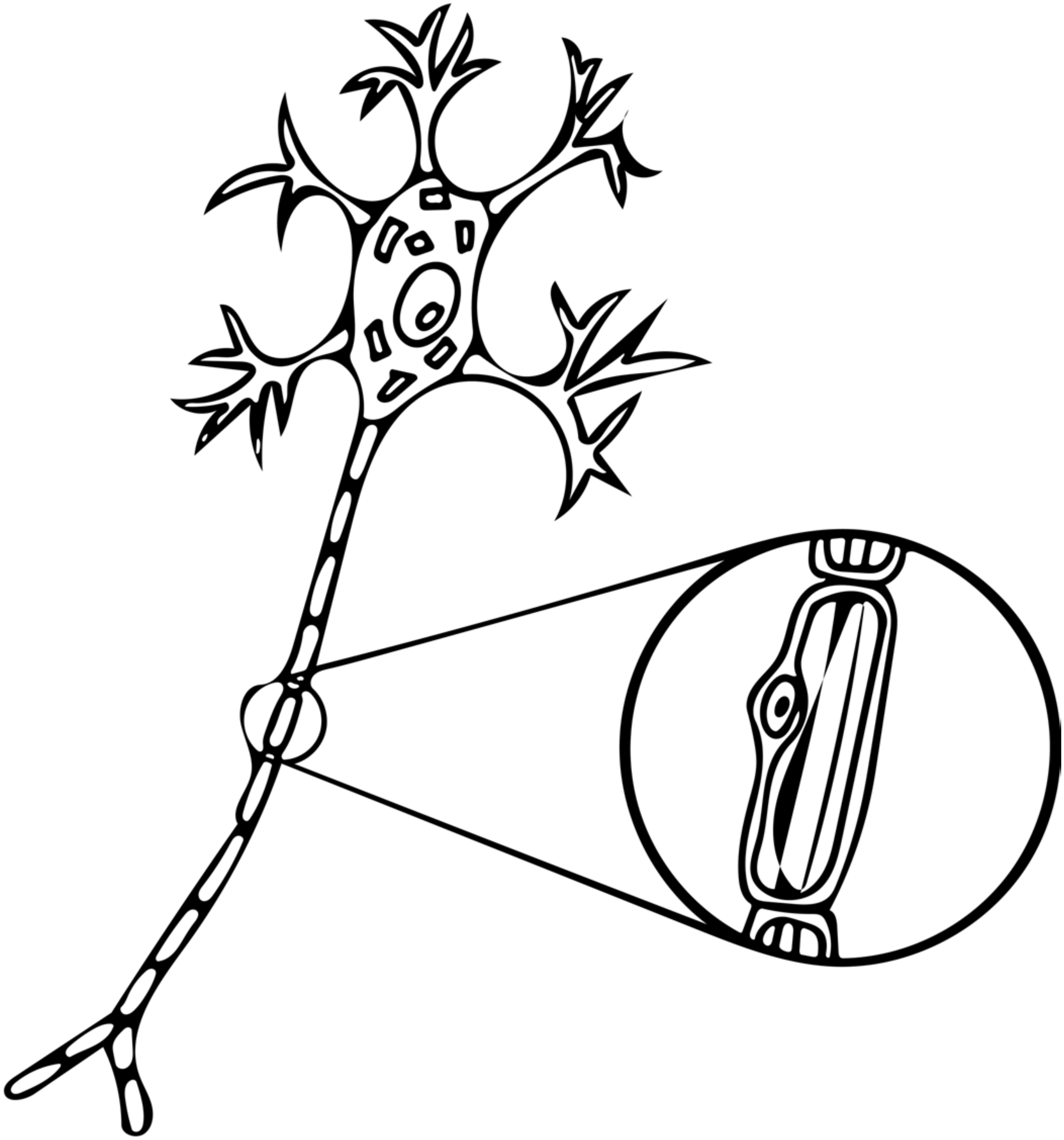
5

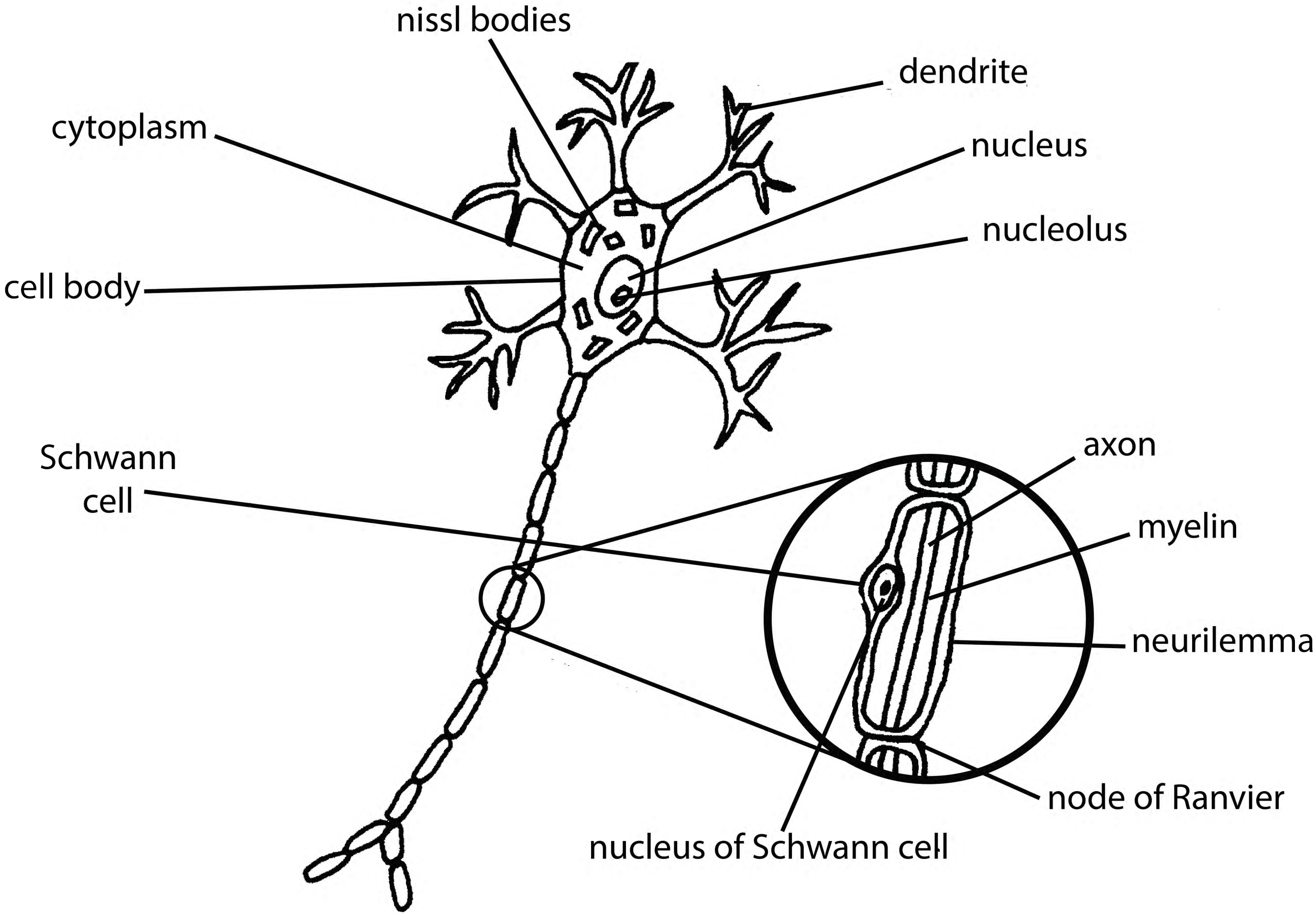
An example of a simple reflex is the patella or knee jerk reflex. By tapping the tendon just below the kneecap, the muscle connected to the tendon quickly stretches. This impulse is transmitted through a sensory neuron over an axon to the spinal cord, then through a synapse to a motor neuron. Another impulse is generated which is transmitted over the axon of a motor neuron back to the stretched muscle. The muscle cells contract when the impulse is received and the lower leg jerks upward. All of this takes place so quickly that the leg jerks immediately after the tendon is tapped.

6

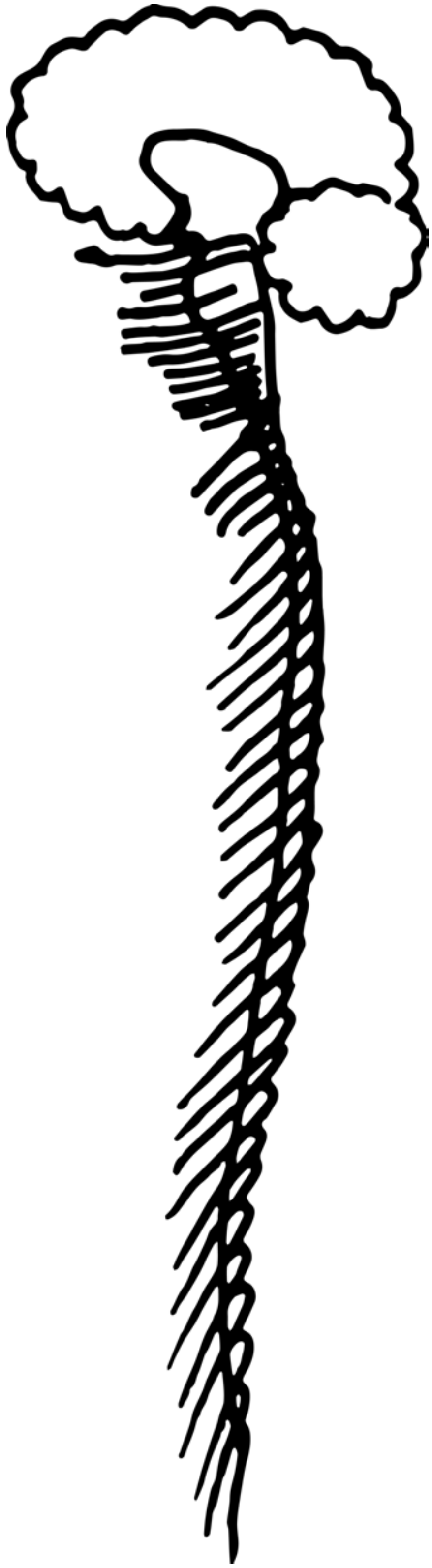
Most neural circuits are very complex, involving sensory, association and motor neurons. Complex reflexes do not require conscious effort, but learned voluntary muscular movements become unconscious only after extensive practice. An example is playing a violin which requires great attention to finger placement and movement and hours of practice before the technique becomes automatic.

7



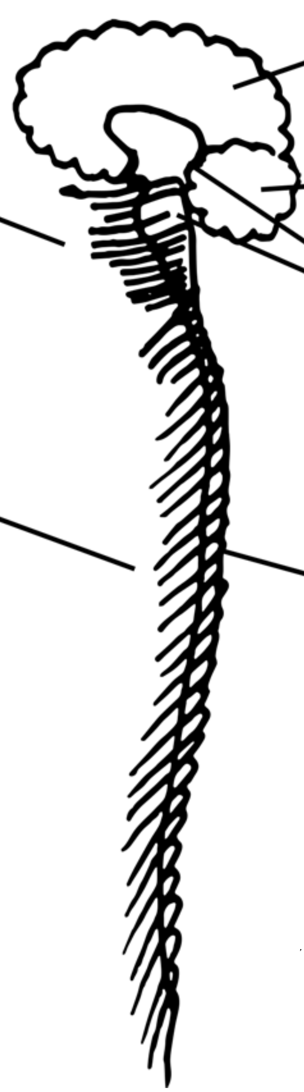

nissl bodies
dendrite
cytoplasm
nucleus
nucleolus
cell body
Schwann
cell
axon
myelin
neurilemma
node of Ranvier
nucleus of Schwann cell

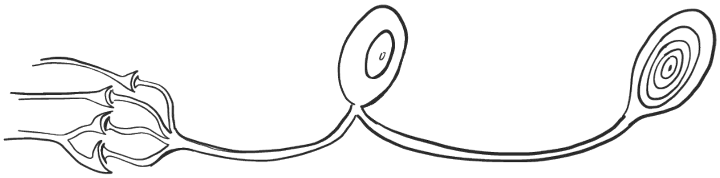
Nerve Cell

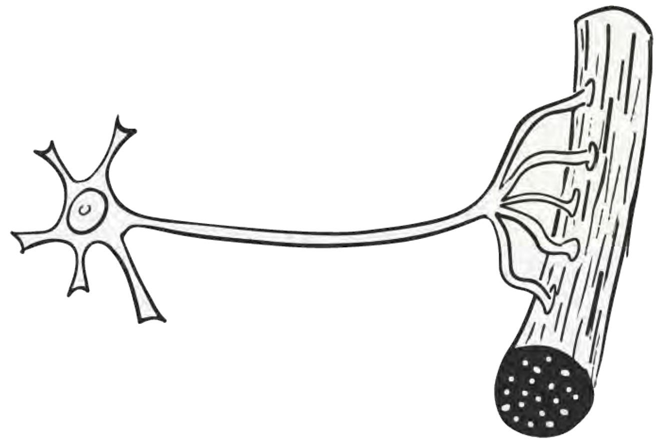


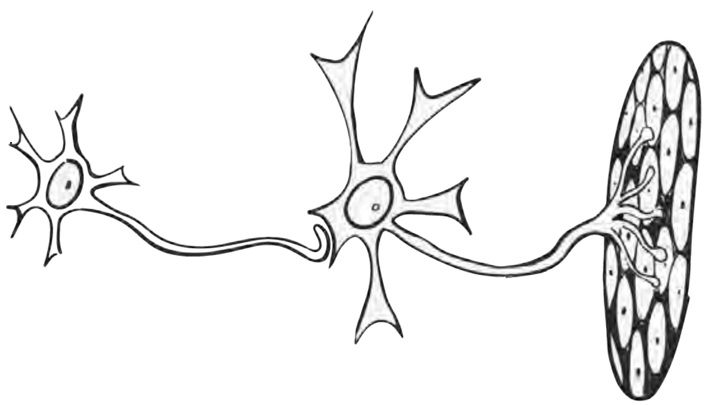
Peripheral Nervous System

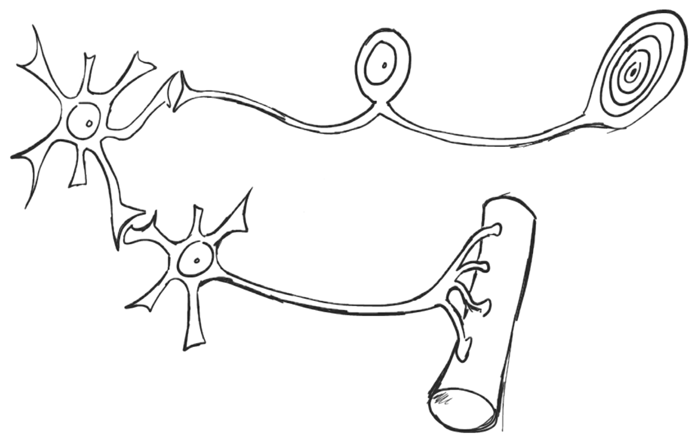
Central Nervous System











sensory **somatic motor**

autonomic motor **association**

Physiology

Sweat Glands

At birth, all humans have the same number of sweat glands. These do not respond to heat at birth.

1

Reflex arcs are established as the infant experiences heat. Nerve reflexes develop as sensory information about heat is sent to the brain. The brain then sends signals to motor nerves which control sweat glands.

2

By about age three, these nerve reflexes are established. The more heat experienced by the child, the greater the number of sweat glands that will function. Moving to a cold climate after the age of three will not change the number.

3

Children who live in cold climates for the first three years develop fewer sweat glands that function. After the age of three, moving to a hot climate will not cause more sweat glands to be available for use.

4

This is an example of **critical-period programming.** It is irreversible and is set within the first three years of life.

5

Respiratory System

nasal cavities

epiglotis

trachea

bronchus

bronchiole

alveoli

diaphragm

intercostal muscles

ribs

Circulatory System

heart

arteries

veins

capiilaries

Parts of the Heart

aorta

superior vena cava

inferior vena cava

pulmonary arteries

pulmonary veins

myocardium

right atrium

interventricular septum

right ventricle

bicuspid valve

left atrium

epicardium

left ventricle

Direction of Blood Flow

tricuspid valve

from the body

chordae tendineae

to the lungs

papillary muscles

from the lungs

endocardium

to the body

cell wall

Muscular System

Muscles allow the organism to control the operation of the body's systems so that functioning is possible. They give shape and form to the body. Muscles are composed of tissue that has the ability to contract or shorten to about one-third of its resting length. They are attached to bones by tendons composed of connective tissue fibers. Muscles are covered with connective tissue which helps to support the nerves and blood vessels which supply the muscle.

1

Muscles require large amounts of oxygen and nutrients to operate. Without these, muscle tissue will spasm or contract violently.

2

There are three kinds of muscle fibers: **smooth or visceral, cardiac** and **skeletal.**

3

Smooth muscles are located within the walls of the viscera which includes the digestive, respiratory and circulatory systems. Cells of smooth muscle tissue are long spindle shapes. The nucleus of a muscle cell is located at its center. There are no cross striations which is the reason it is known as smooth muscle tissue. Smooth muscle contraction is slow, sustained and rhythmic. Smooth muscle functioning is generally not voluntarily controlled but is under the control of the autonomic nervous system.

4

Cardiac muscles are located in the heart. The muscles are striated which means that there are visible junctions between cells. The nucleus of a muscle cell is in its center. The heart is composed of layers of cardiac muscle fibers. Cardiac muscle fiber does not regenerate itself quickly. There are special muscle cells which conduct impulses to cause the cardiac muscle to contract without the action of nerves to initiate contraction. The autonomic nervous system regulates the rate of contraction of the cardiac muscle.

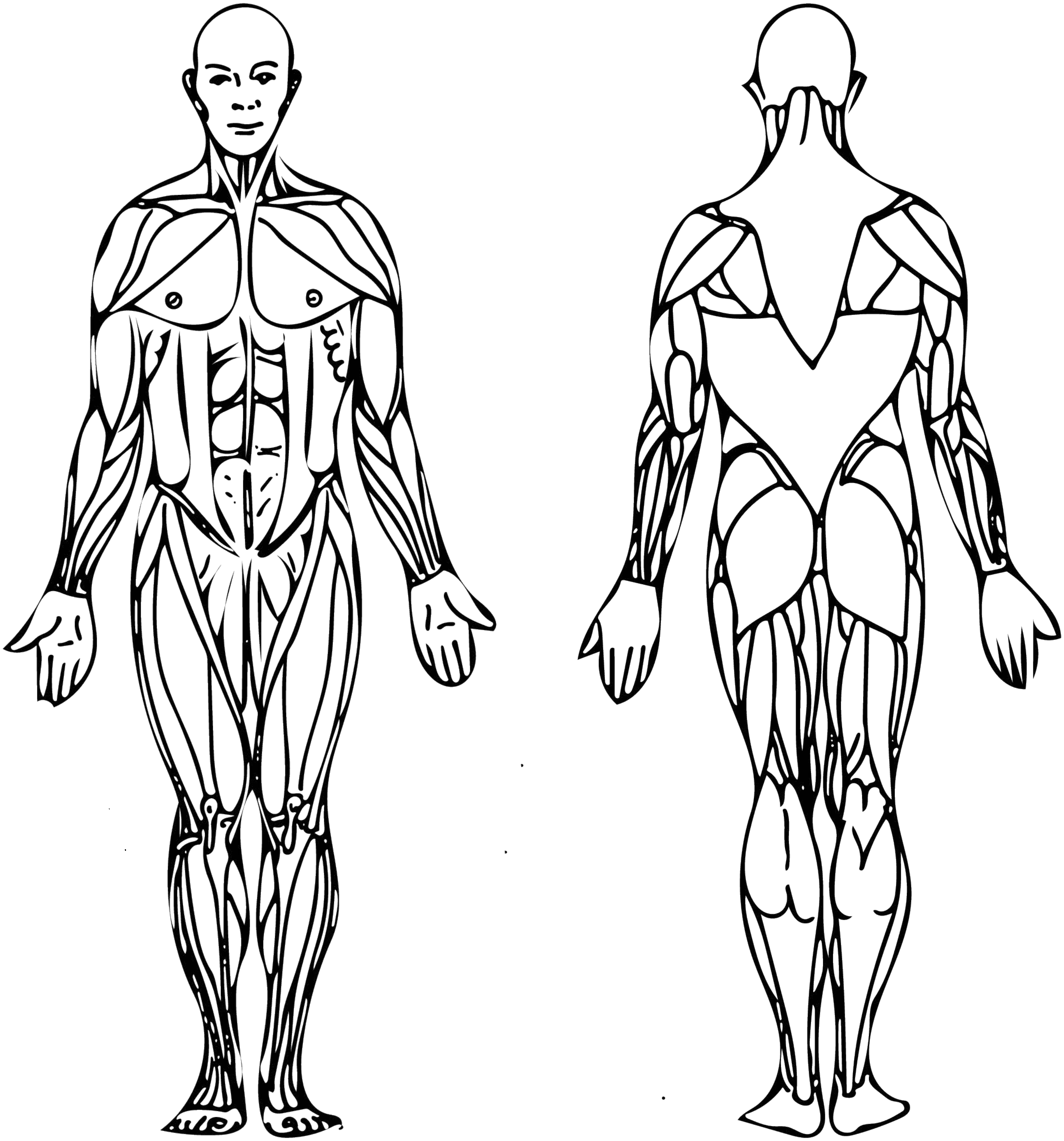
5

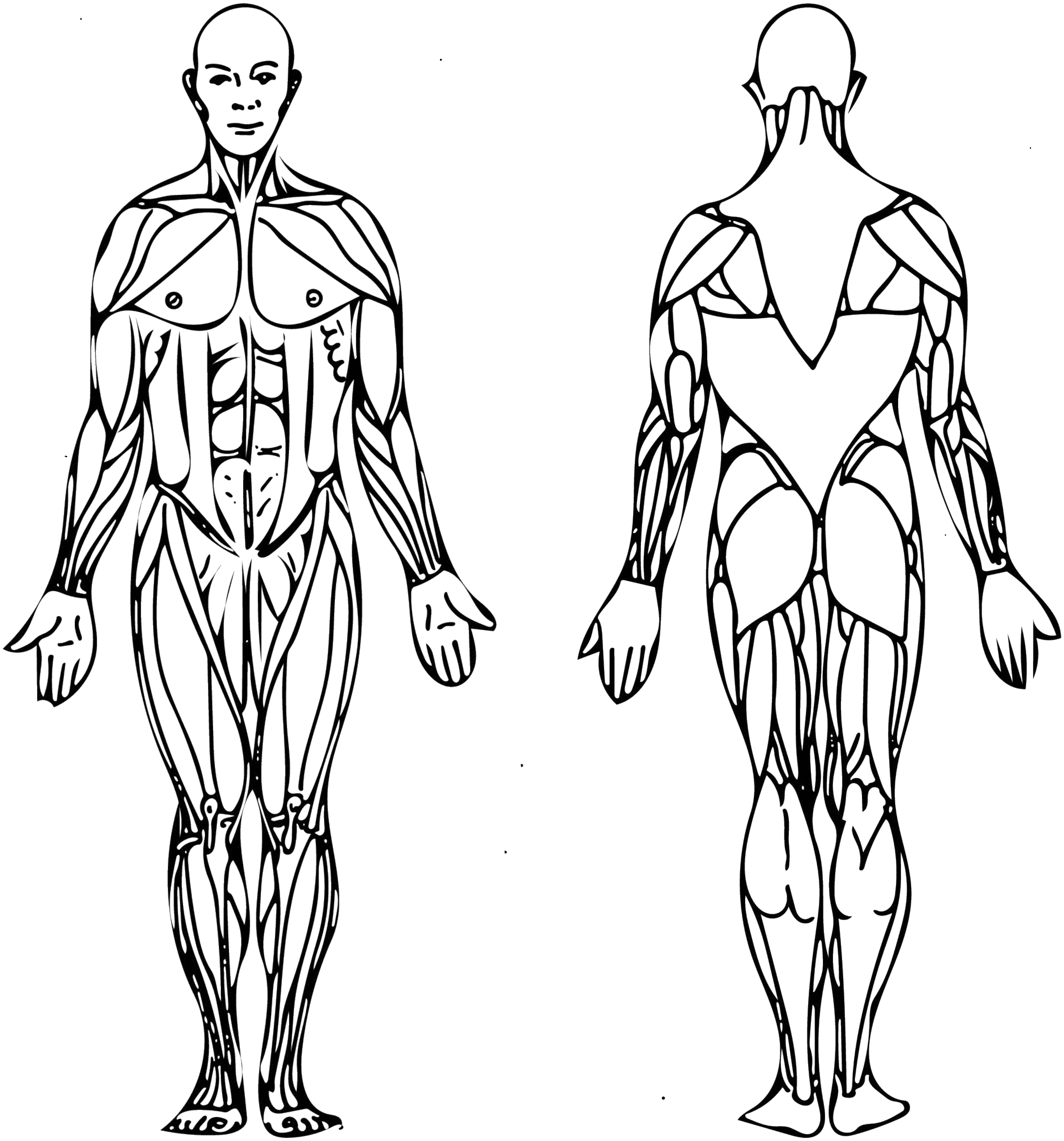
Skeletal muscles usually are attached to the bones of the body by tendons. These muscle are long, cylindrical, striated and have multiple nuclei. Muscular contraction enables bones to move. Contractions of skeletal muscles are fast and short but strong.

6

Nerve impulses make the muscles contract, but the contractions are under voluntary control. With exercise, muscle mass is increased. Without use, muscles atrophy and can be replaced with connective tissue.

7

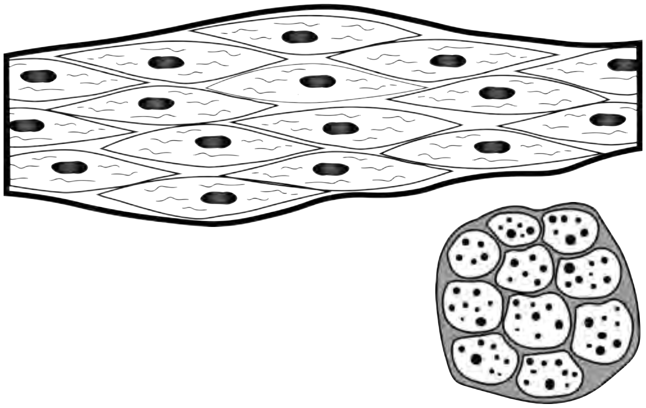


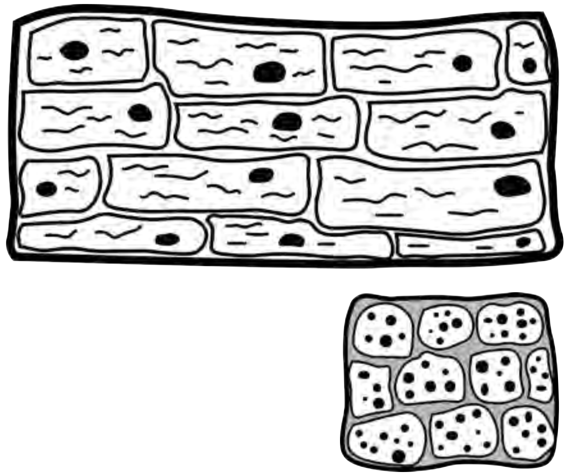


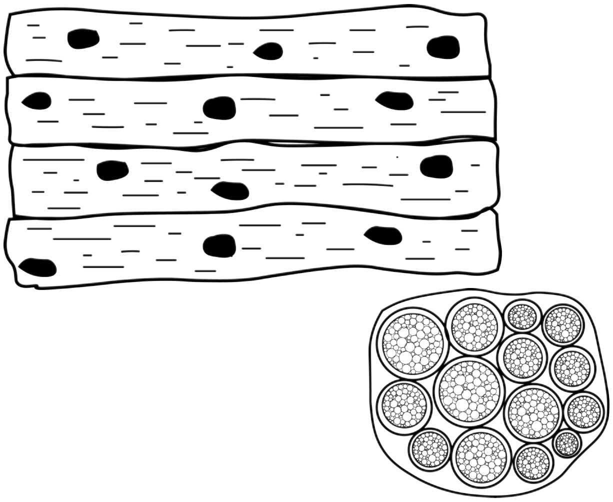
scapula stabilizers	abdominal muscles
flexors	sartorius
abductors	rectus
adductors	deltoid
extensors	trapezius
rotators	muscles of scapula
sterno-mastoid	latissimus dorsi
pectoral	gluteals
biceps	semitendinosus
triceps	smooth muscle

cardiac muscle

skeletal muscle







smooth muscles (involuntary)

skeletal muscles (voluntary)

cardiac muscles

The Digestive System

The alimentary canal or digestive system begins at the mouth and ends at the anus. Digestion begins in the mouth. As the teeth grind food, it mixes with saliva. Saliva is produced in the salivary glands located in the cheek and under the front of the tongue.

1

It contains an enzyme, ptyalin, which begins the digestive process to make food available for the body's use. Ptyalin starts the conversion of starches and sugars to maltose.

2

When chewed food is swallowed, it passes down the esophagus, a tube lined with mucous membrane. It is composed of smooth muscle which moves food toward the stomach by wave-like movements known as peristalsis.

3

Food passes through the cardiac sphincter at the end of the esophagus where it connects with the fundus of the stomach. The cardiac sphincter is a circular band of muscle which can contract to close the opening into the stomach.

4

The stomach is a folded cavity lined with mucous membrane containing glands which secrete mucous and gastric juice. It is strongly acid due to hydrochloric acid produced by some of the stomach's glands. Gastric juice also contains water and mucin, a glycoprotein secreted by the mucous membrane. Several enzymes are present in the gastric juice, the most important one being pepsin. It changes protein into proteases. In the presence of hydrochloric acid, pepsin digests food.

5

Hydrochloric acid does not attack the stomach lining because of the protection of the mucous secretion covering it. Churning motions of the muscular walls of the stomach mix food with digestive juices. Water, alcohol and some glucose are absorbed through the stomach wall.

6

The semi digested food passes in small amounts at intervals from the stomach at its pyloric end through the pyloric sphincter, a circular band of muscle which can contract to close the opening from the stomach into the small intestine. The small intestine is about 23 feet long, wound about in the abdominal cavity.

7

The first portion of the small intestine is known as the duodenum where the major part of digestion begins. Just beyond the pyloric valve, the common duct opens into the duodenum. Bile from the liver's gall bladder and pancreatic juice from the pancreas enter through this duct. These secretions are alkaline. Bile is not an enzyme, but functions to emulsify fats into tiny droplets. Enzymes known as lipases from the pancreas and intestine are able to digest the fine drops of fat to form glycerol and fatty acids.

8

Glands in the walls of the duodenum secrete intestinal digestive juices containing other enzymes which complete the chemical digestion of food. Protein digesting enzymes come from both the pancreas (trypsin) and the intestine (erepsin) to form amino acids. Amylase, also from the pancreas and the intestine, digests starches and dextrins to form maltose. Maltase changes maltose into glucose. Sucrase changes sucrose to glucose and fructose. Lactase changes lactose into glucose and galactose.

9

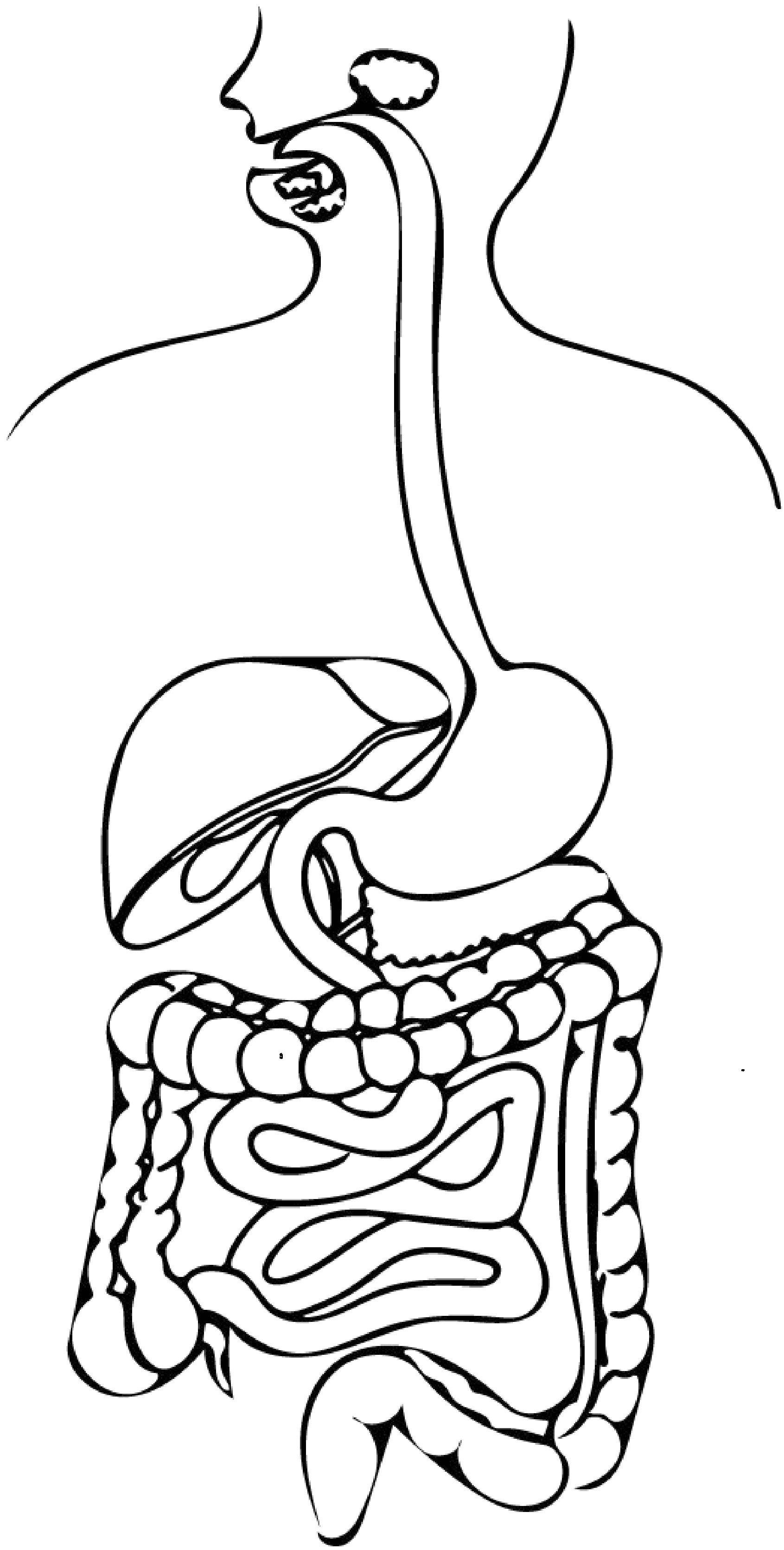
Fluid digested food passes from the duodenum into the second part of the small intestine, the jejunum, then into the final section, the ileum. The tiny projections on the intestinal walls known as villi absorb the nutrients which are transmitted into the blood stream. Most absorption of digested food occurs in the small intestine.

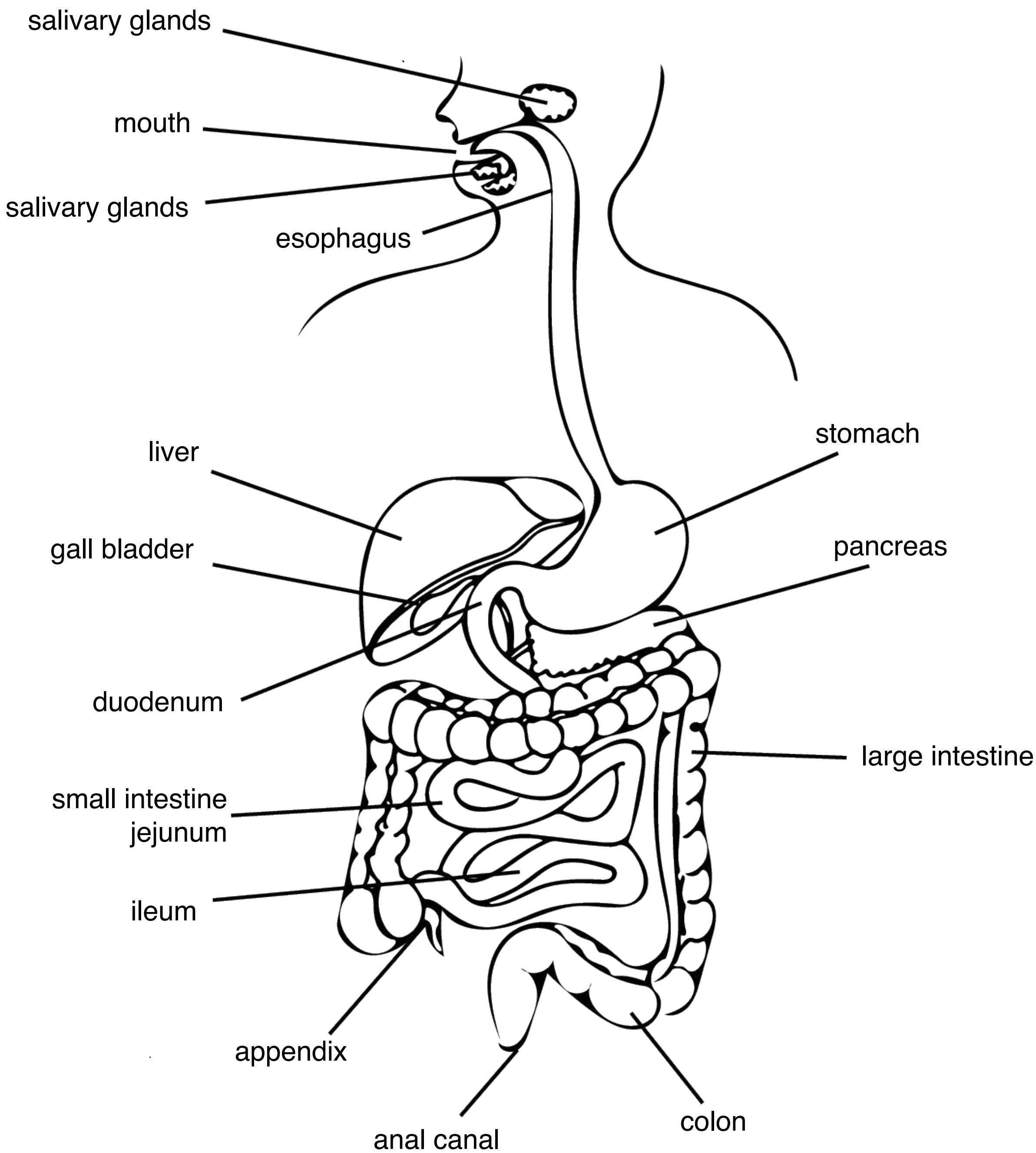
10

The ileum ends at the large intestine or colon where there is a slit like opening with two lips at the side, the colic valve. A pouch or caecum lies just past the beginning of the large intestine. The appendix, a small tube like projection, extends from the caecum. This may become infected in which case it is removed without any bad effects, suggesting that it is not a necessary body part.

11

The large intestine is divided into five parts: ascending colon, transverse colon, descending colon, sigmoid flexure and the anal canal. Water from the remaining digested food is absorbed in the colon. The enzymes produced by the body cannot digest all food. Cellulose from vegetables and fruit passes through the alimentary canal to form feces once the colon has absorbed the water. Feces is expelled from the digestive tract through the anus.





Digestive System

Respiration

Respiration is the process through which oxygen is taken in and carbon dioxide is expelled. There are three types of respiration. External respiration is the act of taking in oxygen from the environment and expelling carbon dioxide. Internal respiration is the process of transporting oxygen to cells within the organism and removing carbon dioxide from cells. Cellular respiration is the process by which oxygen reacts chemically within the cell to produce energy with carbon dioxide and water as waste products.

1

Inspiration is the intake or inhaling of air which inflates the lungs. This is caused by the contraction of the diaphragm and of the intercostal muscles controlling rib movement. An increase in carbon dioxide concentration in the blood stimulates the medulla, the respiratory center in the brain. The medulla directs the muscles and diaphragm to contract.

2

The stretching of the lung tissue during inspiration activates another set of nerve impulses. The muscles relax and the lungs deflate, expelling carbon dioxide.

3

Expiration is the exhalation of air out of the lungs which occurs when the muscles relax. A decrease in the oxygen level of the blood also stimulates the medulla, but it is more sensitive to carbon dioxide increase.

4

The composition of inspired air is 20.96% oxygen, 0.04% carbon dioxide, 78% nitrogen and 1% rare gases. The composition of expired air is 16.3% oxygen, 4% carbon dioxide, 78.7% nitrogen and 1% rare gases.

5

Respiratory System

nasal passage or cavity

pharynx

glottis

epiglottis

larynx

vocal cords

trachea

bronchi

bronchioles

lungs

aveoli

pleura

respiration

external respiration

internal respiration

cellular respiration

inspiration

expiration

diaphragm

place where air enters the body through the nostrils of the nose

the passage at the back part of the throat between the nasal passage and the larynx

small opening through which air passes on the way to the lungs

flap of skin hinged to the throat which closes the glottis when swallowing takes place

also known as the voice box or Adam's apple, a heavy section of cartilage in the air passageway just below the glottis and above the trachea which contains the vocal cords

two folds of muscular tissue extending across the larynx from front to back which vibrate as air is forced over the opening to produce speech sounds

also known as the wind pipe, a tube held open by horseshoe-shaped bands of cartilage, containing epitheliel cells with tiny hairlike projections to sweep mucus and dust out of the passageway

two tubes into which the trachea divides at its lower end, one tube going to each lung smaller divisions of the bronchi within the lungs

pair of spongy complex organs which branch into tubes of diminishing size, the smallest tubes ending in clusters of tiny globular structures known as aveoli

tiny thin walled air sacs within the lungs which have many capillaries so that the exchange of oxygen and carbon dioxide can take place between the air in the lungs and the blood

two-layered movable membrane surrounding the lungs with the inner part adhering to the lungs and the outer part forming the chest lining

process through which oxygen is taken in and carbon dioxide is expelled

the act of taking in oxygen from the environment and expelling carbon dioxide

process of transporting oxygen to cells within the organism and removing carbon dioxide from cells

process by which oxygen reacts chemically within the cell to produce energy with carbon dioxide and water as waste products the intake or inhaling of air which inflates the lungs and which is caused by the contraction of the diaphragm and of the intercostal muscles controlling rib movement

the exhalation of air out of the lungs which occurs when the muscles relax

muscle found at the base of the lungs which is responsible for 75% of respiratory effort

Respiratory System

nasal passage or cavity
place where air enters the body through the nostrils of the nose

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the passage at the back part of the throat between the nasal passage and the larynx

glottis
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smaller divisions of the bronchi within the lungs

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two-layered movable membrane surrounding the lungs with the inner part adhering to the lungs and the outer part forming the chest lining

respiration
process through which oxygen is taken in and carbon dioxide is expelled

external respiration
the act of taking in oxygen from the environment and expelling carbon dioxide

internal respiration
process of transporting oxygen to cells within the organism and removing carbon dioxide from cells

cellular respiration
process by which oxygen reacts chemically within the cell to produce energy with carbon dioxide and water as waste products

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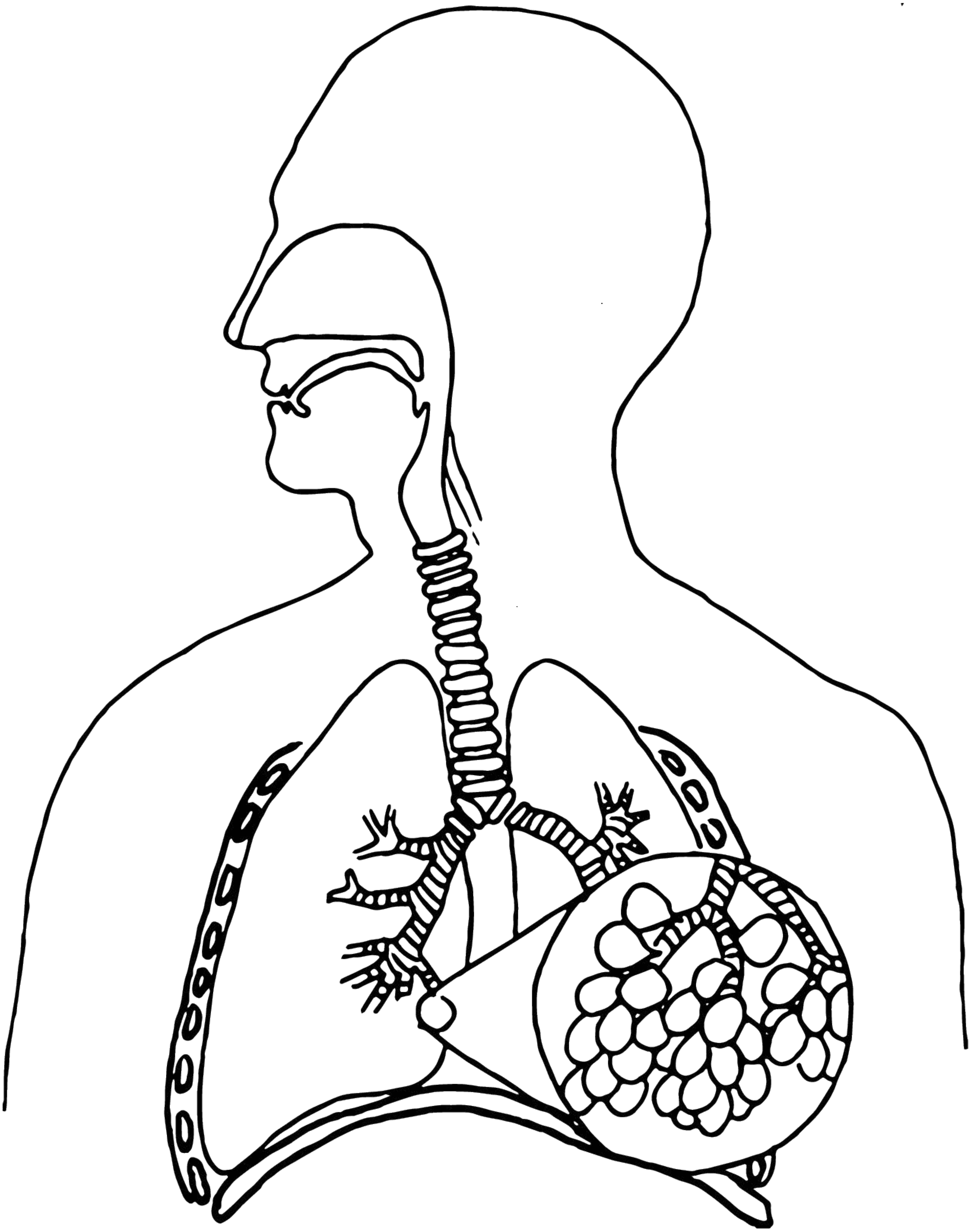
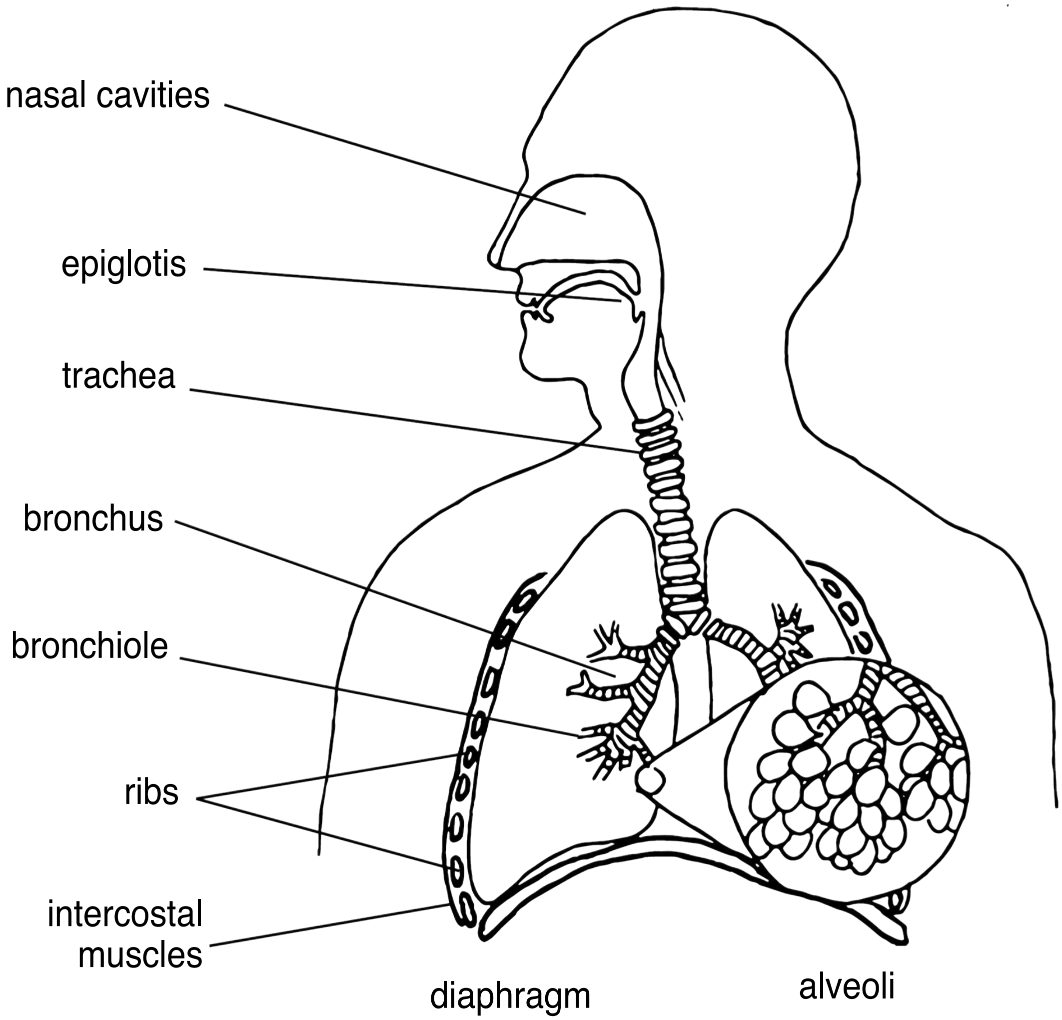
diaphragm
muscle tound at the base of the lungs which is responsible for 75% of respiratory effort





Respiratory System

Urinary System

The body must eliminate waste products formed from all the processes involved in keeping it alive and functioning. The digestive system eliminates wastes from food in the form of feces. The respiratory system eliminates carbon dioxide from breathing. The urinary system eliminates urea, the end product of protein metabolism.

1

The urinary system is composed of two kidneys, two ureters, a bladder and one urethra. The kidneys are about five by two inches in adults and are located in the back below the lowest ribs. The right kidney is slightly lower than the left. The adrenal glands are attached to the upper ends of each kidney.

2

A tough fibrous tissue or capsule covers the outer surface of the kidneys. The cortex lies within the capsule and within the cortex is the medulla which surrounds the pelvis of the kidney. The tubular ureter extends from a funnel-shaped region within the pelvis of the kidney.

3

Each kidney contains millions of tiny filtering units known as nephrons. A nephron consists of a Bowman's capsule which is a cup-shaped structure with a winding tube or tubule emerging from it. This tubule is surrounded by networks of capillaries.

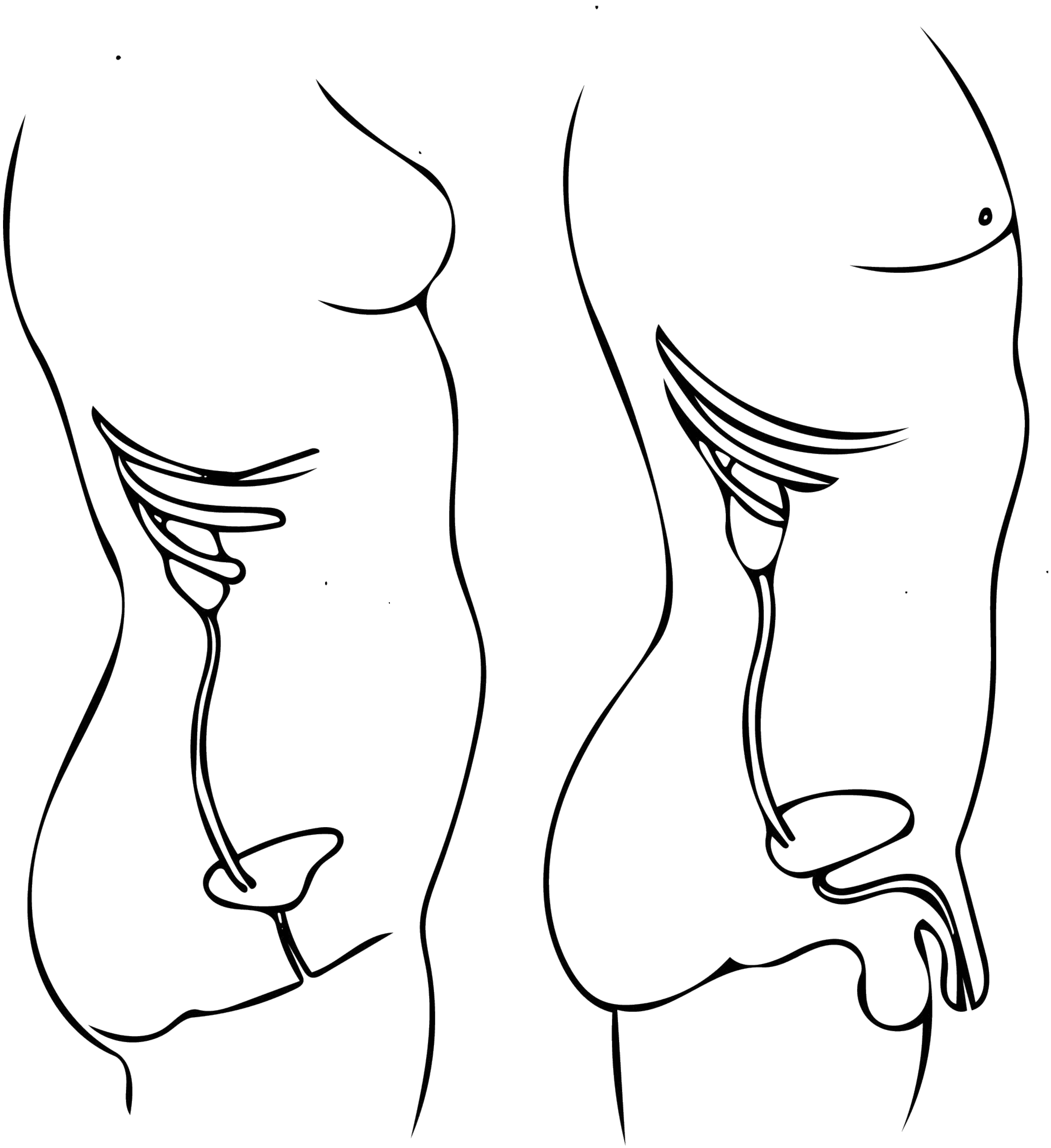
4

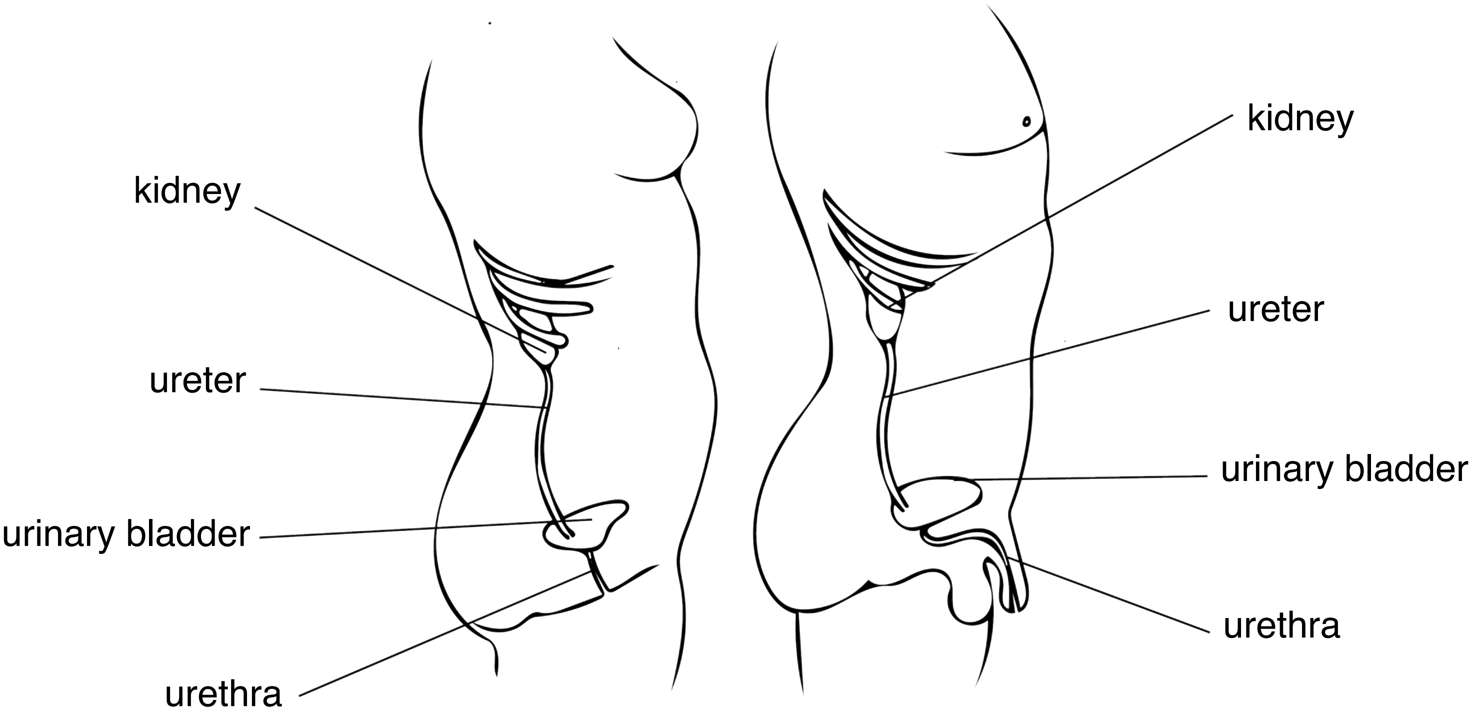
Blood is transported to the kidneys by the renal artery which divides to enter each kidney. There are many very small branches of the arteries each of which ends in a collection of capillaries known as a glomerulus. Each glomerulus is surrounded by a Bowman's capsule. The pressure of blood in the glomerulus forces part of the plasma through the capillary walls into the capsule. Salts, glucose, amino acids, water and urea pass through, but blood cells, platelets and proteins are too large. The liquid flows into the tubule of the nephron where salts, amino acids and water pass through the tubule to the capillaries to be returned to the bloodstream. Filtered blood is transported away by the renal vein.

5

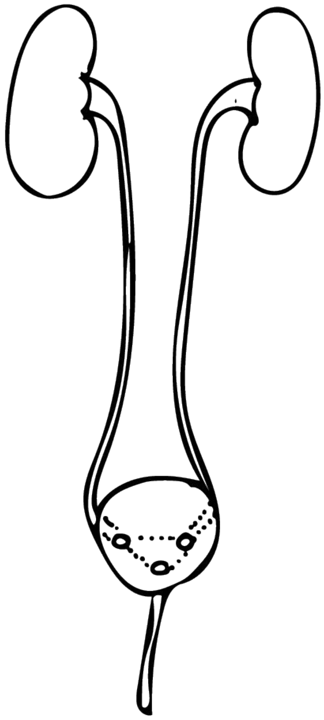
That liquid which remains in the tubule is urine. It flows down the tubule which joins other nephron tubules to form the ureter. The ureter transports urine into the bladder. The bladder is a muscular sac with a capacity of about 12 ounces or 400 cc of urine. A sphincter muscle closes the opening between the bladder and the urethra. When this muscle relaxes, urine flows out of the body.

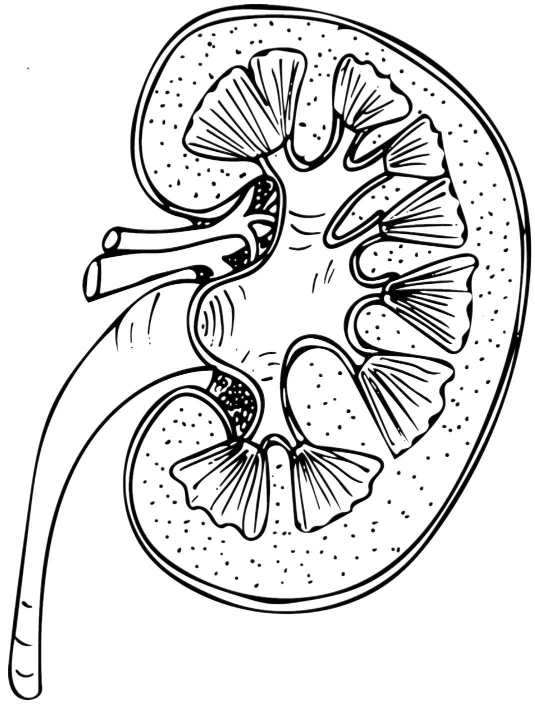
6

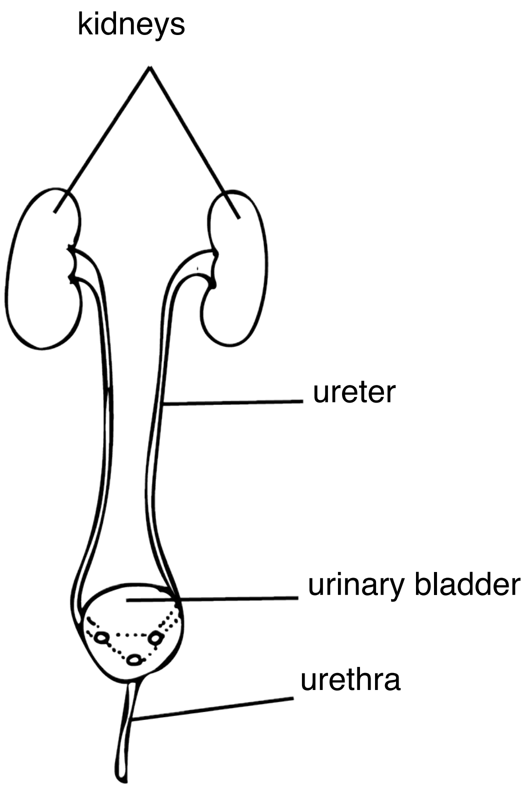


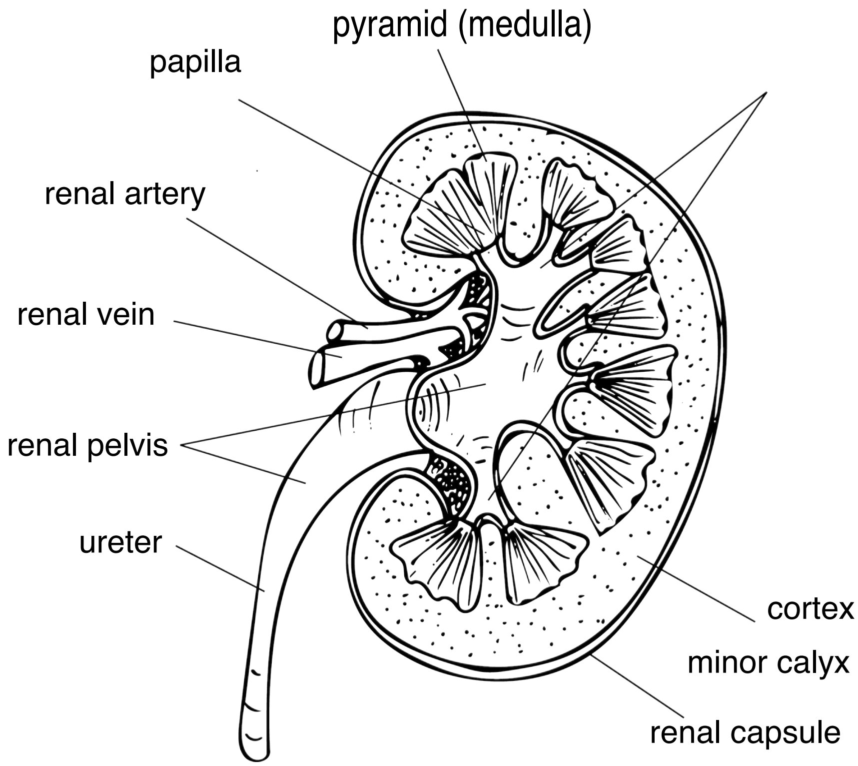


Urinary System









Parts of the Kidney

Endocrine System

Endocrine glands are groups of cells which elaborate or produce chemical substances known as hormones. These are not used by the endocrine gland itself. Endocrine glands have no ducts so their products are distributed to specific organs or tissues through the blood. Either too much or too little of a hormone can cause health problems.

1

Exocrine glands have ducts which discharge the hormones they produce into the digestive tract directly.

2

Pituitary Gland

The pituitary gland is also known as the hypophysis. It is referred to as the "master gland" because it secretes so many different hormones which regulate other endocrine glands.

3

The pituitary gland has two lobes, the anterior and the posterior. It is located above the roof of the mount at the lower part of the brain.

4

The anterior lobe of the pituitary produces several hormones which affect other endocrine glands.

These pituitary hormones are:

1. adrenocorticotropic (ACTH) which regulates growth and function of adrenal glands;
2. thyroid stimulating (TSH)which stimulates thyroxine production in the thyroid gland;
3. gonadotropic which affect hormone production in the sex glands (follicle stimulating, lutenizing, interstitial cell stimulating);
4. growth which.produces abnormally large persons if too abundant or abnormally small persons when insufficient.

5

The posterior lobe of the pituitary produces two hormones which are;

1. anti diuretic (ADH) which regulates the secretion of urine;

2. oxytotic principle which increases uterine contractions.

6

Thyroid Gland

The thyroid gland is located at the front of the neck where the neck joins the body. There are two connected lobes, one on either side of the trachea.

7

The thyroid secretes thyroxine which regulates the body's general metabolism. Too little thyroxine causes cretinism in infancy. This can be relieved by thyroid treatment. Too little thyroxine in adults results in hair loss, mental dullness, low blood pressure and myxedeme or bloating of the face. An
excess of thyroxine causes a high basal metabolic rate, tremor or shaking, tension and exophthalmic goiter, a protrusion of the eyes being a symptom.

8

There are four atoms of iodine in normal thyroxine. If iodine is missing in the diet, the
pituitary gland secretes an excess of thyroid stimulating hormone. This causes goiter, a swelling of the thyroid gland. Adding iodine to the diet
through iodized table salt relieves the condition.

9

Parathyroids

There are two pairs of parathyroids located on the thyroid gland. These secrete parathormone which regulates calcium and potassium metabolism. It is involved in blood clotting.

10

An excess of parathormone causes loss of bone minerals. A deficiency causes tremors, muscle spasms, irritability, deep breathing and increased heart rate. Injections of calcium
gluconate relieve the conditions.

11

Adrenal Glands

An adrenal gland is located on the upper end of each kidney. Each gland is composed of an outer layer, the cortex, and an inner layer, the medulla.

12

The adrenal cortex produces about thirty hormones. These may be grouped into three classes. Those controlling the level of salts of calcium and potassium and chloride balance include the hormone, aldosterone. Another class of hormones affect carbohydrate metabolism. The third class of hormones affect secondary sex characteristics. These include the estrogenic and androgenic substances.

13

The adrenal medulla produces adrenaline or epinephrine in response to impulses from the autonomic nervous system. This hormone is produced under stressful conditions such as fear, anger, hemorrhage and asphyxia. Adrenaline stimulates smooth muscles such as those in the bladder and arterioles. It raises the blood sugar level and increases heart beat.

14

Gonads

The male gonads are the testes located in a scrotal sac at the base of the pubis.

The interstitial cells produce testosterone which causes changes upon sexual maturity: growth of a beard, body hair, development of sex organs, lowering of the voice.

15

The female gonads are the pair of ovaries on either side of the uterus. Eggs grow within small cavities or follicles. Ovarian hormones are produced by the follicles. The principal hormone is estradiol, an estrogen. This affects the secondary sex structures: uterus, breasts and oviducts. The lining of follicles, the corpus luteum, produces progesterone which is involved with pregnancy.

16

Islets of Langerhans

These cells are scattered throughout the pancreas. They produce insulin which regulates the blood sugar level by allowing cells to use glucose and the liver to store glycogen.

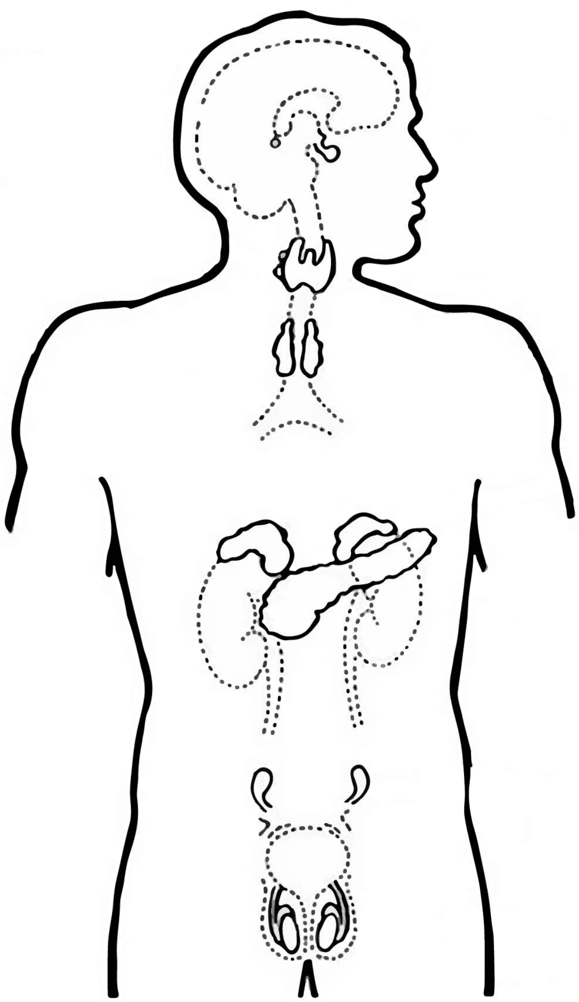
17

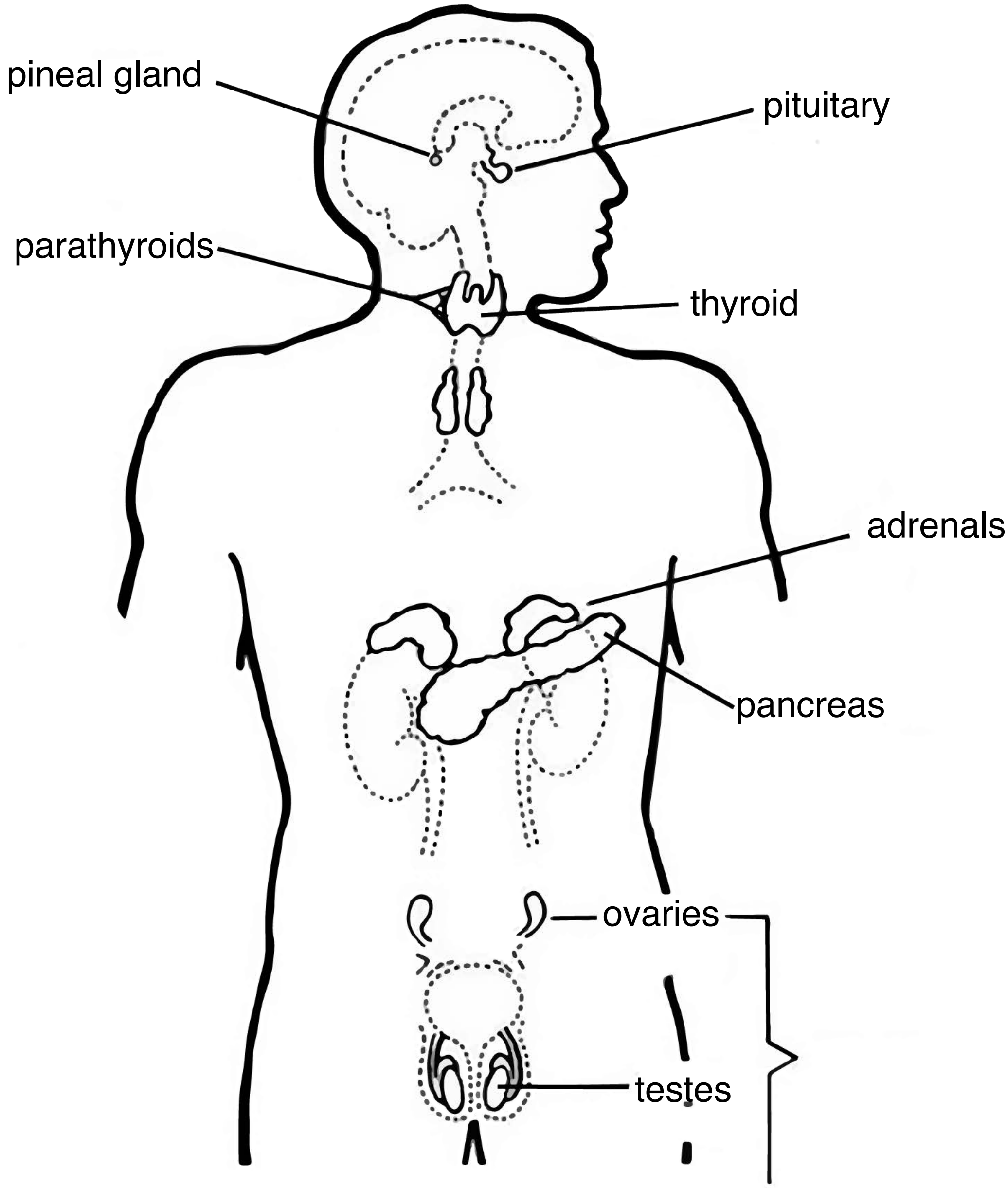
Mucosa

Gastrin is a hormone released by the mucus membrane lining the stomach. It is transported to the gastric glands through the blood stream to stimulate the secretion of gastric juice. Secretin and pancreozymin are hormones secreted by the intestinal lining when acidified food enters the intestine. These are transported through the blood stream to the pancreas which then secretes pancreatic juice necessary for digestion.

18

19





Endocrine System

The Integument

The body is covered by the integument or skin, the largest organ of the body. It varies in thickness and is highly sensitive to touch, heat, cold and pain. Its purpose is to protect the body from the outside environment and to regulate body temperature. The body is kept at a fairly constant temperature by the action of blood vessels, sweat glands and hairs.

1

Sweat glands cool the body through evaporation of sweat on the skin. Nervous reactions also cause sweating, especially in the areas where there are more sweat glands, the underarms and palms of the hands. Blood vessels dilate to cool the body by bringing more blood to the surface, thus releasing heat. Body hairs lie flat so that warm air is not trapped next to the skin.

2

The body is warmed by the narrowing of blood vessels to keep heat in the body. The erector muscles contract, causing the body hairs to stand up and trap the body's warmth between them. Other muscles contract to produce heat by shivering.

3

The epidermis is the exterior layer of the integument. The visible skin is composed of dead cells of the epidermis. These wear off the skin's surface. At the bottom of the epidermis in the malphigian layer, new cells are formed. These move upward, but by the time they reach the surface, they are dead. Dead cells form a relatively strong covering because they contain keratin, a protein.

In the malphigian layer a pigment known as melanin is produced. The more melanin present, the darker the skin. The dark color protects the skin from the harmful rays of the sun. More melanin is produced when the skin is exposed to the sun, causing it to darken.

Beneath the malphigian layer lies the dermis. It contains nerves, hair follicles, blood vessels and glands. There are different nerve receptors for cold, heat, pressure, texture and pain, but there are more receptors for pain.

Beneath the dermis lies a layer of fat known as adipose tissue. This acts as an insulator and stores food. It also forms vitamin D. Females deposit more fat than males. The thickness of adipose varies in different parts of the body.

gland which excretes fluid through a small pore in the skin to regulate temperature by evaporation

layer of connective tissue which contains the sweat and sebaceous glands as well as networks of blood and lymphatic vessels, hair follicles and arrector pili muscles

gland which excretes an oily substance, sebum, to help protect the skin from dehydration

layer of varying thickness located below the dermis, also known as subcutaneous tissue

muscle which is attached to the hair follicle which elevates the hair shft and aids in excretion of sebum

tube through which the hair grows

the multilayered outer portion of skin which varies in thickness

concentrated layers of keratanized, pigmented cells, which grow out beyond the surface of the skin vessel through which blood flows from the heart

nerves which respond to different stimuli such as temperature, pressure, pain

vessel through which blood flows to the heart

projections of connective tissue which extend into the epidermis, nourishing it

vessel through which lymph flows

opening in the surface of the skin through which sebum or sweat is excreted sweat gland

vein

sebaceous gland

lymphatic vessel

arrector pili muscle

pore

epidermis

sensory receptor

dermis

papaillae

superficial fascia

hair follicle

hair

artery

sweat gland
gland which excretes fluid through a small pore in the skin to regulate temperature by evaporation

dermis
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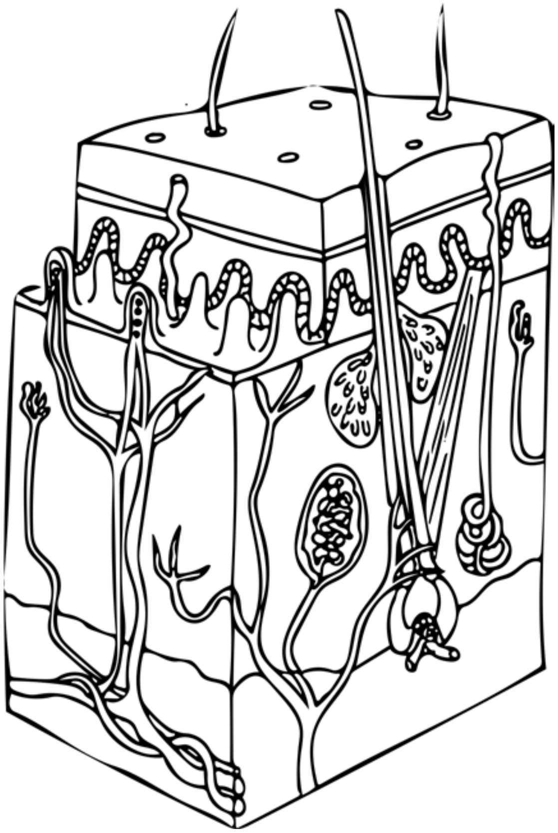
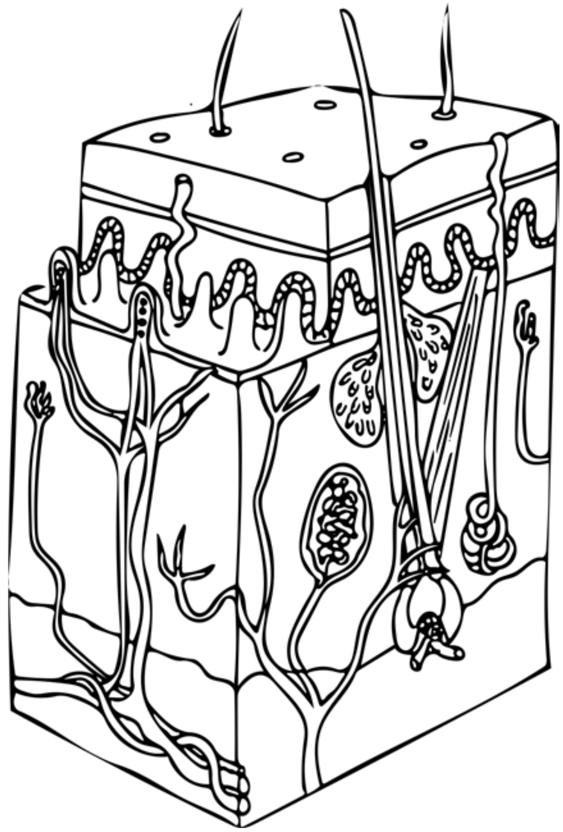
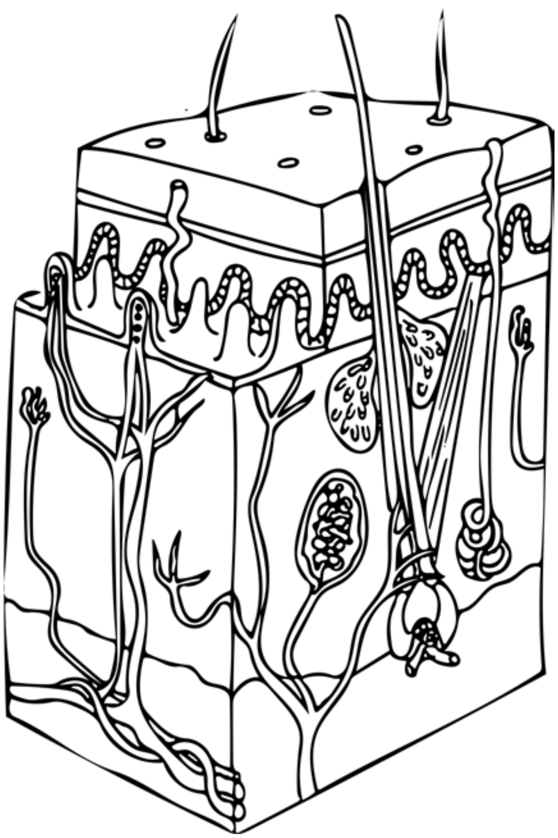
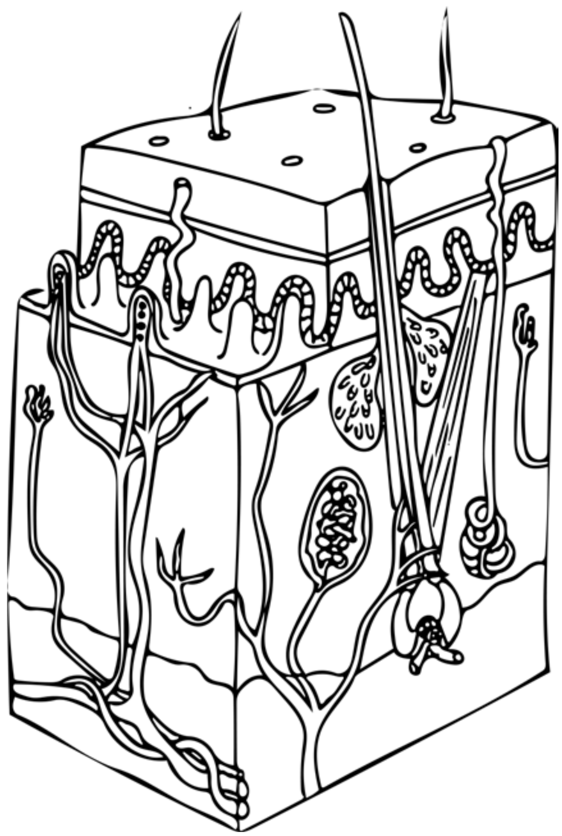
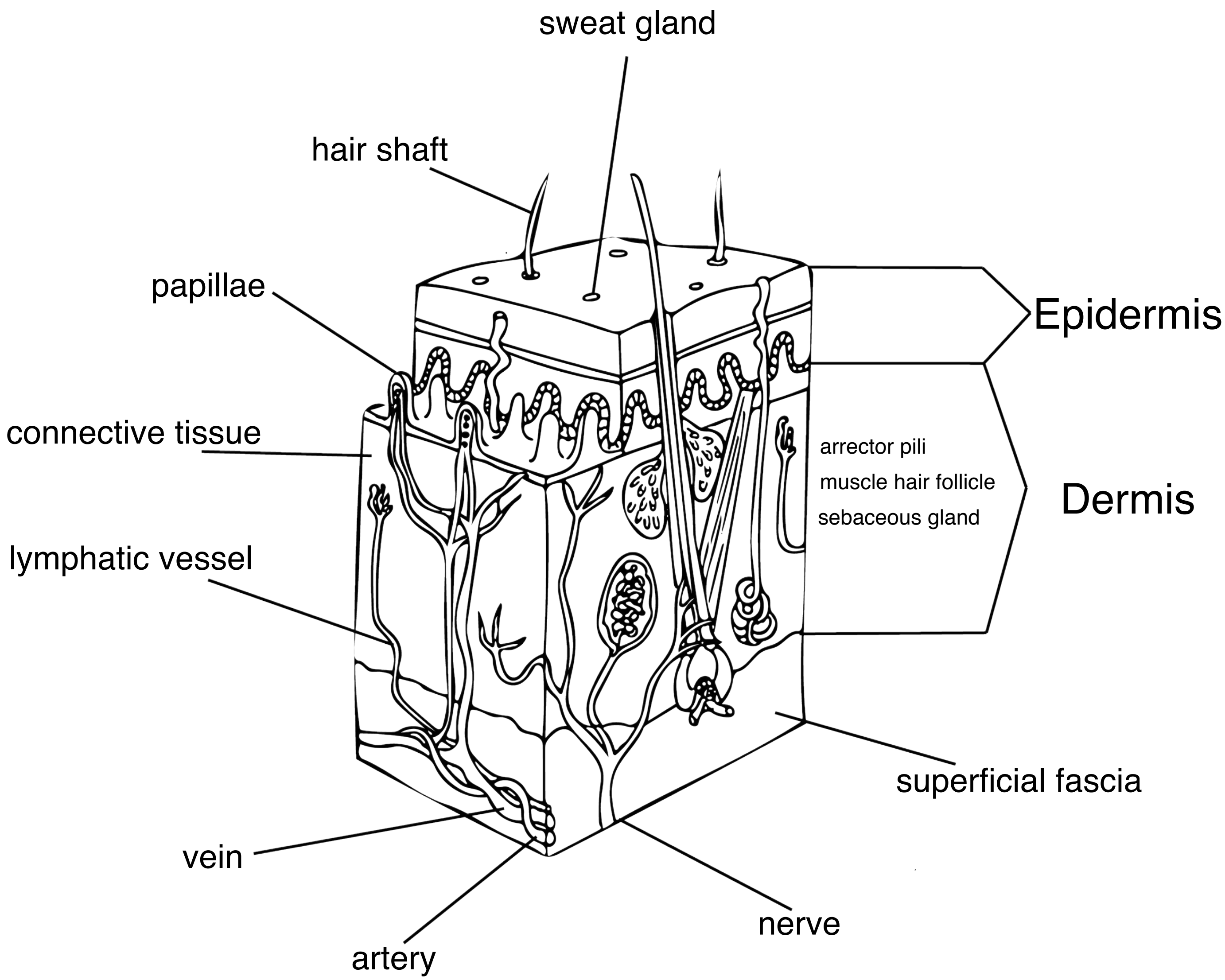









sweat gland
hair shaft
papillae
connective tissue
lymphatic vessel
vein
artery
nerve
superficial fascia
Epidermis
Dermis
arrector pili
muscle hair follicle
sebaceous gland

Female Reproductive System

The primary organs of the female reproductive system are the two ovaries, about the size of walnuts. The ovaries' egg-producing tissue lie near the surface. As egg cells mature, they enlarge and crowd into the interior of the ovary. The follicles in which the eggs are enveloped produce hormones known as estrogens.

1

When the follicle matures, it ruptures and sends the egg into an oviduct. Beginning with the process of meiosis, final maturation takes place after the egg is released from the ovary. If the egg is fertilized in the oviduct, it moves into the uterus.

2

The uterus is a sac with heavy walls of smooth muscle. It is lined with mucous membrane and has a good supply of blood vessels. The hormone progesterone causes the uterine lining to thicken and become abundantly supplied with blood. When the fertilized egg contacts the wall, it embeds itself by a process known as implantation. It becomes enclosed by a transparent membrane, the amnion, filled with amniotic fluid.

3

As the embryo becomes larger, blood sinuses develop in the placenta. Root like projections or villi are sent by the embryo into the blood sinuses of the placenta to absorb nourishment and oxygen and to release embryonic waste. The embryo is connected with the uterus by the umbilical cord through which blood vessels pass. The embryo forms its own blood.

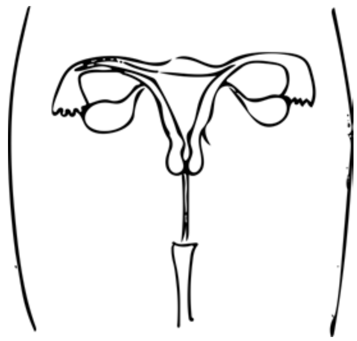
4

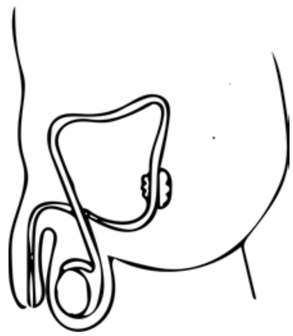
The period of gestation for humans is nine months, the time from conception to birth. When the amnion ruptures, amniotic fluid is released. The smooth muscle of the uterine wall begins waves of contractions, forcing the baby toward the cervix, the neck of the uterus. It then moves into the vagina and birth occurs. The placenta and fetal membranes are expelled as the "after birth". The umbilical cord is severed, stopping the supply of oxygen.

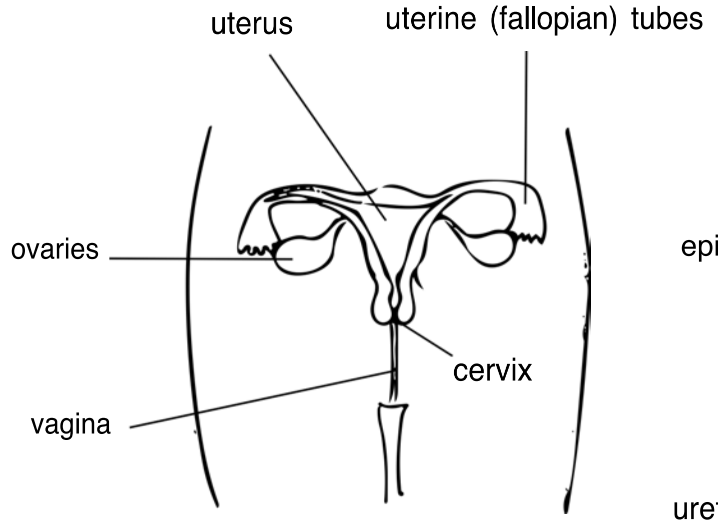
5

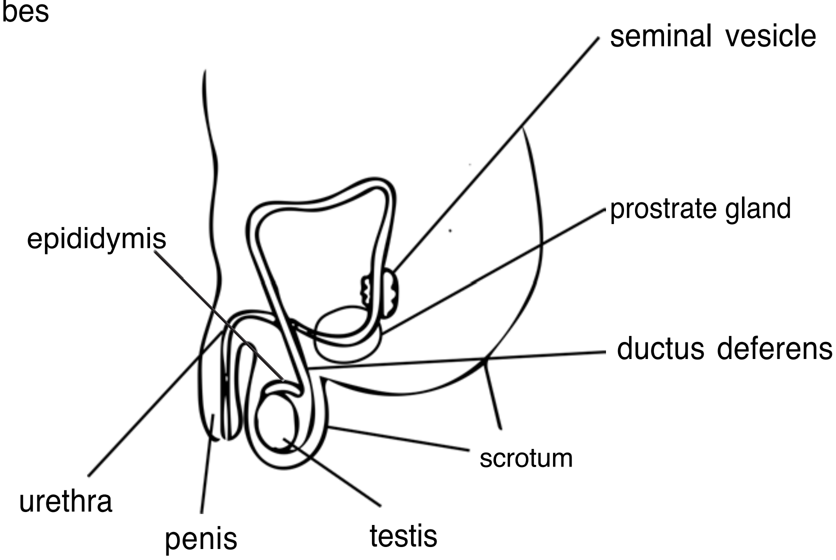
Carbon dioxide concentration in the newborn baby causes the breathing center in the brain to activate breathing reflexes. Hormones have enlarged the mother's mammary glands and the flow of milk begins soon after birth.

6









Reproductive System

Male Reproductive System

The primary organs of the male reproductive system are the two testes. These are suspended externally within the scrotum, a sac of skin.

1

Each testis is ovoid in shape. There is an outer capsule of connective tissue. Inside this capsule interstitial cells secrete testosterone, the male hormone. There are many small spaces filled with tiny tubules. These contain reproductive tissue where the cells first divide by mitosis then undergo meiosis to form sperm. These cells contain only half the normal number of chromosomes. Sperm are composed of a very small cell body which is mostly nucleus from which a long filament protrudes. This moves about to give mobility to the sperm.

2

The testicular tubules come together to form groups of sperm ducts. Sperm are stored in coiled tubes, the epididymus, on the outer side of the testis. A tube from each epididymus passes into the lower abdomen over the urinary bladder. Here they are joined by ducts from the seminal vesicles and the prostate gland to enter the urethra.

Fluids from the seminal vesicles and the prostate gland mix with sperm to form semen. Each milliliter of semen contains sixty million sperm cells.

3

Some sperm enter the uterus and a few pass into the oviducts. If a mature egg is present in an oviduct, it may be fertilized. Only one sperm unites with one egg.

4

Urinary System

papilla

kidney

minor calyx

kidneys

major calyx

ureter

renal pelvis

urinary bladder

ureter

urethra

renal artery

Parts of the Kidney

renal vein

renal capsule

Lymphatic System

cortex

spleen

pyramid (medulla)

tonsils

adenoids

Parts of the Bone

thymus

epiphysis (end)

Endocrine System

epiphyseal line

pituitary

diaphysis (shaft}

thyroid

articular cartilage

parathyroids

periosteum

adrenals

cancellous (spongy) bone

pancreas

compact bone

ovaries

medullary cavity

testes

nutrient artery

red marrow

Digestive System

mouth

salivary glands

esophagus

stomach

small intestine

liver

pancreas

gall bladder

duodenum

jejunum

ileum

large instestine

appendix

colon

anal canal

Reproductive System

uterine (fallopian) tubes

scrotum

uterus

testis

vagina

epididymis

cervix

ductus deferens

Central Nervous System

seminal vesicle

cerebrum

prostrate gland

brain stem

urethra

cerebellum

penis

spinal cord

ovaries

Peripheral Nervous System

cranial nerves

nucleus

spinal nerves

nucleolus

Parts of the Brain

cytoplasm

occipital lobe

nissl bodies

temporal lobe

myelin

prefrontal lobe

neurilemma

frontal lobe

node of Ranvier

parietal lobe

nucleus of Schwann cell

Nerve Cell

dendrite

cell body

axon

Types of Neurons

sensory neuron

somatic motor neuron

autonomic motor neuron

association neuron