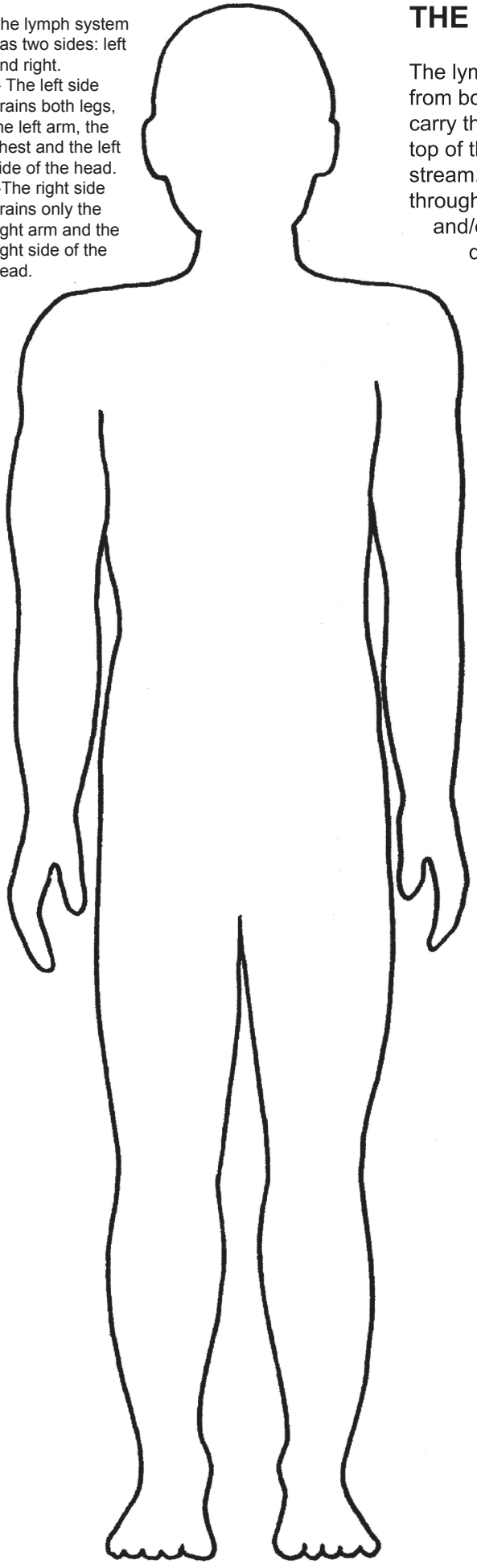
THE LYMPHATIC SYSTEM

The lymph system has two sides: left and right.
-- The left side drains both legs, the left arm, the chest and the left side of the head.
--The right side drains only the right arm and the right side of the head.



The lymph system is made of a network of vessels that drain extra fluid from body tissues (the interstitial spaces between cells) into vessels that carry the fluid through lymph nodes and then up (against gravity!) to the top of the rib cage where lymph vessels dump the fluid back into the blood-stream. As the fluid makes its way up through the lymph vessels, it passes through lymph nodes where lymphocytes and macrophages can recognize and/or destroy any pathogens in the fluid. Also, macrophages and dendritic cells from the tissues can intentionally hop into the lymph vessels and drift to the nearest nodes so that they can present their antigens to T cells.

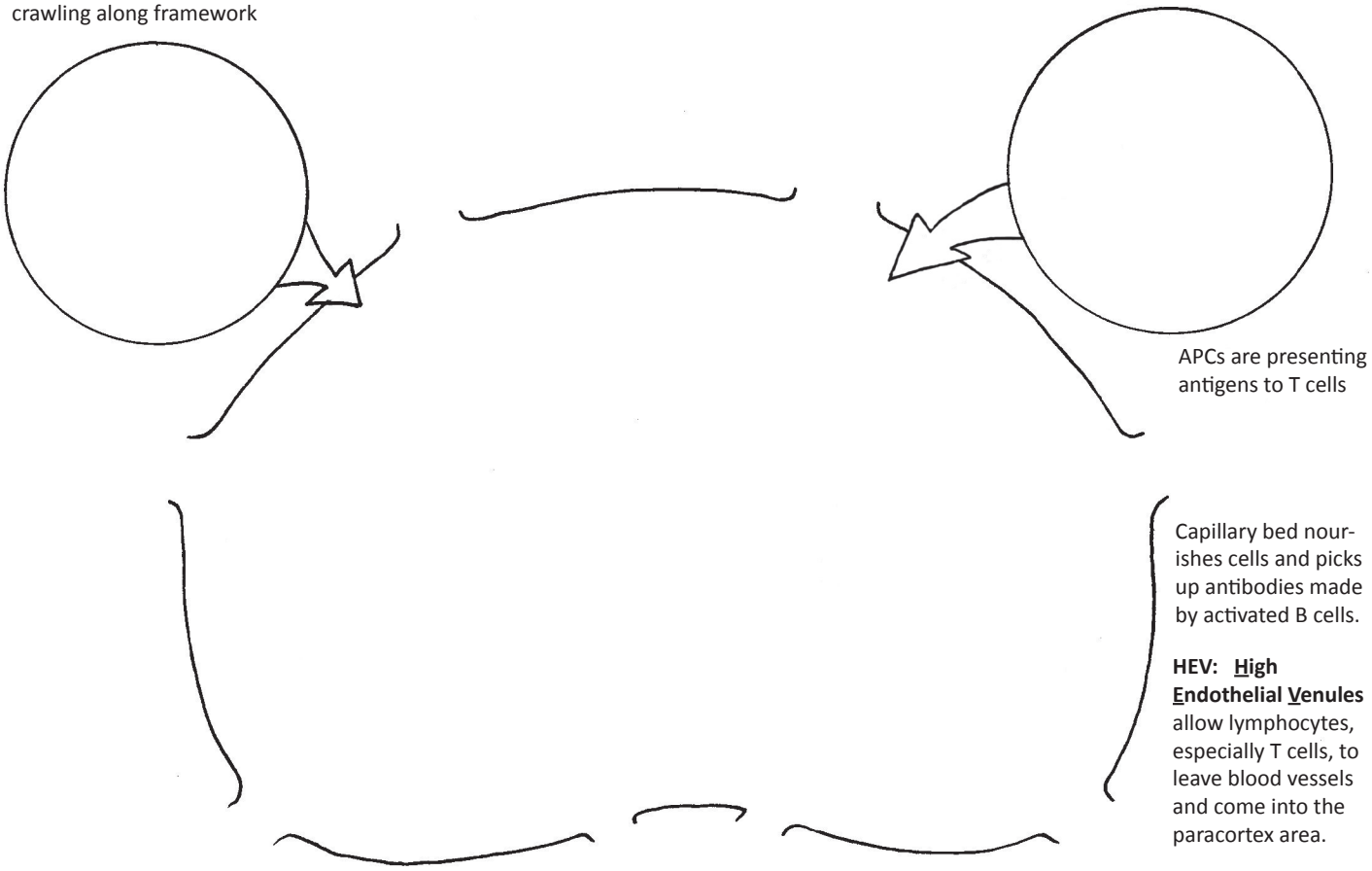
Lymph vessels have one-way valves so that the fluid can't go backwards. The fluid is pushed along through the vessels simply by the motion of our muscles as we go about our daily routines.

LYMPH NODES and the SPLEEN

LYMPH NODE

Reticular fibers with macrophages and dendritic cells crawling along framework

Naive B cells (can be activated by T cells and turn into plasma cells)



APCs are presenting antigens to T cells

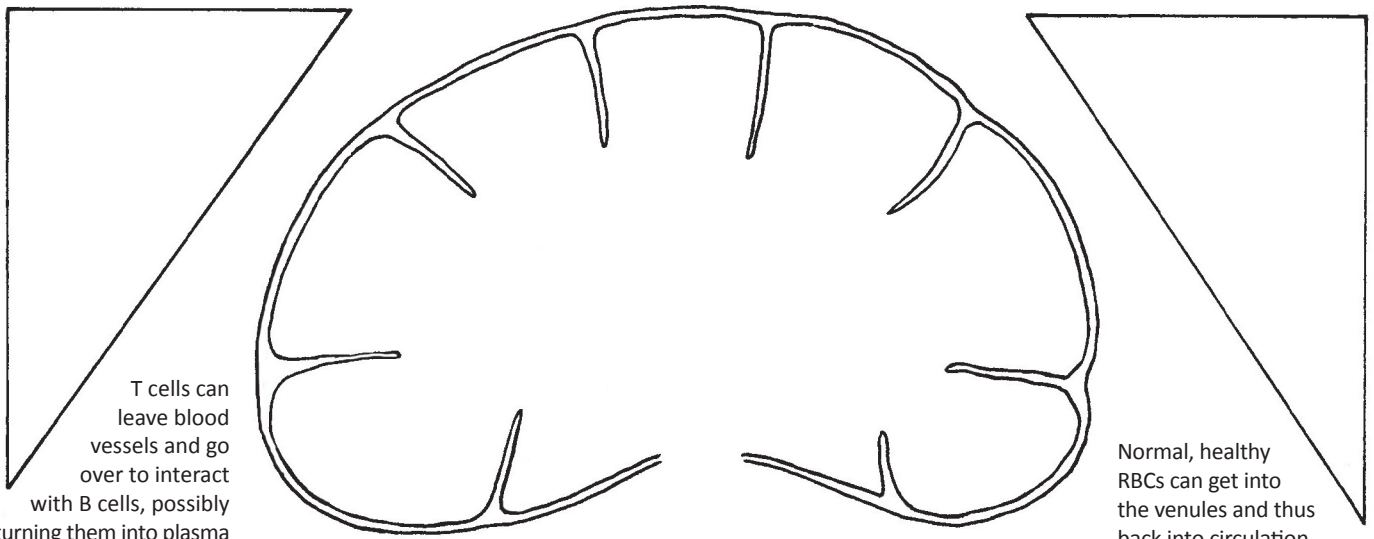
Capillary bed nourishes cells and picks up antibodies made by activated B cells.

HEV: <u>H</u>igh <u>E</u>ndothelial <u>V</u>enules allow lymphocytes, especially T cells, to leave blood vessels and come into the paracortex area.

SPLEEN

WHITE PULP

RED PULP



T cells can leave blood vessels and go over to interact with B cells, possibly turning them into plasma cells. Both macrophages and B cells present antigens to T cells.

White pulp has follicles filled with B cells.

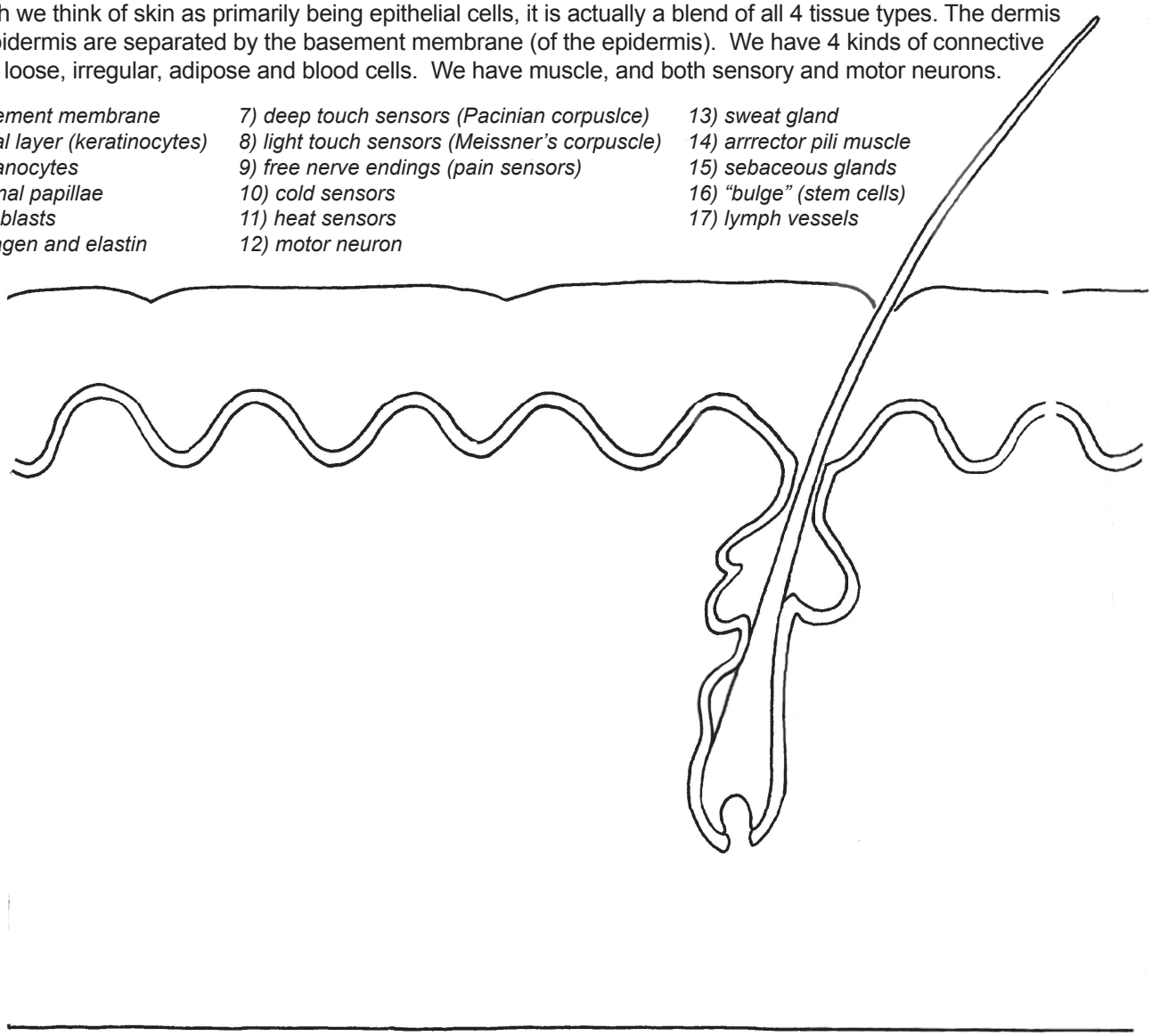
Red pulp also acts as reservoir for extra RBCs. In case of emergency, the spleen can release many RBCs.

Normal, healthy RBCs can get into the venules and thus back into circulation. Deformed or diseased RBCs cannot. Abnormal RBCs are eaten by macrophages.

SKIN

Though we think of skin as primarily being epithelial cells, it is actually a blend of all 4 tissue types. The dermis and epidermis are separated by the basement membrane (of the epidermis). We have 4 kinds of connective tissue: loose, irregular, adipose and blood cells. We have muscle, and both sensory and motor neurons.

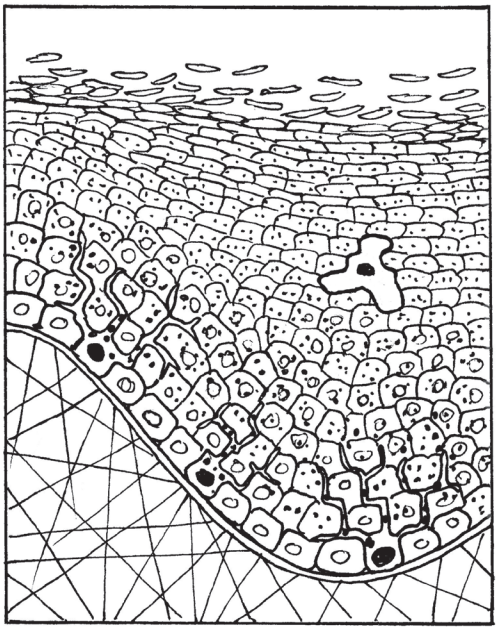
1) basement membrane
2) basal layer (keratinocytes)
3) melanocytes
4) dermal papillae
5) fibroblasts
6) collagen and elastin
7) deep touch sensors (Pacinian corpuslce)
8) light touch sensors (Meissner's corpuscle)
9) free nerve endings (pain sensors)
10) cold sensors
11) heat sensors
12) motor neuron
13) sweat gland
14) arrrector pili muscle
15) sebaceous glands
16) "bulge" (stem cells)
17) lymph vessels



THE EPIDERMIS is made of mostly **keratinocytes**. The keratinocytes in the basal layer are the only ones that go through mitosis. As they divide, the new cells go upwards. As the cells mature, they begin producing a lot of a waxy protein called **keratin** and they also begin to lose their organelles.
By the time they reach the top, they have lost everything, even their nucleus. They are dead cells filled with keratin. We have these dead cells flaking off our skin all the time.

FIBROBLASTS

COLLAGEN AND ELASTIN



Top layer of dead cells is called the **STRATUM CORNEUM**

KERATINOCYTES: all cells except melanocytes and Langerhans cells

LANGERHANS cells are a type of macrophage and are the only immune cells in the epidermis.

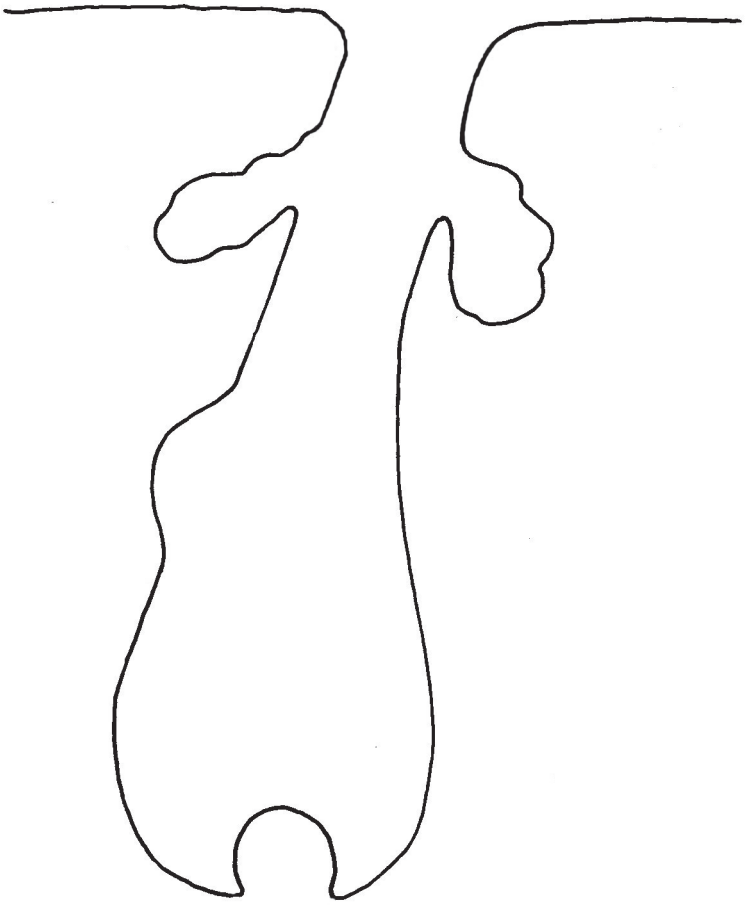
MELANOCYTES produced the pigment **melanin**. Melanin is brown or red (usually brown). Dark skin has more melanin than light skin. Melanocytes release the melanin in little vesicles and these vesicles are taken in by keratinocytes.

BASAL LAYER (of keratinocytes)

BASEMENT MEMBRANE

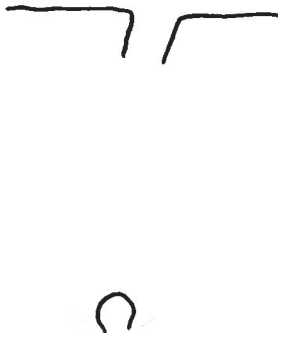
HAIR and NAILS

Hair and nails are part of skin and grow in much the same way. However, unlike skin, the keratinocytes in hair and nails don't produce destructive enzymes that cut the bonds bewteen the cells. The cells stay firmly connected.

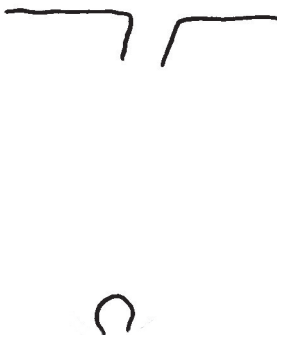


HAIR GROWTH CYCLE

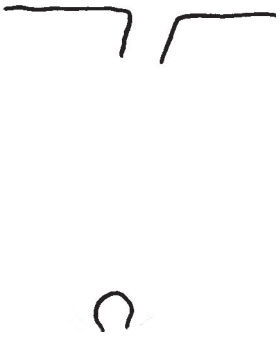
1) ANAGEN: active growth



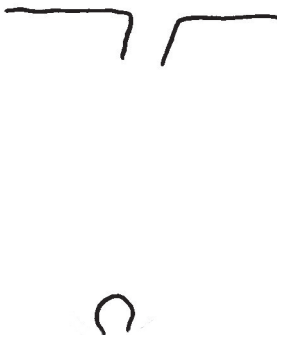
2) CATAGEN: growth slows



3) TELOGEN: resting, shrinks and disconnects from papilla



1) back to ANAGEN: stem cells begin a new hair



CROSS SECTIONS showing shapes of hair shaft:

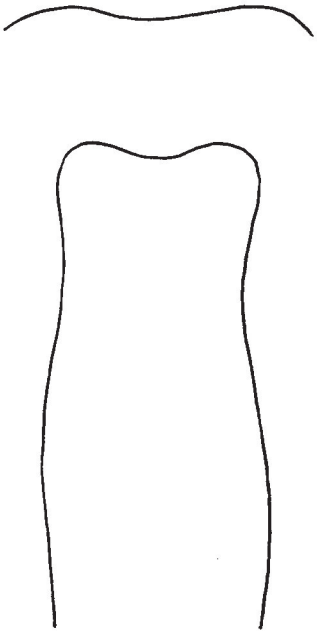
NAILS

TOP VIEW:

SIDE VIEW CROSS SECTION:

TEETH and TONGUE

Most of a tooth lies below the surface. Teeth have deep roots that go down into the bone. The white enamel is the hardest substance in the body and is non-living. The inner pulp is alive.



Enamel was made by ameloblasts, which disappear once they have done their job.

Odontolbasts made the dentin and are still there on the inside of the dentin, next to the pulp.

periodontal membrane

Cementum is secreted by cementoblasts. It is 50% collagen, and 50% minerals such as calcium, phosphorus, and fluorine. Unlike enamel and dentin, cementum is made throughout our lifetime.

The tongue is much larger than it appears. We see the body of the tonuge, but the large "root" is below the surface. The tongue is made of many muscles, and it connects to many others.

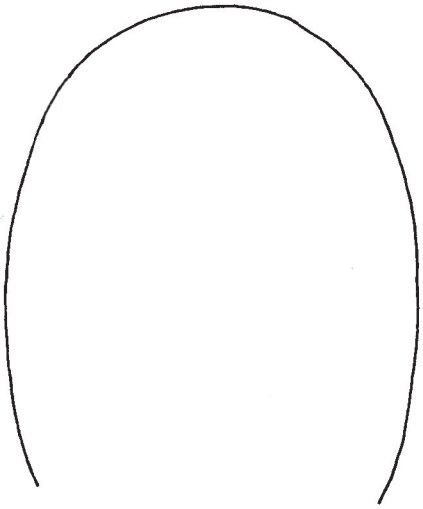
Four types of lingual papillae:

1) circumvallate
We only have 8-12 of these.

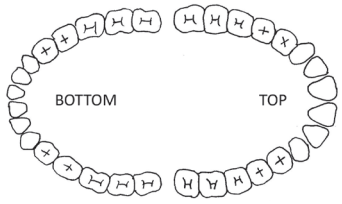
2) foliate
Located along the back sides.

3) filiform
These are most numerous and we have thousands.

4) fungiform
We have 200-300 located mainly near tip and sides.

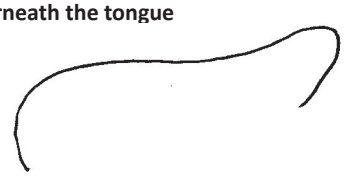


Those tongue maps are no longer valid. Current research shows that all areas of the tongue can taste sweet, sour, salty, bitter and umami (savory).



<u>Types of teeth</u>:
Incisors
Cuspids ("canines")
Bicuspids
Molars

Underneath the tongue

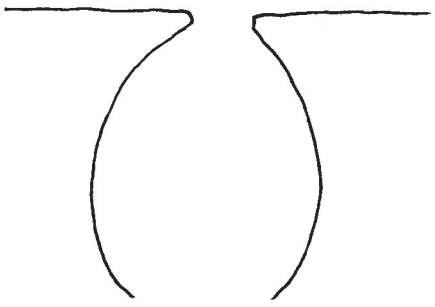


PAPILLAE

The bumps you see on your tongue are papillae, not taste buds. Taste buds are microscopic. The filiform papillae do not have taste buds. They simply provide friction and sensation.
(Animal tongues (notably cats) often have very large and long papillae, making their tongues feel rough.)

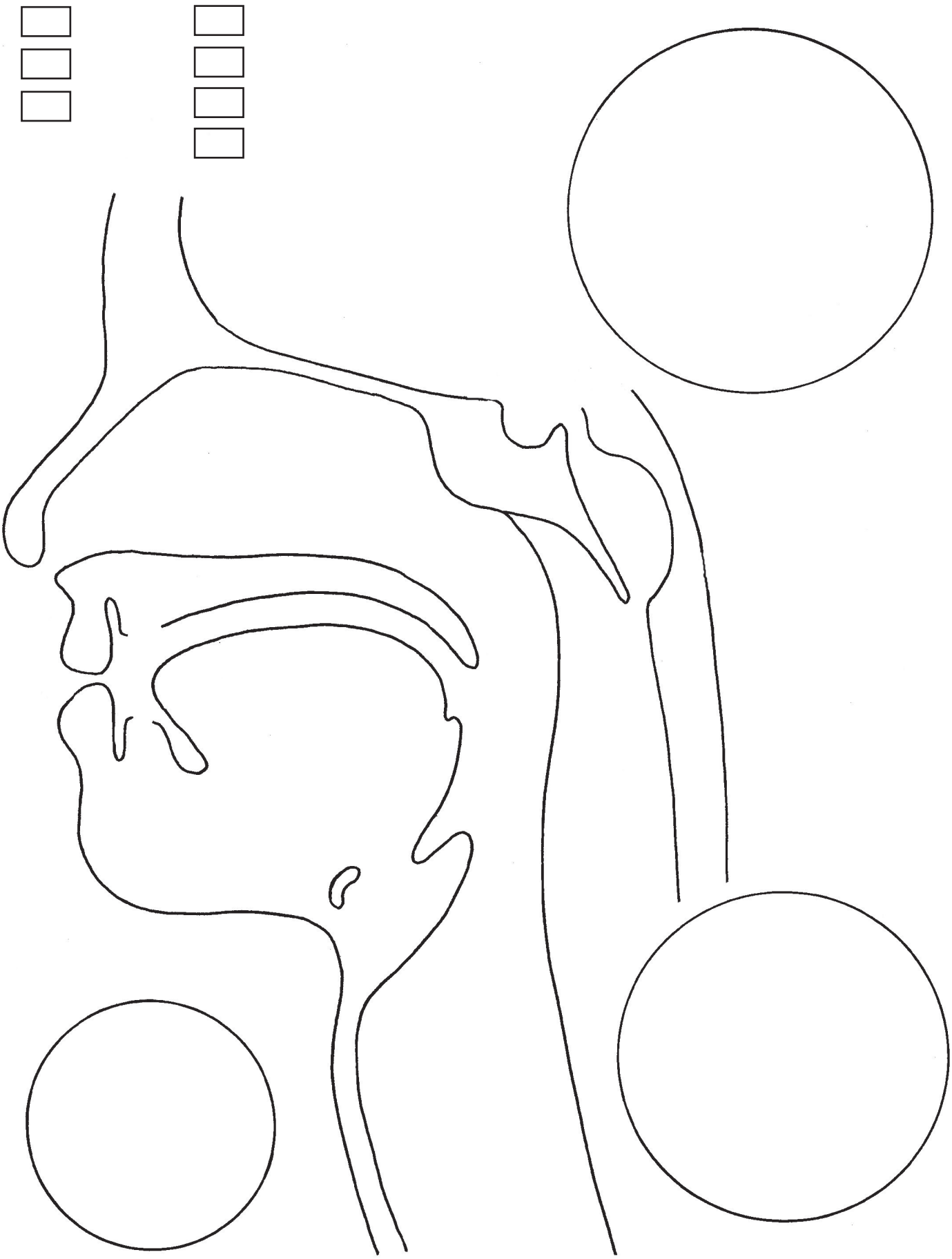
TASTEBUDS

Taste receptors in taste buds are similar to smell receptors in the nose. Both are triggered by chemicals. The cells start an action potential in the nearby neurons, which travels to the brain where it is interpreted as an odor.

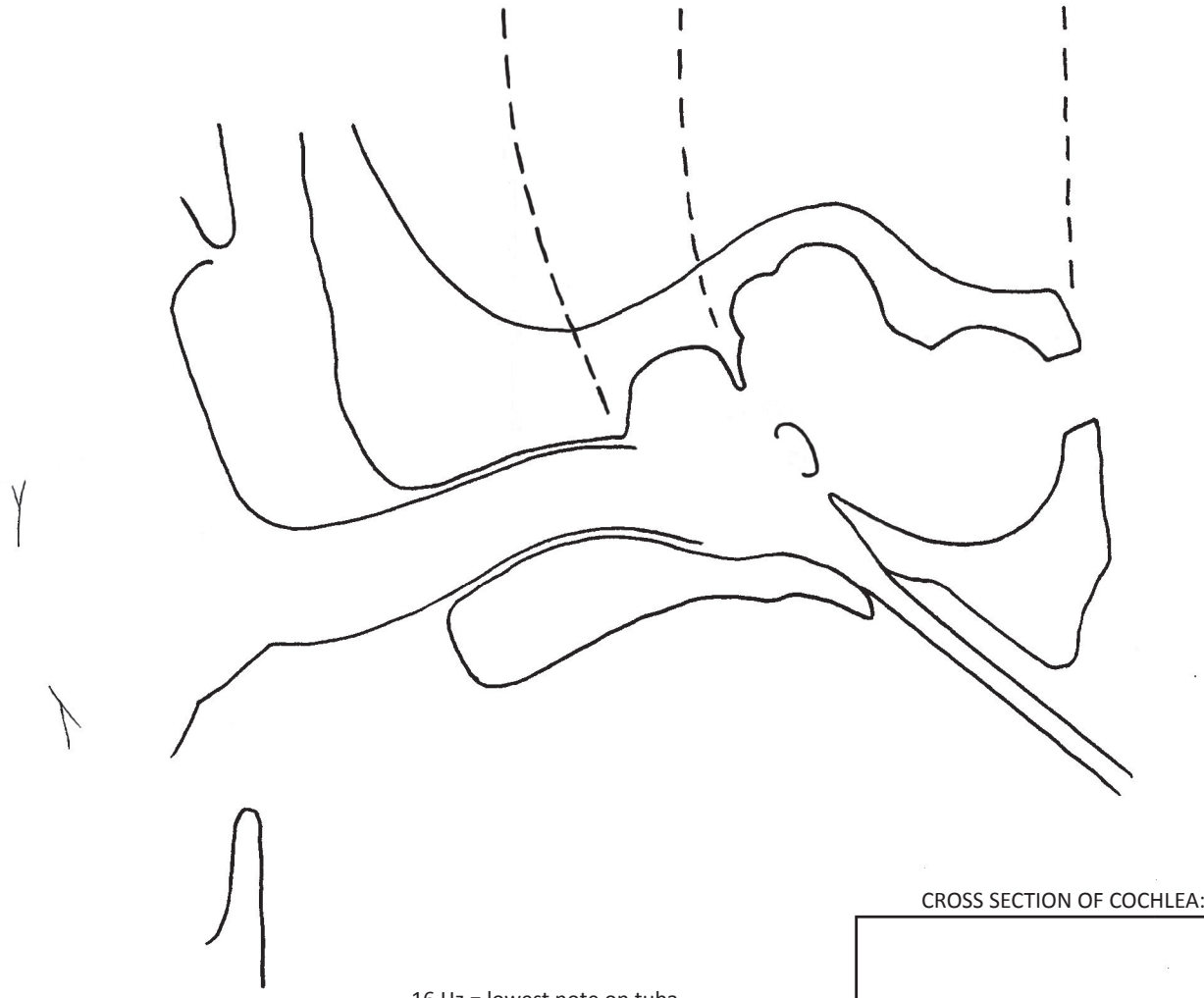


Taste buds can only sense sweet, sour, bitter, salty and umami (savory). Most of taste involves smell.

MOUTH, NOSE and THROAT



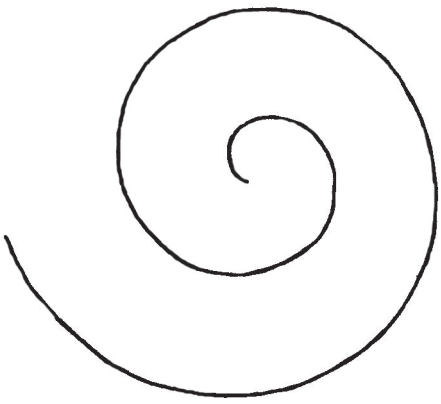
THE EAR



CROSS SECTION OF COCHLEA:

16 Hz = lowest note on tuba
65 Hz = lowest note on cello
261 Hz = "middle C"
440 Hz = "A" for tuning orchestra
4186 Hz = highest note on piano
1,000-8,000 Hz - bird songs

SENSITIVITY AREAS OF THE COCHLEA:



ORGAN OF CORTI:

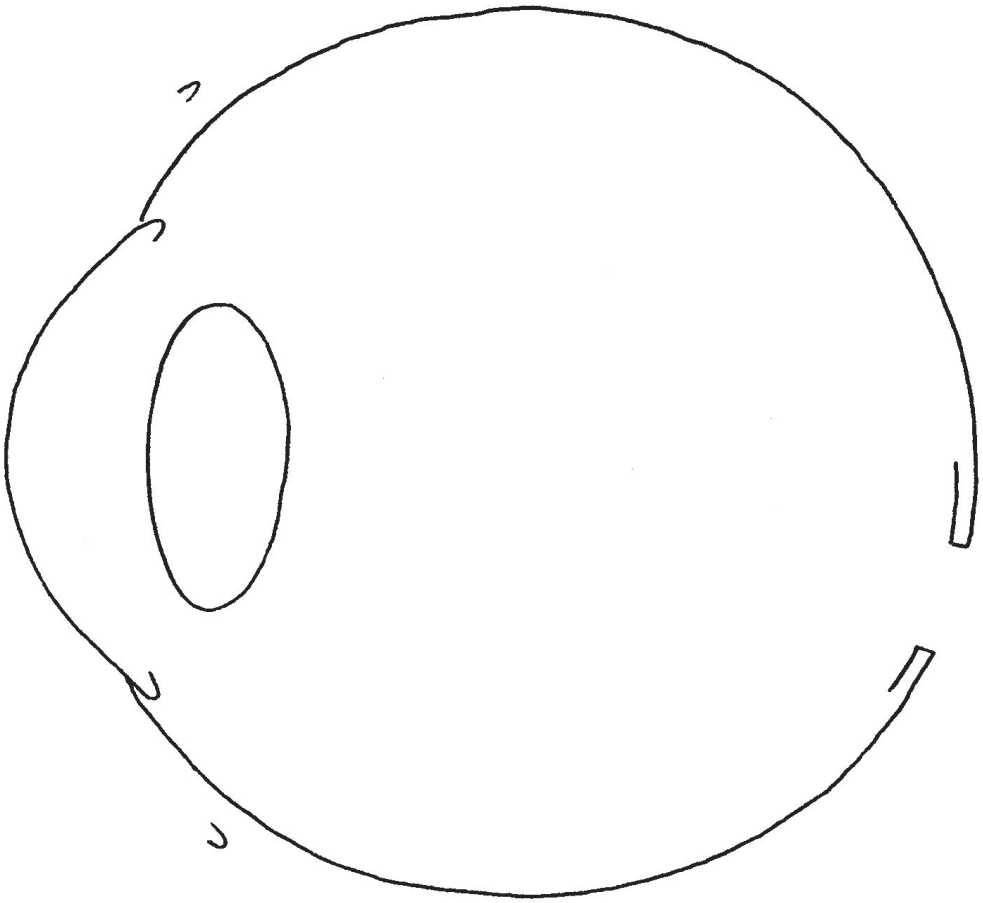
SOUND WAVES:

Long waves sound low.

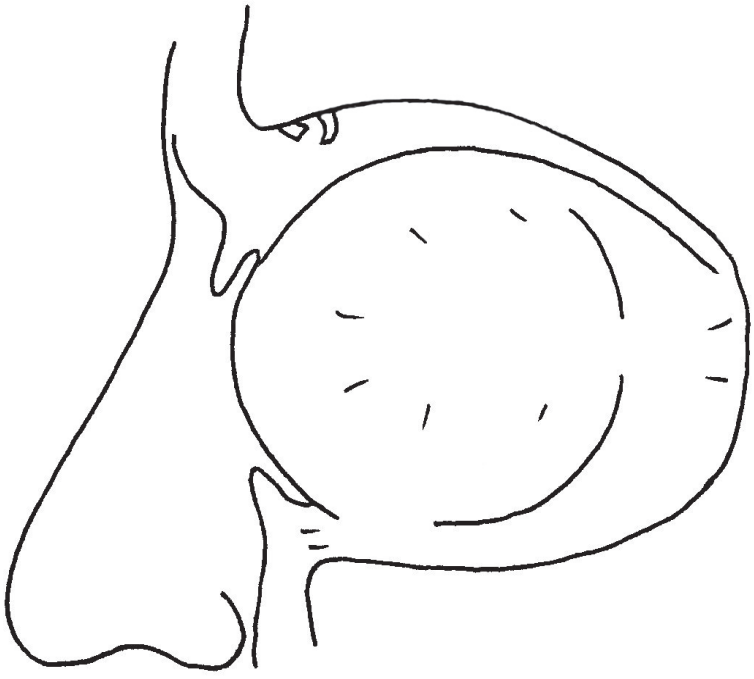
Short waves sound high.

THE EYE (anatomy)

REAR VIEW of ciliary body:

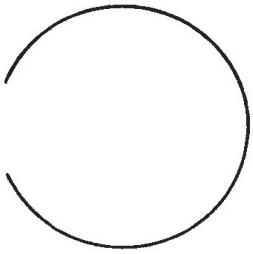


EYE MUSCLES (left eye shown)

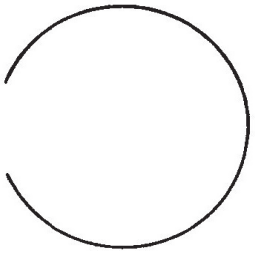


THE EYE (physiology)

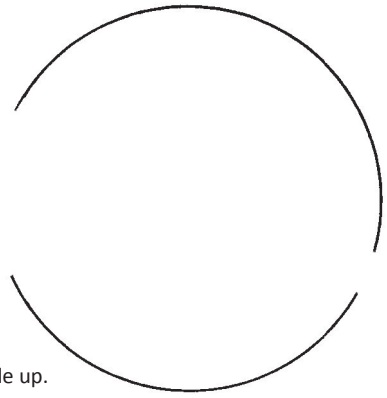
How does the eye focus? The ciliary body controls the shape of the lens.



To focus on distant objects, the ciliary body relaxes, causing the zonlues to tighten, making the lens become more flat.

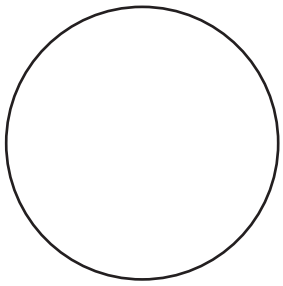


To focus on objects that are close, the ciliary body tightens, causing the lens to become more round.



The image hits the retina upside down.
The brain must learn to see the image right side up.

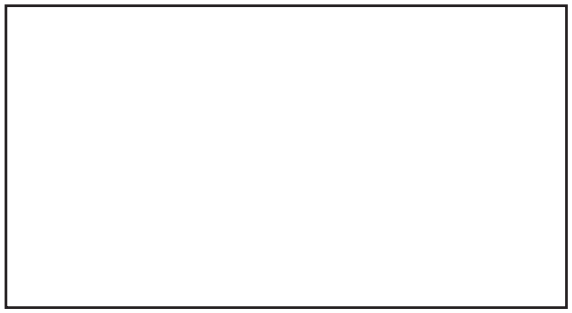
THE RETINA (front view):

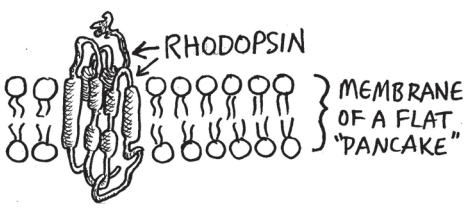


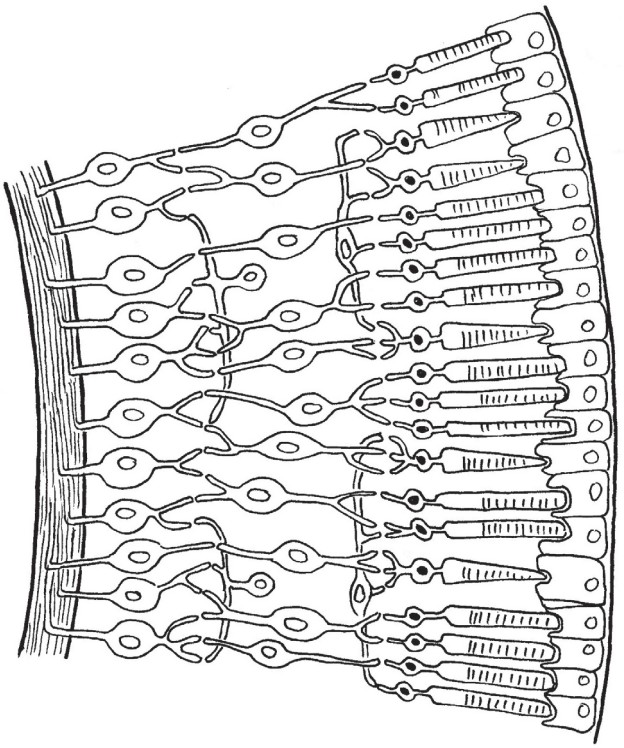
HOW THE RETINA WORKS

Rods and cones are backwards from other receptor cells. They are turned on all the time, constantly releasing neurotransmitters. Light actually turns off rods and cones, and prevents them from being active. It is when they stop "firing" that a signal is sent to the bipolar cells.

The mechanism that starts the turning-off process is a pigment molecule called **rhodopsin**. Rhodopsin is found in the phospholipid membranes in the "pancakes" (discs) in the ends of the rods and cones. It holds a smaller molecule called **retinal**. When light hits retinal, its shape changes and this starts a chemical cascade that results in sodium ions rushing into the cell. The influx of sodium stops the cell from releasing its inhibitory neuro-transmitters. The bipolar cells are then activated.







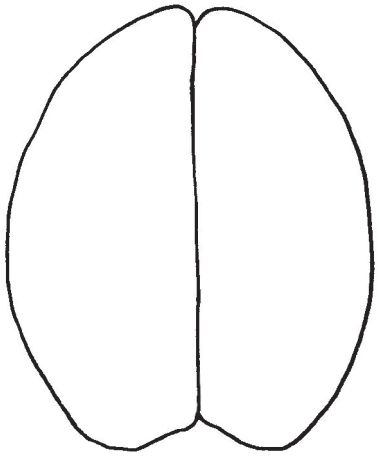
RODS: Cannot sense color, only light/dark. Function in low light conditions.
CONES: Sense one of these: red, green blue. Need lots of light to function.

The fovea has about 150,000 cones per mm^2. Other parts of the retina might have 10,000 or fewer cones per mm^2.

BRAIN (part 1)

The brain is extremely complicated. All these drawings and labels have been simplified. If you want more detailed information, the Internet can provide plenty. (There are dozens of small parts and connecting pieces with long Latin names.)

TOP VIEW

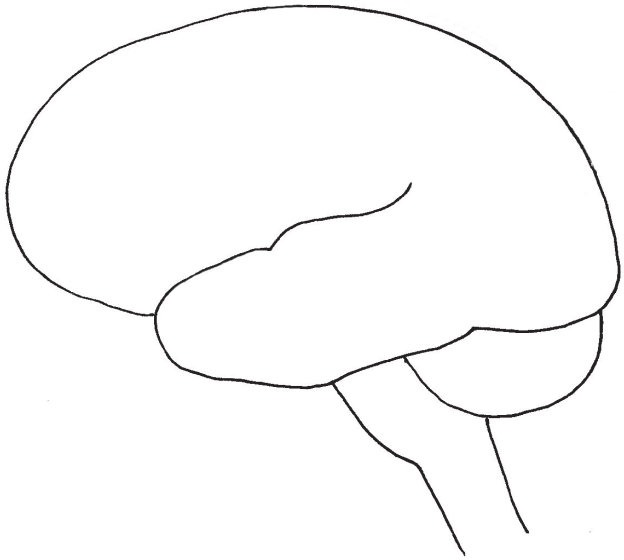


The **LEFT** hemisphere controls the right side of the body.

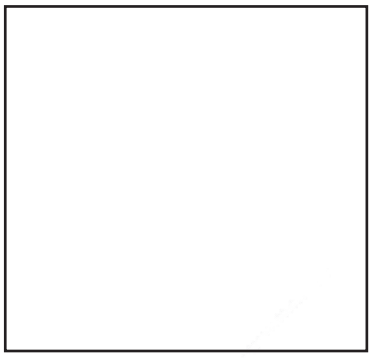
The **RIGHT** hemisphere controls the left side of the body.

SIDE VIEW

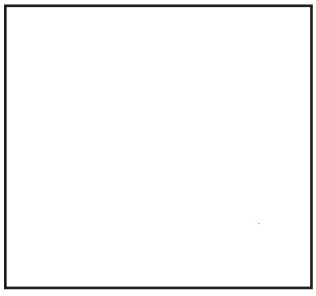
The purpose of wrinkles is to provide more surface area. The surface is where all the neuron cell bodies are and where most of our "thinking" takes place.



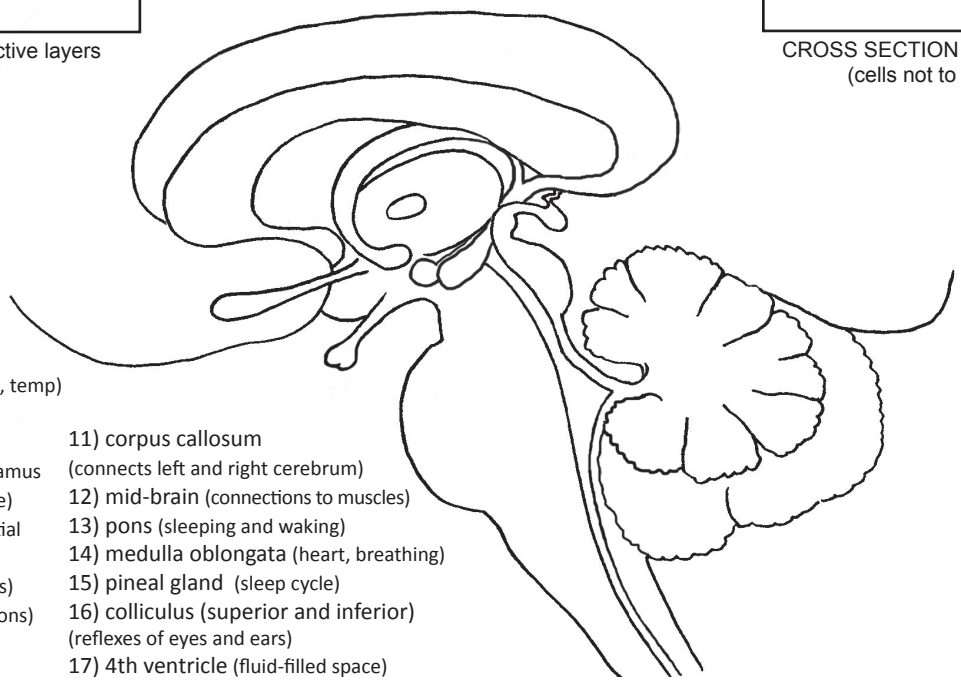
SAGITTAL SECTION



CLOSE-UP of protective layers



CROSS SECTION of cortex (cells not to scale)



1) olfactory bulb (smell)
2) pituitary (growth and reproductive hormones)
3) hypothalamus (appetite, temp)
4) thalamus (sorts signals)
5) intermediate mass connecting two sides of thalamus
6) fornix (a connecting piece)
7) mammillary body (spatial memory, sense of direction)
8) hippocampus (memories)
9) amygdala (strong emotions)
10) cingulate gyrus (connects top to bottom)
11) corpus callosum (connects left and right cerebrum)
12) mid-brain (connections to muscles)
13) pons (sleeping and waking)
14) medulla oblongata (heart, breathing)
15) pineal gland (sleep cycle)
16) colliculus (superior and inferior) (reflexes of eyes and ears)
17) 4th ventricle (fluid-filled space)

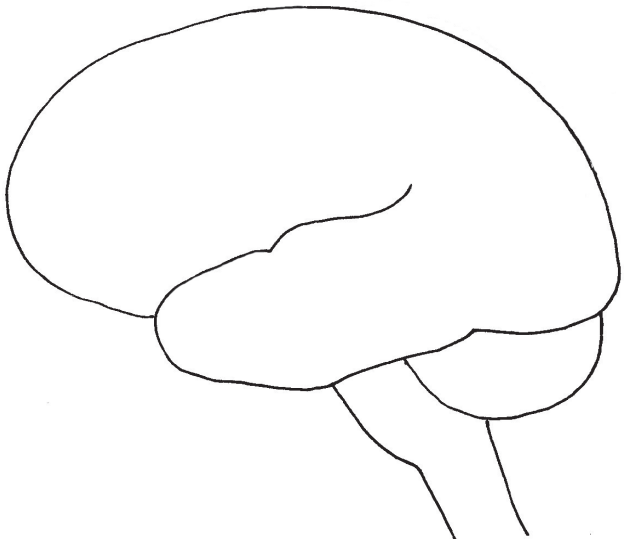
BRAIN (part 2)

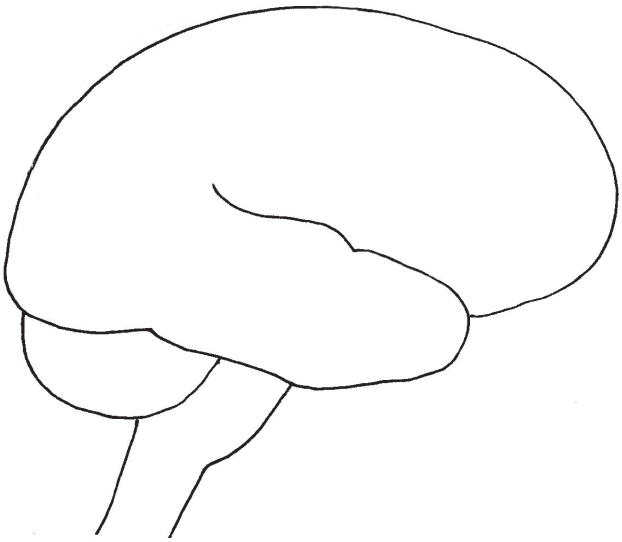
The LEFT hemisphere is known for:

1) _____ 4) _____
2) _____ 5) _____
3) _____ 6) _____

The RIGHT hemisphere is known for:

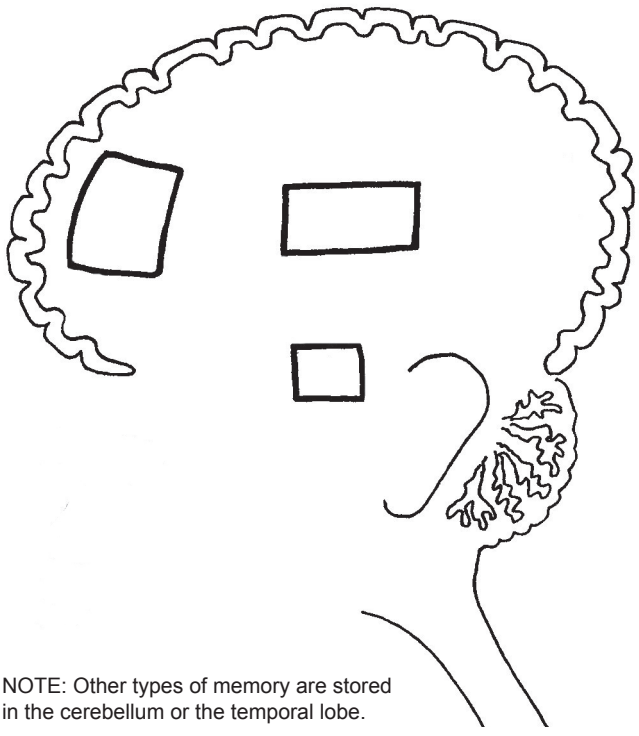
1) _____ 4) _____
2) _____ 5) _____
3) _____ 6) _____





HOW SOME MEMORIES ARE ENCODED:
(This would be declarative/explicit memories.)

Short term involves glutamate crossing synapses.
Long term involves production of new spines on dendrites.



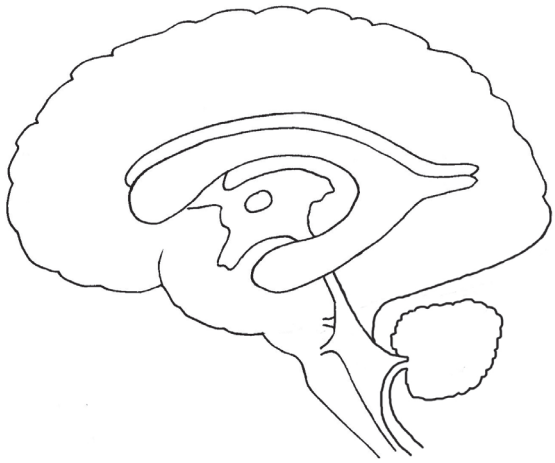
NOTE: Other types of memory are stored in the cerebellum or the temporal lobe.

VENTRICLES:

Ventricles are filled with cerebrospinal fluid (CSF).
Ventricles and CSF help the brain by providing:

1) _____
2) _____
3) _____
4) _____

CSF is found in the 4 ventricles, as well as under the arachnoid layer around the exterior. The CSF circulates around these spaces, then drains either into veins at the top and middle of the brain, or down into the central canal that goes into the spinal cord.



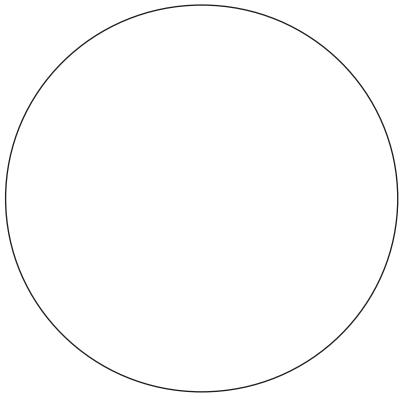
CHOROID PLEXUS: epithelial cells that produce CSF

BLOOD VESSELS

There are 3 main types of vessels: **arteries** (away from the heart), **veins** (toward the heart) and **capillaires** (microscopic).

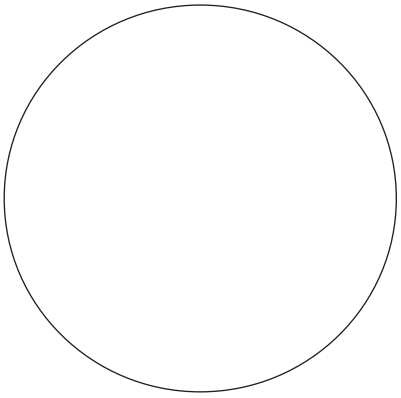
ARTERIES : built for high pressure

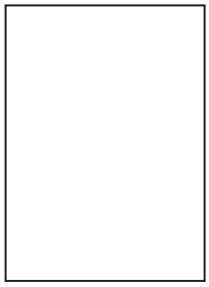
The heart is a very strong pump. When blood leaves the heart, it does so under high pressure. Arteries must be able to withstand high pressure. Smooth muscles in the vessels contract with each pump.



VEINS: built for low pressure

Veins experience much less pressure because they are farther away from the heart. In fact, they have one-way valves to ensure that blood does not flow the wrong way.





CAPILLARIES form "beds" (networks)

ARTERIOLE (small artery)

The smooth muscles of arterioles control how much blood goes to which parts of the body.

VENULE (small vein)

TYPES of CAPILLARIES:

1) **Continuous**
Where? _____

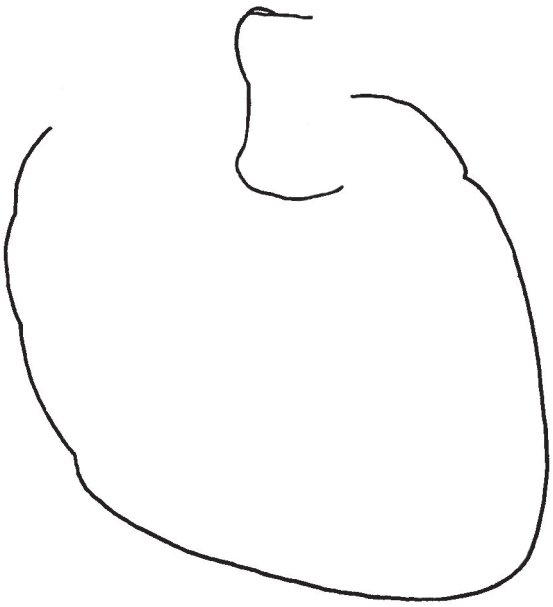
2) **Fenestrated** ("fenestra" = "window")
Where? _____

3) **Sinusoidal**
Where? _____

THE HEART

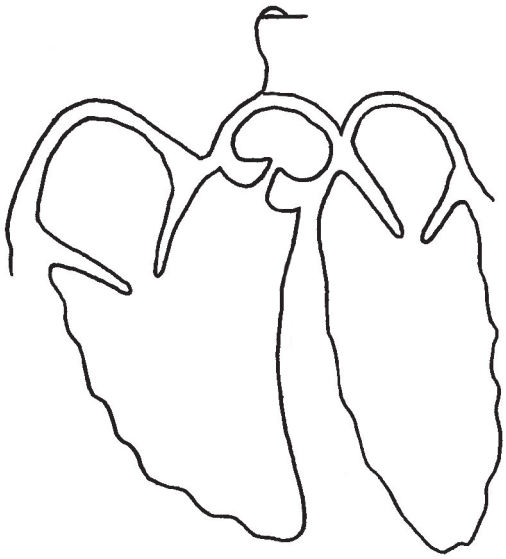
ARTERIES go away from the heart. VEINS go toward the heart.

EXTERIOR ANATOMY



The **pericardium** is a membrane "bag" that goes around (peri) the heart (cardi).

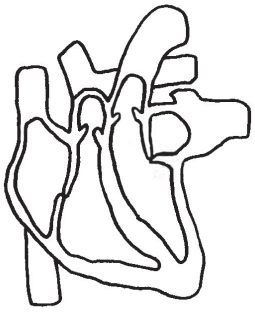
INTERIOR ANATOMY



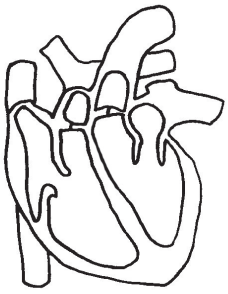
VALVES:
1: Tricuspid
2: Bicuspid (a.k.a. mitral valve)
3: Semilunar valves

"LUB DUB" (the cardiac cycle)

The familiar "lub dub" sound of a beating heart is made by the valves opening and closing.



The first sound, the "lub," is when the cuspid flaps close.

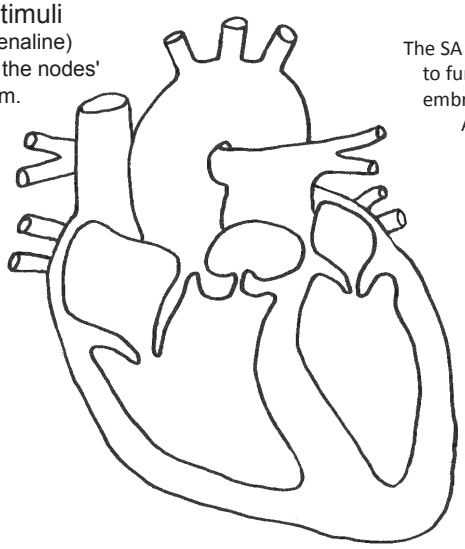


The second sound, the "dub," is when the semilunar flaps close.

Intrinsic Conduction System

(how the heart beats in rhythm)

Extrinsic stimuli (such as adrenaline) can override the nodes' normal rhythm.



The SA and AV nodes began to function very early in embryonic development. An embryo's heart cells begin beating in rhythm long before the shape of the heart has been completed.

The two phases of rhythm:

1) _____: _____

2) _____: _____

THE LUNGS

Although the lungs are the main organs of the respiratory system, the action of the lungs is actually called **ventilation**, not respiration. Respiration is what happens in the cells ("cellular respiration" from lessons 18 and 20 in module 1).
When the lungs take in air, this is called **inhalation**. When the lungs expel air, this is called **exhalation**.

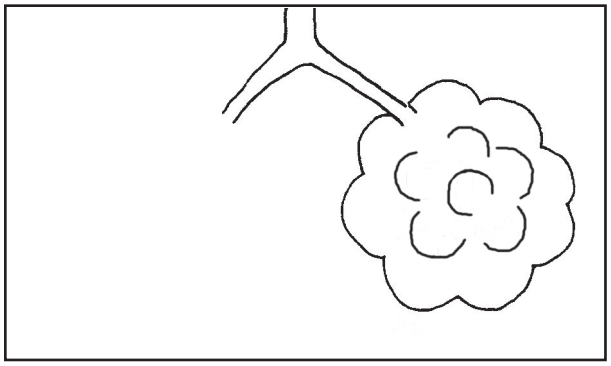
The **THORACIC CAVITY** contains the lungs, the heart, the trachea and the esophagus. The **diaphragm** separates the thoracic cavity from the abdominal cavity below.

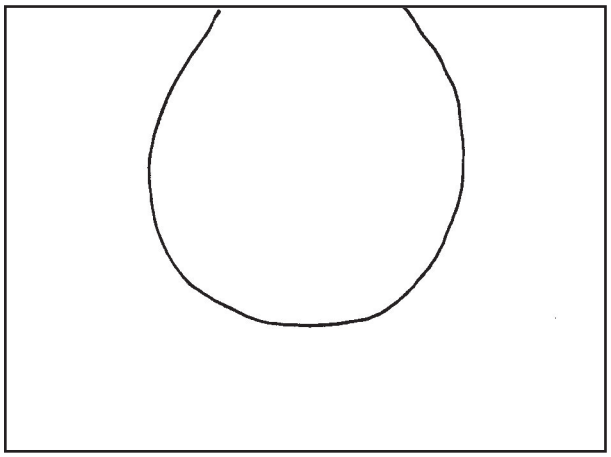
The diaphragm is shaped like an upside down bowl.

Three holes in diaphragm:
1) inferior vena cava, 2) descending aorta, and 3) the esophagus.

Contraction of the diaphragm causes the chest to expand, causing air to rush in.

At the end of each bronchiole is a **lobule** made of microscopic **alveoli**. Each alveolus is covered with a bed of capillaries.



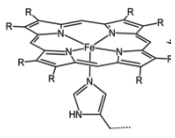


1) ultra-thin squamous epithelial cells
2) cuboidal epithelial cells that secrete **surfactant**
3) macrophages called "dust cells"
4) layer of water that contains surfactant (phospholipids that lower the surface tension of water so that O_2 can pass through)
5) endothelial cells of the capillaries
6) red blood cells that pick up the O_2

WHAT CAUSES US TO BREATHE:
The diaphragm is "wired" to the medulla oblongata in the brain. The medulla is very good at sensing small changes in the CO_2 level in the blood and sends signals for the diaphragm and the intercostal muscles (between the ribs) to contract when CO_2 gets too high.

HOW O_2 IS TRANSPORTED IN THE BLOOD:

RBCs contain billions of hemoglobin molecules.



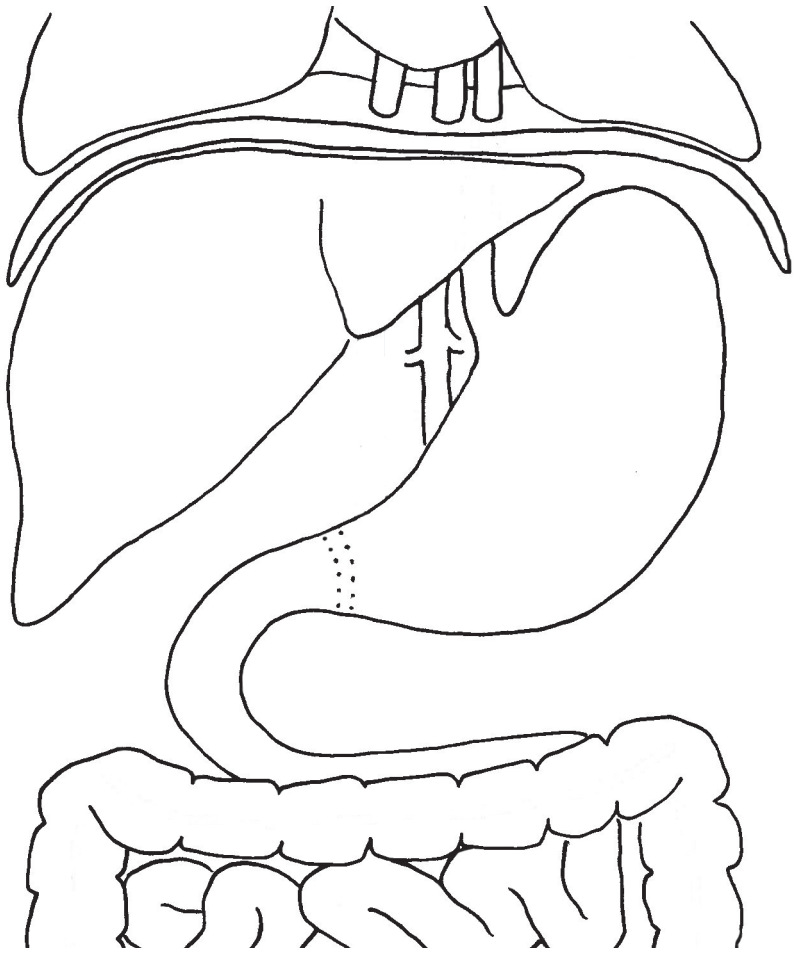
HOW CO_2 IS TRANSPORTED IN THE BLOOD:

1) A small amount is carried by the globin part of hemoglobin, or is dissolved directly into the plasma.

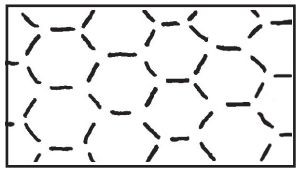
2) Most CO_2 is combined with water to form carbonic acid (H_2CO_3), then bicarbonate ions (HCO_3^-) and hydrogen ions (H^+). HCO_3^- diffuses out into the plasma. To keep the pH even, Cl^- ions diffuse in to replace HCO_3^-

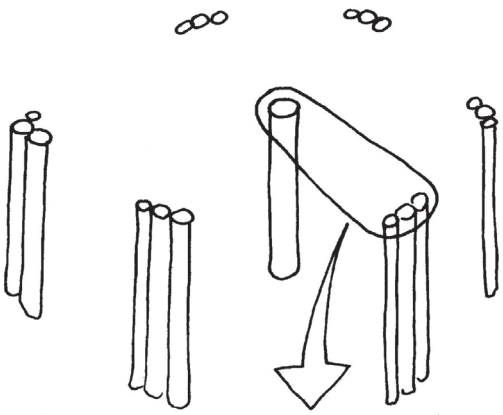
THE LIVER and GALL BLADDER

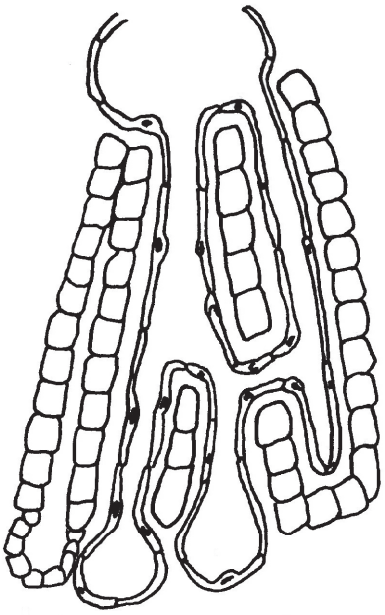
The liver is the largest gland in the body. It weighs about 3 lbs (1.5 kg). It is the ultimate "mulit-tasker" and by some counts does as many as 500 jobs! The gall bladder is simply a storage bag for one of the products that the liver makes.

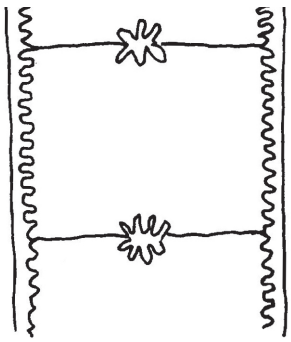


MICROSCOPIC VIEWS:









MAJOR FUNCTIONS of the LIVER:

A: _____ : _____
_____

B: _____ : _____
_____

C: _____ : _____
_____

C: _____ : _____

C: _____ : _____
_____

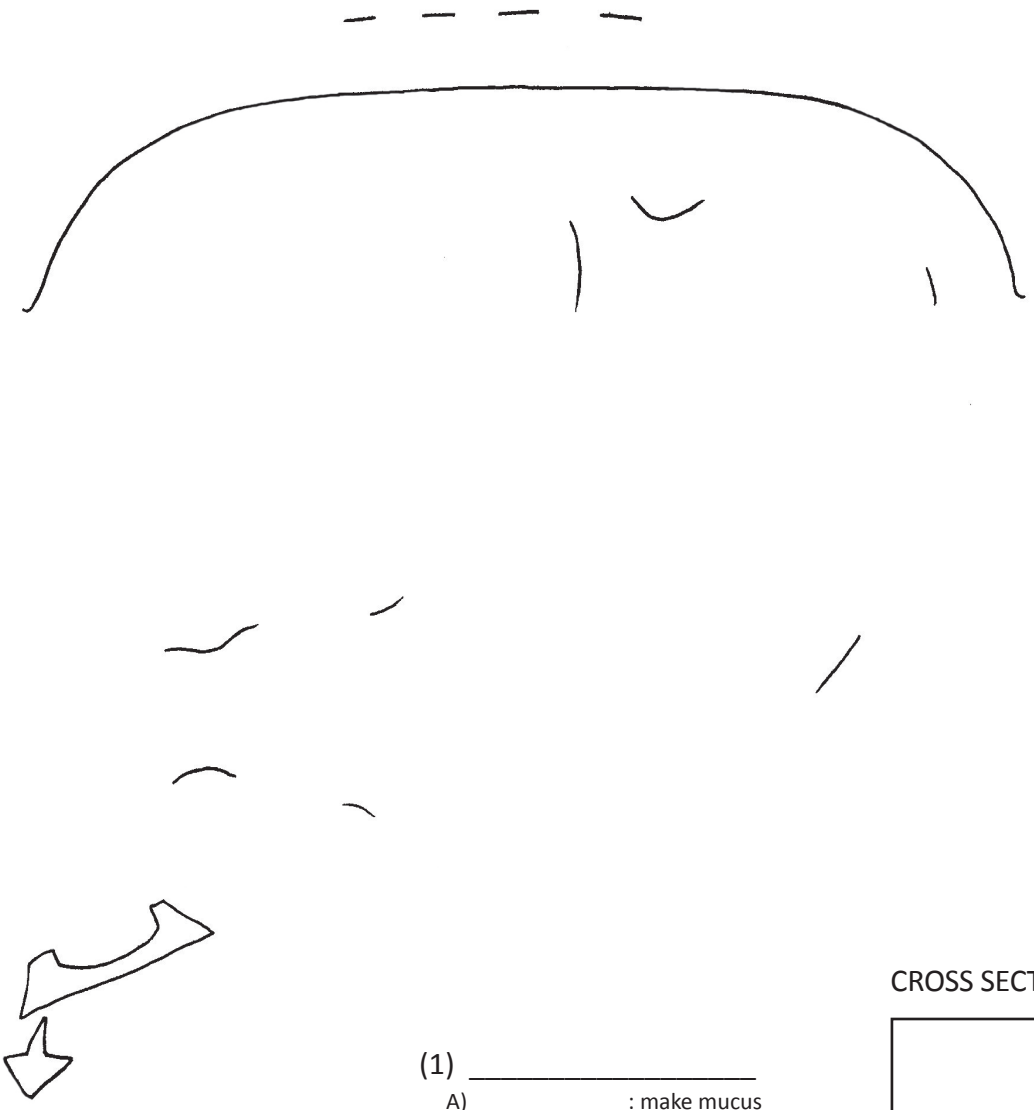
D: _____ : _____

E: _____ : _____

F: _____ : _____

G: _____ : _____

STOMACH (and duodenum)



WORDS TO KNOW:

_____ : a wad of food traveling down the esophagus

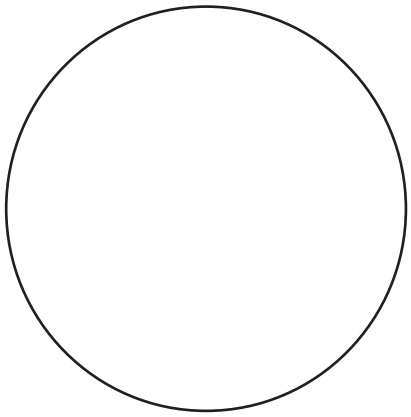
_____ : mushy stuff that leaves stomach

_____ : muscular action of the digestive tract to push food along

_____: a sore in the lining of the stomach

_____ : a "precursor" of an enzyme, meaning an enyzme that has not yet been activated. Examples: fibrinogen, pepsinogen ("zym" meaning "enzyme," and "gen" meaning "to make")

CROSS SECTION:



(1) _____

A) _____: make mucus

B) _____: make HCl (acid that makes stomach have pH of about 2)

C) _____: make pepsinogen and "IF" factor that protects vit. B12 from acid of stomach

D) _____: make gastrin, a hormone that stimulates parietal cells

E) _____: secrete many hormones that control aspects of digestion

(2) _____

Loose connective tissue that contains blood vessels

(3) _____

A) _____

B) _____

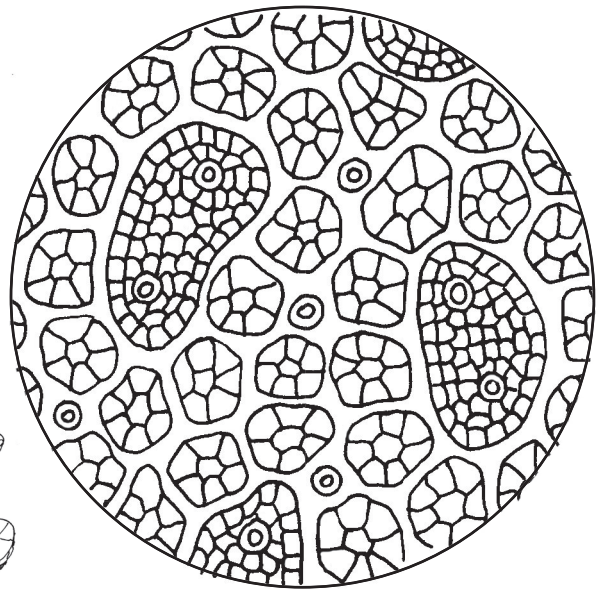
C) _____

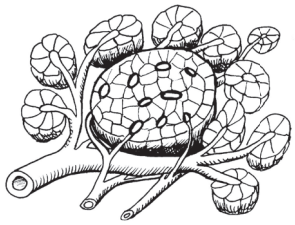
(4) _____ : epithelial cells secrete serous fluid for lubrication

CROSS SECTION OF STOMACH WALL:

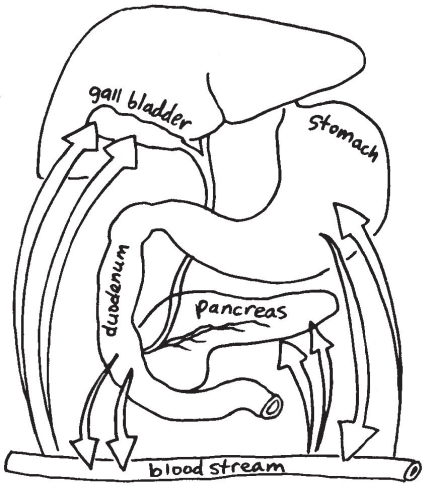
PANCREAS (and enzymes)

The pancreas is a "mixed gland" meaning that it performs both **endocrine** and **exocrine** functions.
The exocrine products go into the duodenum. The endocrine products go into the blood.





Organs communicate using hormones. When the duodenum detects protein, fats and stomach acid coming into it, its cells start making **secretin** and **CCK**. These hormones go into the blood and eventually reach the pancreas and gall bladder, causing them to increase their output.



<u>EXO</u>CRINE: secreted to <u>OUT</u>SIDE

The exocrine cells are called: _____

<u>Exocrine products of pancreas</u>:

1) _____
($NaHCO_3$ that neutralizes stomach acid
(In kitchen we call it: _____)

2) _____ break proteins
ex: _____
ex: _____
ex: _____
These are made as zymogens which are activated by an enzyme in the intestines.

3) _____ breaks apart fats

4) _____ breaks starch into units of maltose (disaccharide)

5) _____ break RNA and DNA

<u>ENDO</u>CRINE: absorbed (by the blood) while <u>IN</u>SIDE the gland

The endocrine cells are organized into:
_____ of _____

<u>Endocrine products of pancreas:</u>

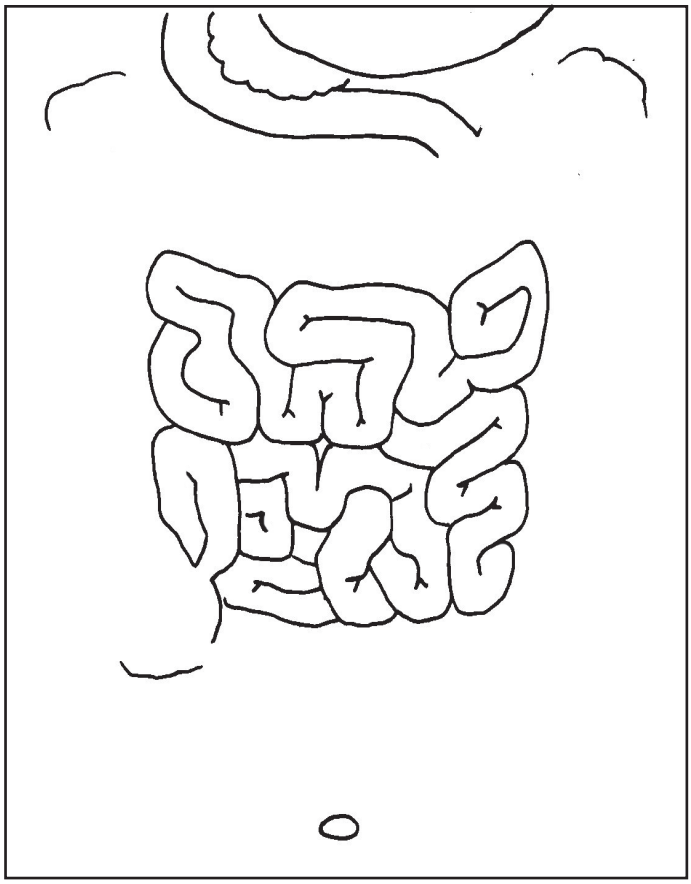
1) ___ cells make _____
that_____
_____

2) ___ cells make _____
that_____
_____

3) ___ cells make _____
that _____
_____

INTESTINES

The intestines consist of two distinct regions: the small intestine (divided into **duodenum**, **jejunum**, and **ileum**), and the **large intestine** (also called the **colon)**.



What do the jejunum and ileum have in common?

1) _____

_____

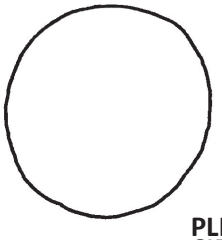
2) _____

Differences between jejunum and ileum:

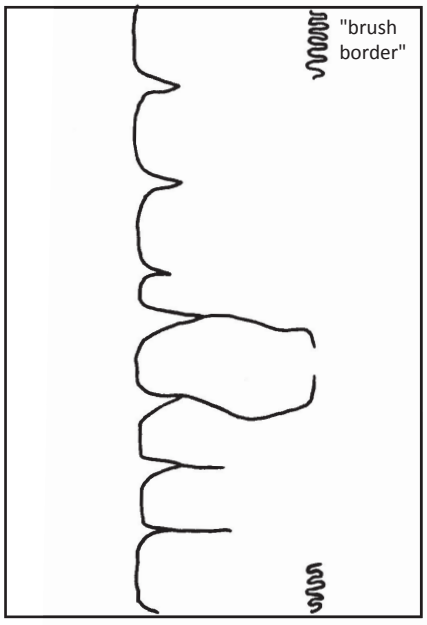
Jejunum	Ileum
1) _____	1) _____
2) _____	2) _____
3) _____	3) _____
4) _____	4) _____

The colon's function is to reabsorb:

_____

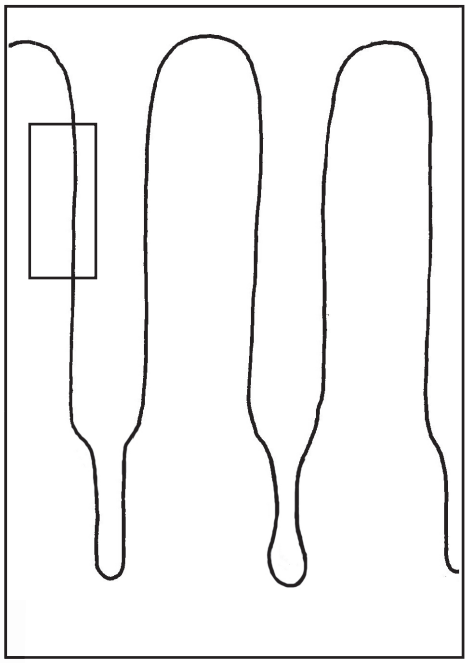


MICROVILLI



The enterocytes are the masters of endocytosis and diffusion! Nutrients pass through these cells and out the other side. The cells package triglycerides into chylomicrons that go into the lacteals (lymph vessels). Glucose and amino acids go into the blood capillaries.

VILLI



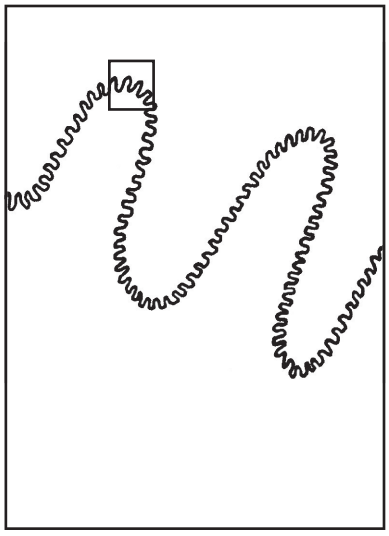
crypts/glands

= enterocytes = goblet cells

= enteroendocrine cells = stem cells

= Paneth cells (antibiotic chemicals)

PLICAE CIRCULARES



(1) _____

a) Epithelium

b) Lamina Propria (loose connective)

c) Muscularis Mucosa (very tiny muscles)

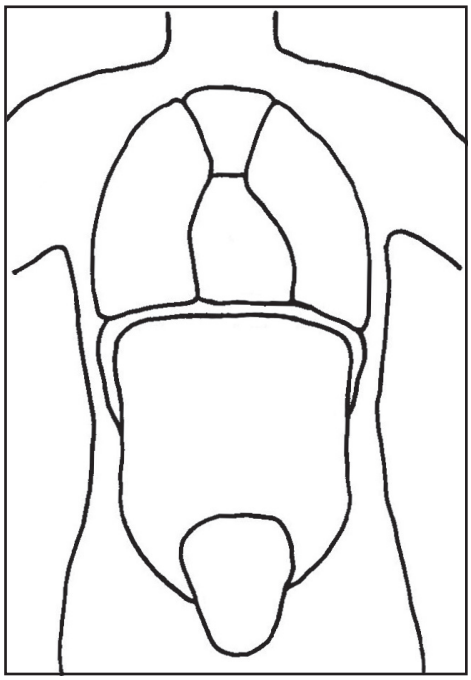
(2) _____

(3) _____ (circular, long.)

(4) _____

BODY CAVITIES and MESENTERY

BODY CAVITIES are large sections of the body that are enclosed by membranes.



There are 3 main body cavities:

1) _____

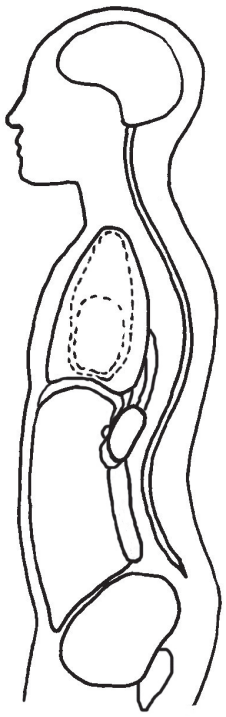
a) _____ (_____)

b) _____ (_____)
(is inside mediastinum)

c) _____
(superior part shown)
(includes superior vena cava, aortic arch, thymus, part of esophagus, part of trachea

2) _____
(contains stomach, spleen, liver, gall bladder, part of pancreas, all of small intestines, transverse colon)

3) _____
(contains urinary bladder, reproductive organs such as uterus, and sigmoid colon)

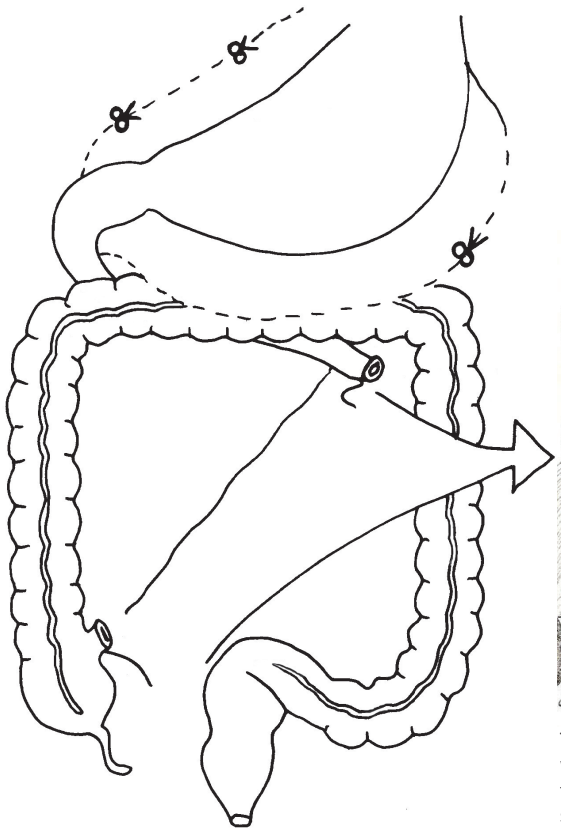


Just FYI, there are 2 other "official" body cavities:
-- CRANIAL
-- SPINAL

A few organs lie outside of the cavities.
They are called **retroperitoneal** ("retro" means "behind").

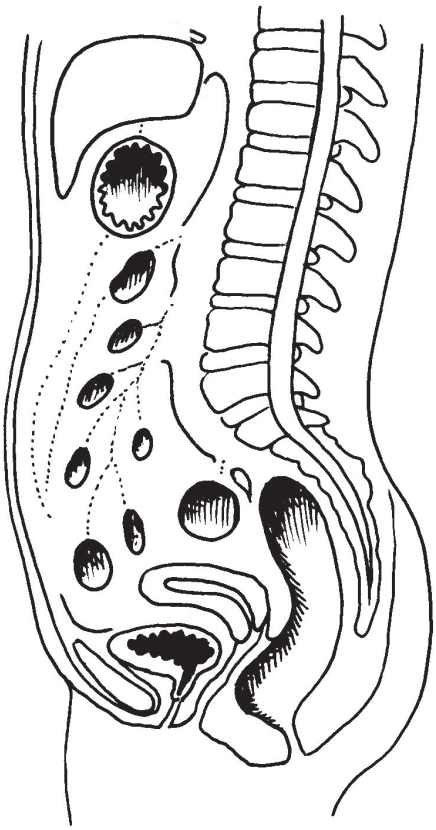
-Aorta (descending)
-Vena cava (inferior)
-Kidneys
-Part of duodenum
-Part of pancreas
-Ascending colon
-Descending colon
-Rectum

THE MESENTERY is a very thin membrane that holds all the organs in place. The mesentery also provides a surface for nerves, blood vessels, and lymph vessels. Mesentery is made of serous membrane (which is made of a layer of simple squamous epithelial cells stuck to a layer of connective tissue).

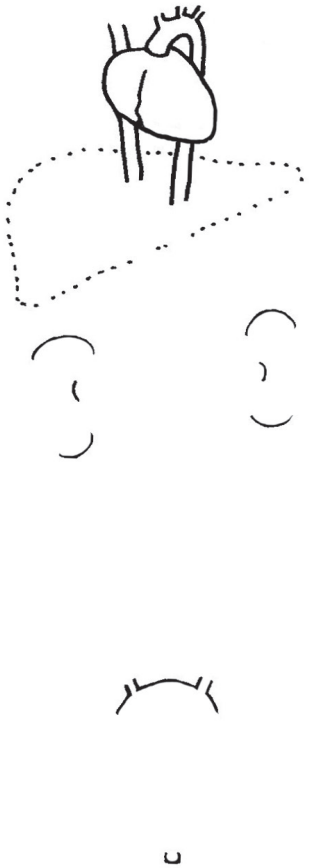


NOTE: Small intestines have been removed in this diagram.

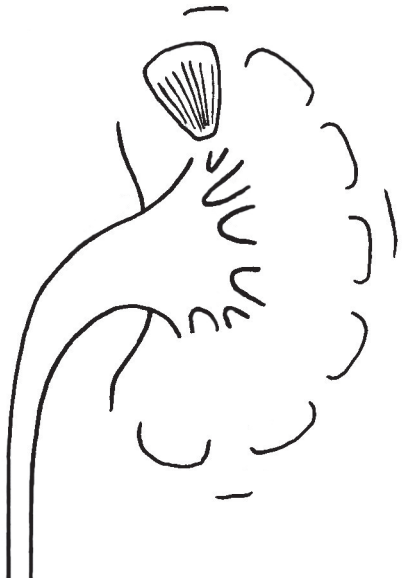
This is how the mesentery would look if you cut off all the intestines. (The wavy shape might remind you of some plant leaves such as kale or parsley.)

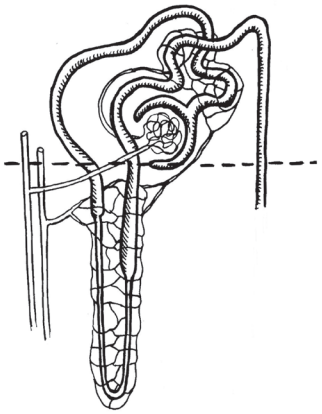


KIDNEYS and BLADDER



The functional unit of the kidney is the **NEPHRON**

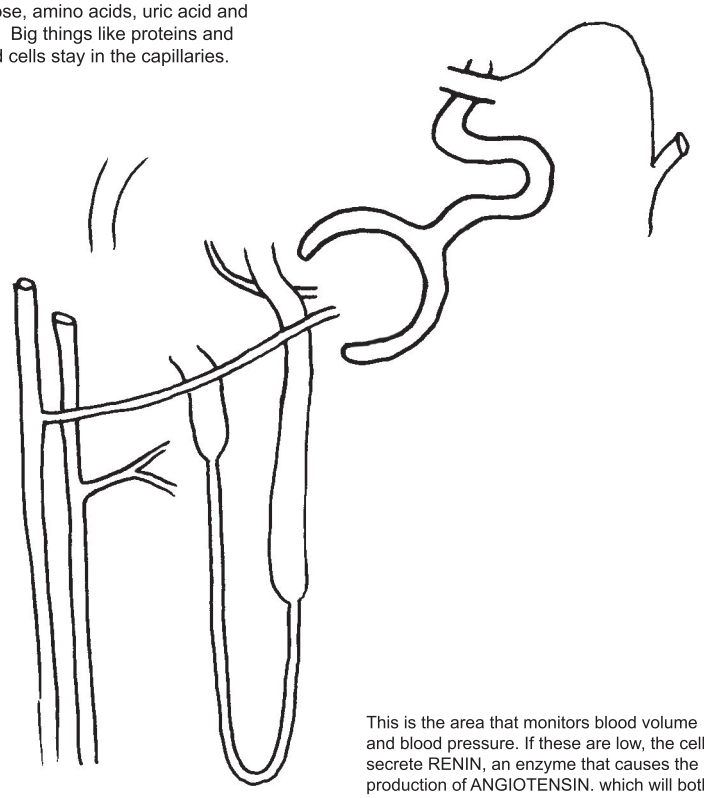




LENGTH OF URETHRA	WALL OF BLADDER

In the **GLOMERULUS**, the blood is under pressure. Very tiny molecules are pushed out: water, salts, ions, glucose, amino acids, uric acid and urea. Big things like proteins and blood cells stay in the capillaries.

In the **CONVOLUTED TUBULES**, water is reabsorbed and goes back into capillaries, but only a certain number of small molecules go back.



This is the area that monitors blood volume and blood pressure. If these are low, the cells secrete RENIN, an enzyme that causes the production of ANGIOTENSIN. which will both constrict blood vessels and tell the adrenal cortex to produce ALDOSTERONE, which makes more sodium go into the blood.

SUMMARY OF KIDNEY FUNCTIONS:

1) _____

Nitrogenous wastes come from the breakdown of amino acids, which have a nitrogen atom. (The liver turns ammonia into urea.)

2) _____

This is achieved through a balance of water and salt in the blood. The more salt in the blood, the more water goes into the blood, and that means greater blood volume and greater pressure. To increase blood pressure, the kidneys secrete renin, which activates angiotensin, which tells the adrenals to make aldosterrone which causes more sodium to go into the blood.

3) _____

The kidneys can excrete or reabsorb both H^+ ions (which make things acidic) and HCO_3^- ions (alkaline).

4) _____

If the kidneys sense that there is less oxygen in the blood, they will begin to produce more erythropoietin, which tells the hematopoietic stem cells to make more red blood cells.

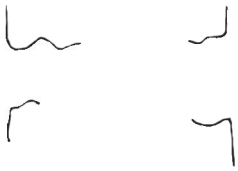
5) _____

Vitamin D from the diet must be converted to a more active form that the digestive system can use to absorb calcium ions.

NOTE: The pituitary gland (in the brain) secretes a chemical called ADH (anti-diuretic hormone) at night, which causes more water to be reabsorbed, making less urine.

BONES (as organs)

You will want to go back and review drawings 35 and 36 before doing this drawing.



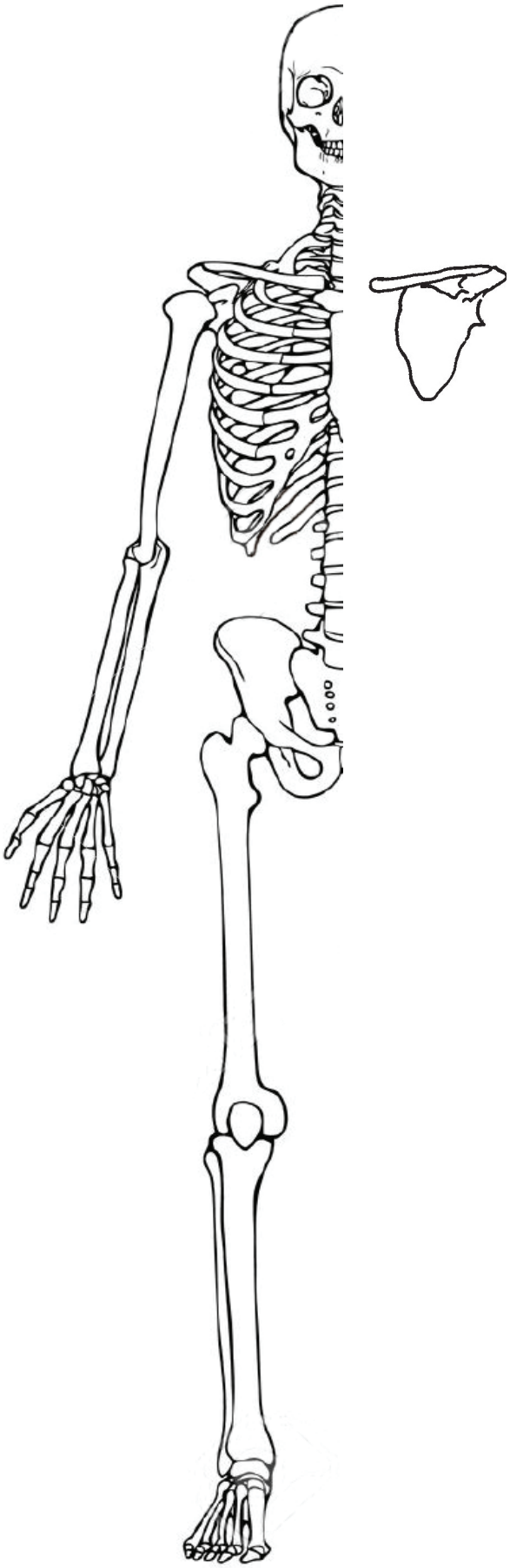
BONE REMODELING (Blasts VS Clasts)

- Osteons are constantly being torn apart and rebuilt.
- When calcium levels in the blood get too low, **OSTEOCLASTS** dissolve bone to release calcium ions (Ca^{2+}).
- When calcium levels in the blood are high, the **OSTEOBLASTS** put calcium back into bone by building up the osteons.

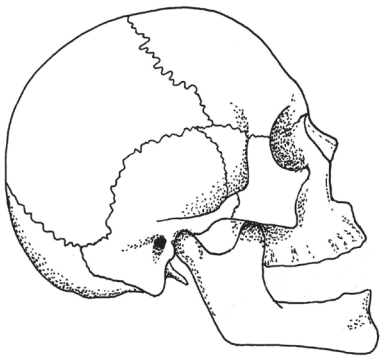
CLAST = tear down BLAST = build up

Osteoclast is secreting acid (H^+ ions) to dissolve the mineral content. It will secrete an enzyme called **collagenase** to dissolve collagen.

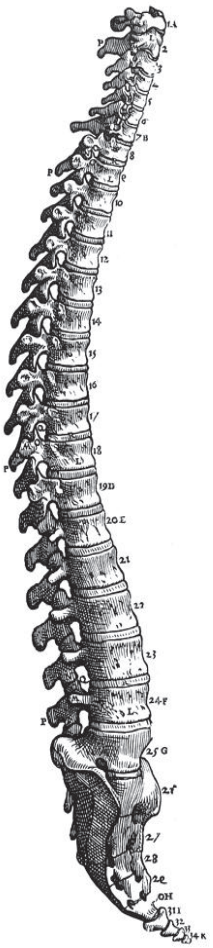
Osteoblasts might be a type of macrophage.

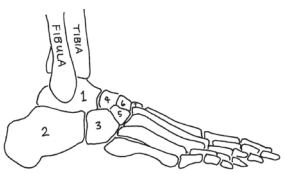


BONES of the SKULL:



BONES of the SPINE:





This drawing is by Andreas Vesalius, first published in 1543. His book, "De Humani Corporis Fabrica" is considered to be the first modern anatomy textbook.

JOINTS

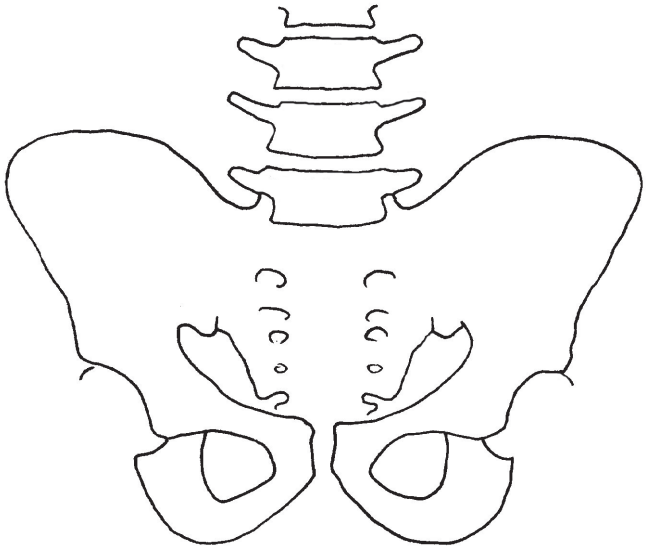
There are three kinds of joints: 1) FIBROUS, 2) CARTILAGINOUS, 3) SYNOVIAL

FIBROUS: (don't move at all)

Ex: sutures in skull, teeth in sockets, ends of ulna/radius, tibia/fibula

CARTILAGINOUS: (move only slightly)

Ex: discs between vertebrae, pubic symphysis, ribs/sternum

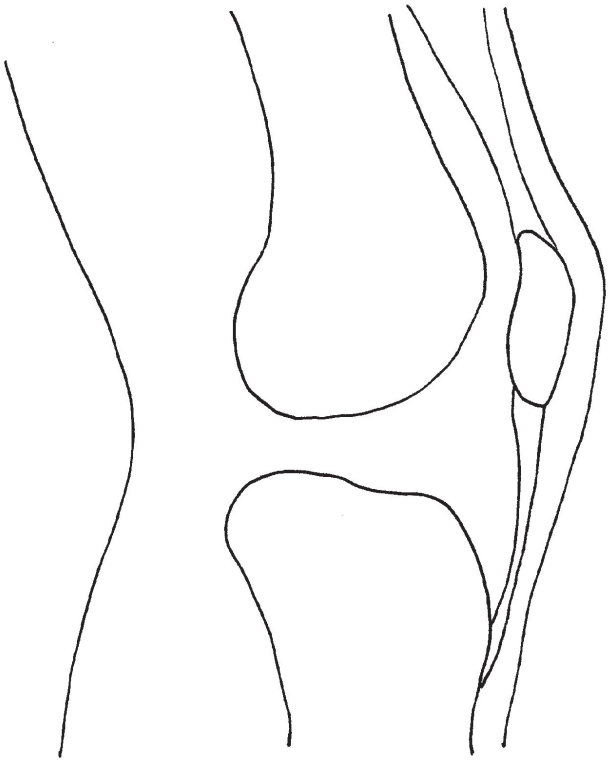


SYNOVIAL: (very flexible)

Synovial joints have fluid-filled capsules in and around the joint to decrease friction. They also have slippery (white) hyaline pads. There are 6 types of synovial joints: hinge, ball and socket, pivot, saddle, plane and ellipsoidal.

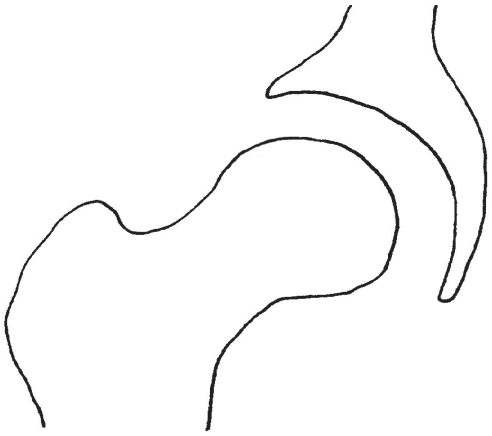
HINGE: the knee (shown) and the elbow

☐ hyaline cartilage ☐ synovial cavity ☐ fat
☐ ligaments, tendons ☐ bursa (fluid filled sac)

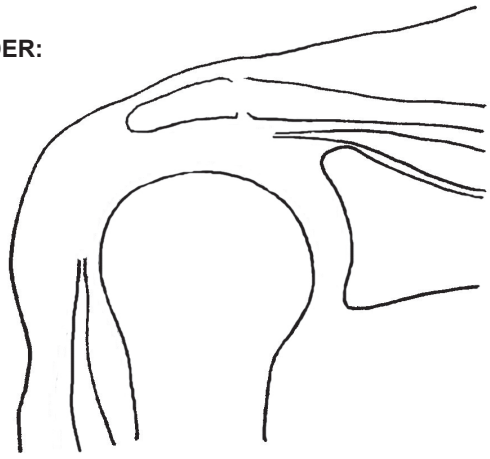


BALL AND SOCKET: hip and shoulder

HIP:



SHOULDER:



MUSCLES (as organs)

There are 3 kinds of muscles: 1) SKELETAL (voluntary), 2) SMOOTH (involuntary), 3) CARDIAC (heart)

SKELETAL:	**SMOOTH:**	**CARDIAC:**
1) _____	1) _____	1) _____
2) _____	2) _____	2) _____
3) _____	3) _____	3) _____
4) _____	4) _____	4) _____

SKELETAL MUSCLES WORK IN PAIRS

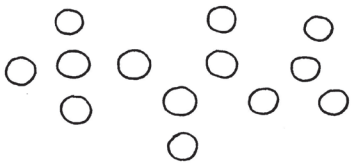
Muscles can only do one thing: CONTRACT.
A prime mover and its antagonist work together.

MOTIONS can be classified

Abduction: body part moves away from midline
Adduction: body part moves toward midline
Extension: joint angle increases
Flexion: joint angle decreases
Rotation: rotates around axis
Circumduction: cone shape is outlined

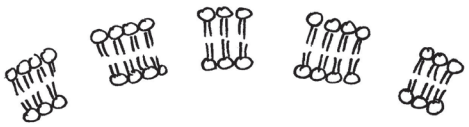
WHERE DO SKELETAL MUSCLES GET THEIR ENERGY? Here they are, in order of preference.

1) CREATINE PHOSPHATE



CREATINE is first choice, but can be sustained for only 8 seconds. Creatine holds onto a phosphate. An enzyme can take the P off, and then put it onto an ADP, making ATP. No oxygen is needed.

2) CELLULAR RESPIRATION (the ETC)



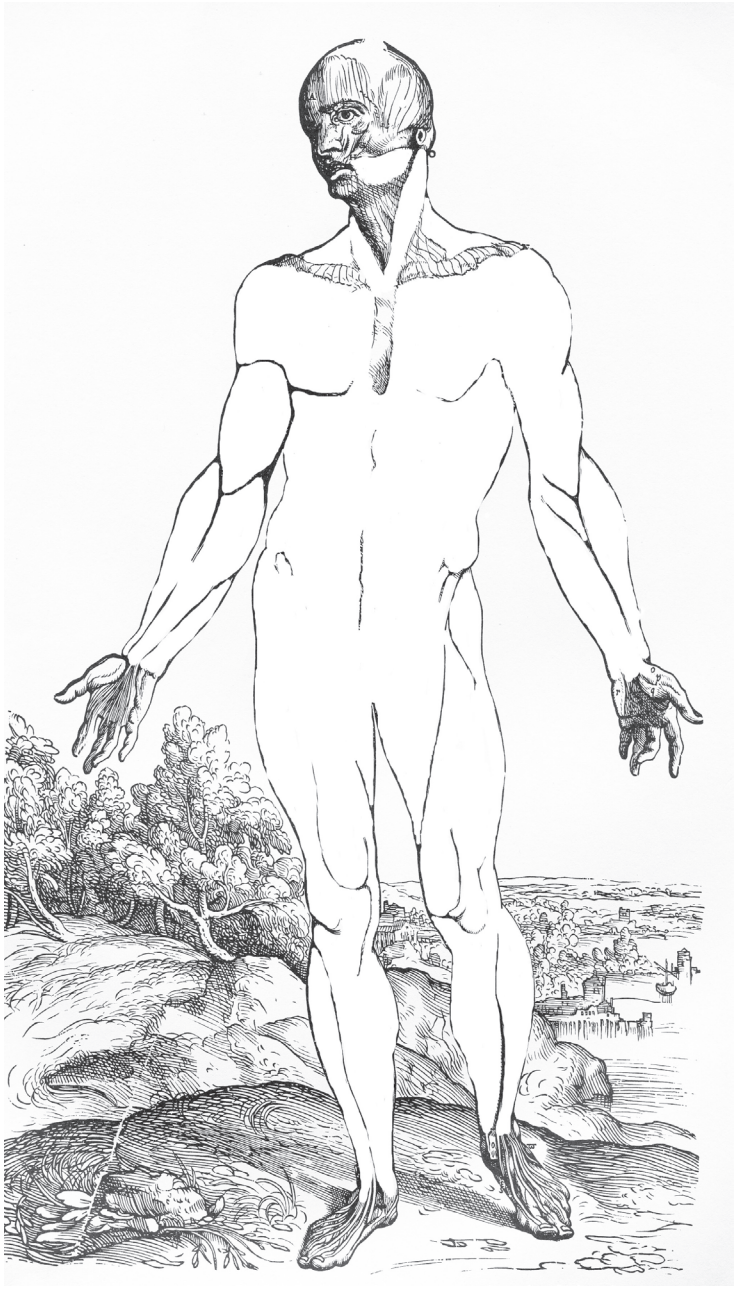
After 8 seconds, cellular respiration kicks in. Oxygen is needed for the Electron Transport Chain to turn ADP back into ATP. Glucose from glycogen is the preferred fuel for the ETC in skeletal muscles.

3) FERMENTATION

Lactic acid fermentation is the third and last choice for energy. This must be used if oxygen is not available. Lactic acid gives that burning sensation in muscles when they are fatigued.

THE SKELETAL MUSCLES

In this lesson, we will be using drawings made by famous anatomist Andreas Vesalius in the year 1555.



HEAD and NECK

1) **Frontalis:** *wrinkles forehead and moves eyebrows.*

2) **Orbicularis oculi:** *closes eyes*

3) **Zygomaticus:** *smiling*

4) **Masseter:** *closes jaw*

5) **Orbicularis oris:** *closes and protrudes lips (like a kiss)*

6) **Occipitalis:** *moves scalp backwards*

7) **Sternocleidomastoid:** *turns and twists head*

UPPER LIMBS

8) **Deltoid:** *raises arm at shoulder joint ("delts")*

9) **Triceps brachii:** *straightens arm*

10) **Biceps brachii:** *bends arm at elbow*

11) **Flexor carpi group:** *bends hand down at wrist*

12) **Extensor carpi:** *pulls hand up at wrist*

13) **Flexor digitorum:** *closes hand*

14) **Extensor digitorum:** *opens hand*

TORSO

15) **Trapezius:** *moves head, shrugs shoulders ("traps")*

16) **Pectoralis major:** *("pecs") pulls arm across chest*

17) **Rectus abdominis:** ("abs") *"sit-up" muscles*

18) **Latissimus dorsi:** *("lats") pulls arm across back and extends shoulders*

19) **External oblique:** *rotates torso*

20) **Teres major and minor:** *pulls arm down and back*

LOWER LIMBS

21) **Gluteus maximus:** *going from sitting to standing*

22) **Quadriceps group:** *straightens leg*

23) **Hamstring group:** *bends leg at knee*

24) **Sartorius:** *rotates thigh (so you can sit cross-legged)*

25) **Gastrocnemius:** *points toes ("calf")*

26) **Tibialis anterior:** *pulls toes up, and inverts foot*

27) **Achilles tendon**

THE ENDOCRINE SYSTEM (overview)

Endocrine glands secrete hormones into the blood. Hormones are messenger molecules.

PEPTIDE HORMONES are made of _____

Peptide hormones never enter a cell. They bind to external receptors. Usually, ATP is turned into cAMP, which starts a cascade reaction. Cascades allow for rapid manufacturing.

STEROID HORMONES are made using _____

Steroid hormones enter the cell and bind to a receptor inside. That receptor molecule will attach to DNA and cause a certain part to be copied into mRNA, which will then build a protein.

THE ENDOCRINE GLANDS

_____ gland has two parts.

_____
-TSH
-ACTH
-FSH, LH
-GH

_____
-ADH (for kidneys)
-oxytocin (females)

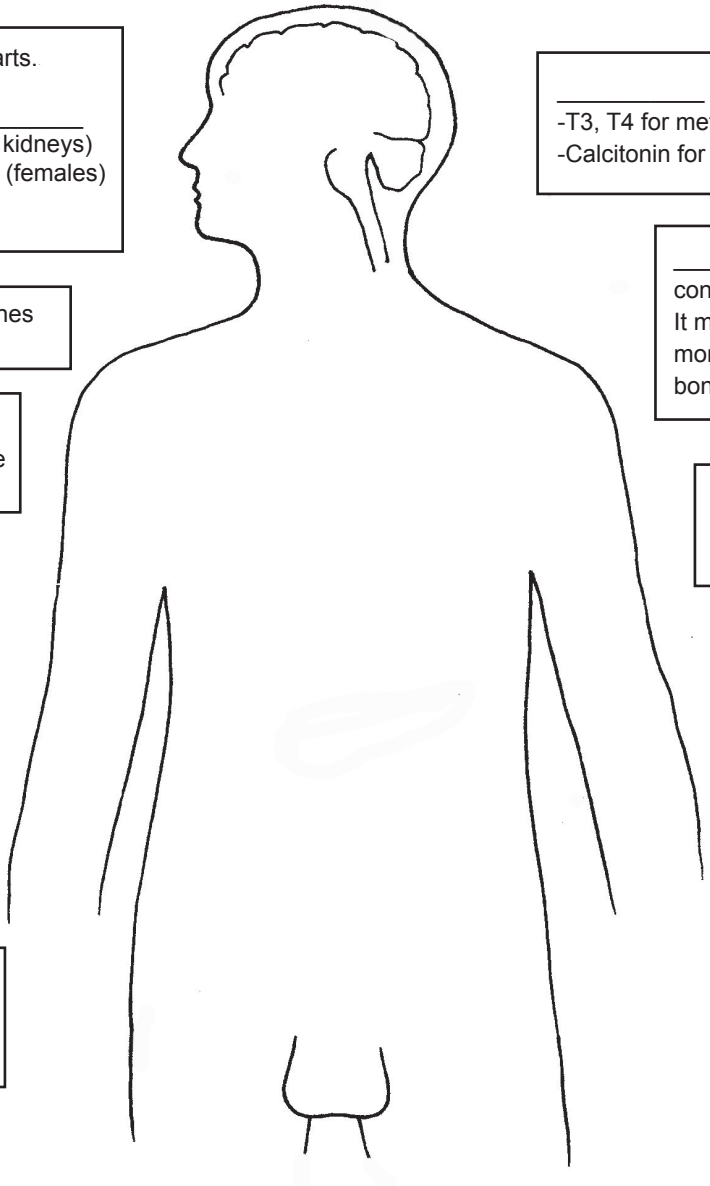
_____ gland makes
-T3, T4 for metabolism and growth
-Calcitonin for lowering blood calcium

_____ makes hormones that affect the pituitary gland.

_____ gland consists of 4 spots on the thyroid. It makes PTH (parathyroid hormone) for taking calcium out of bones and putting it into blood.

_____ gland makes melatonin, which helps to regulate sleep cycle.

_____ gland is most active during childhood. It trains T cells (lesson 46).



_____ glands have two parts.

_____ (inside)
-epinephrine (adrenalin)
-norepinephrine

_____ (outside)
-aldosterone (for kidneys)
-cortisol (raises blood glucose, anti-inflammatory)

_____ in females
-estrogen
-progesterone

_____ makes
-insulin (lowers blood glucose)
-glucagon (raises blood glucose)
(lesson 71)

_____ in males
-testosterone

HYPOTHALAMUS and PITUITARY

Review of location of hypothalamus and pituitary

The **HYPOTHALAMUS** is a very important control center. It receives input, from both the senses (afferent nerves), and from the conscious mind. It also samples the blood to find out if there is too much or too little of various chemicals.

"ANT-ERIOR" (front)

6 major hormones

1)

2)

3)

4)

5)

6)

The hypothalamus also has a direct connection to the adrenal medulla.

1) ADH sticks to receptors in cells that form the collection tubes at the end of the nephrons.

2) When ADH sticks to a receptor, cAMP is formed (see lesson 80)

3) cAMP triggers the release of aquaporins that are in storage. and they go and embed themselves along the side that faces the lumen (inside) of the tube.

4) Water flows back into tissues and is conserved (less urine).

How ADH works in kidneys

POSTERIOR (back)

Your "posterior" (gluteus) has 2 parts.
(Go ahead and giggle, but you'll remember!)

1)

2)

THYROID and PARATHYROID

The thyroid and parathyroid control the level of calcium ions in the blood.
The thyroid also makes hormones that affect the health of all body cells.

The **thyroid** makes:

1)_____
which inhibits osteoclasts, stopping them from dissolving bone

2) ____

3) ____

Both of these affect many body cells and help with normal functioning of:

The **parathyroid** makes: _____

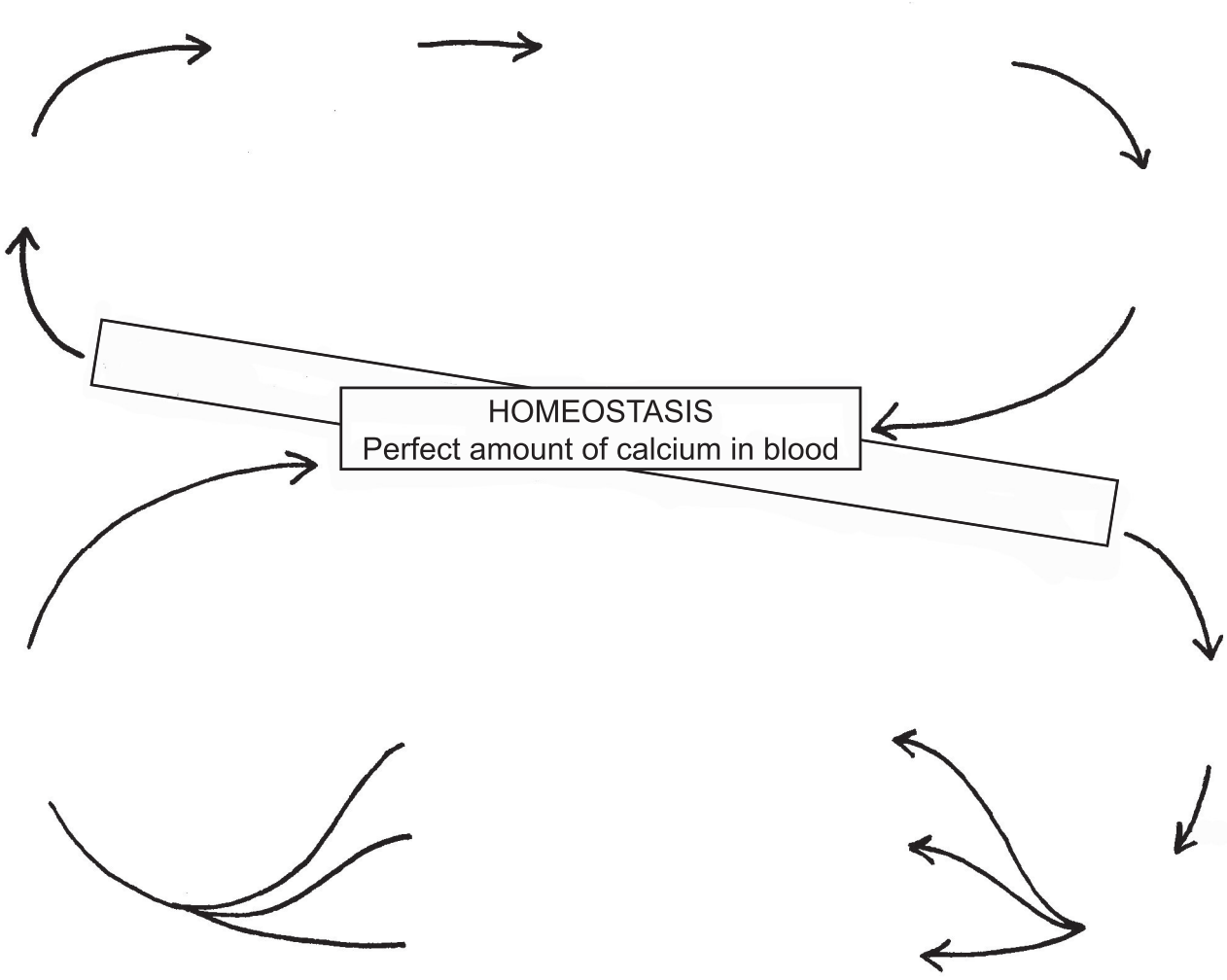
This hormone acts opposite calcitonin and raises blood calcium levels by:

1)

2)

Over 99% of T3 and T4 ride around in globulin taxis. While bound to a taxi, they are inactive. This provides safe storage.

NEGATIVE FEEDBACK LOOPS are the body's way of maintaining homeostatis



ADRENAL GLANDS

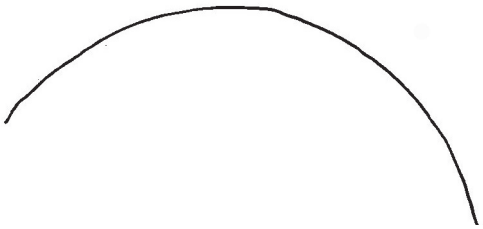
The adrenal glands are under the control of the hypothalamus, both directly and indirectly.

CROSS SECTION:

The "HPA axis" is the feedback loop between:

Hypothalamus
Pituitary
Adrenal cortex

In repsonse to stress, the hypothalamus tells the pituitary to secrete ACTH, which acts on the adrenals to make them secrete cortisol.



MEDULLA hormones deal with immediate stress:

1) _____ aka _____

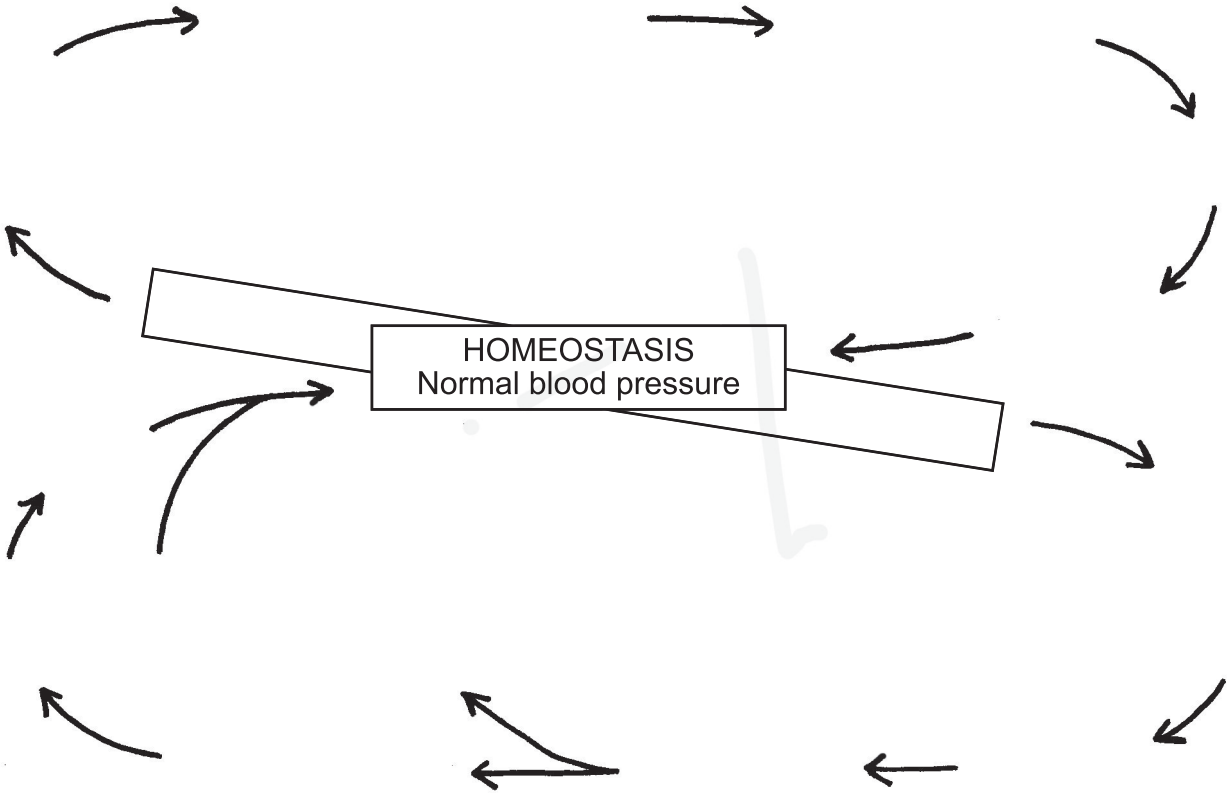
2) _____ aka _____

Effects:

Heart _____ Vessels _____
Bronchioles _____ Pupils _____
Glucuse level in blood goes _____
_____ _____ get ready in the blood.
Slowing down of: _____, _____, and _____

RECOVERY: In 30- 60 minutes the body will have gotten rid of all the adrenaline and noradrenaline molecules.

ANOTHER NEGATIVE FEEDBACK LOOP:

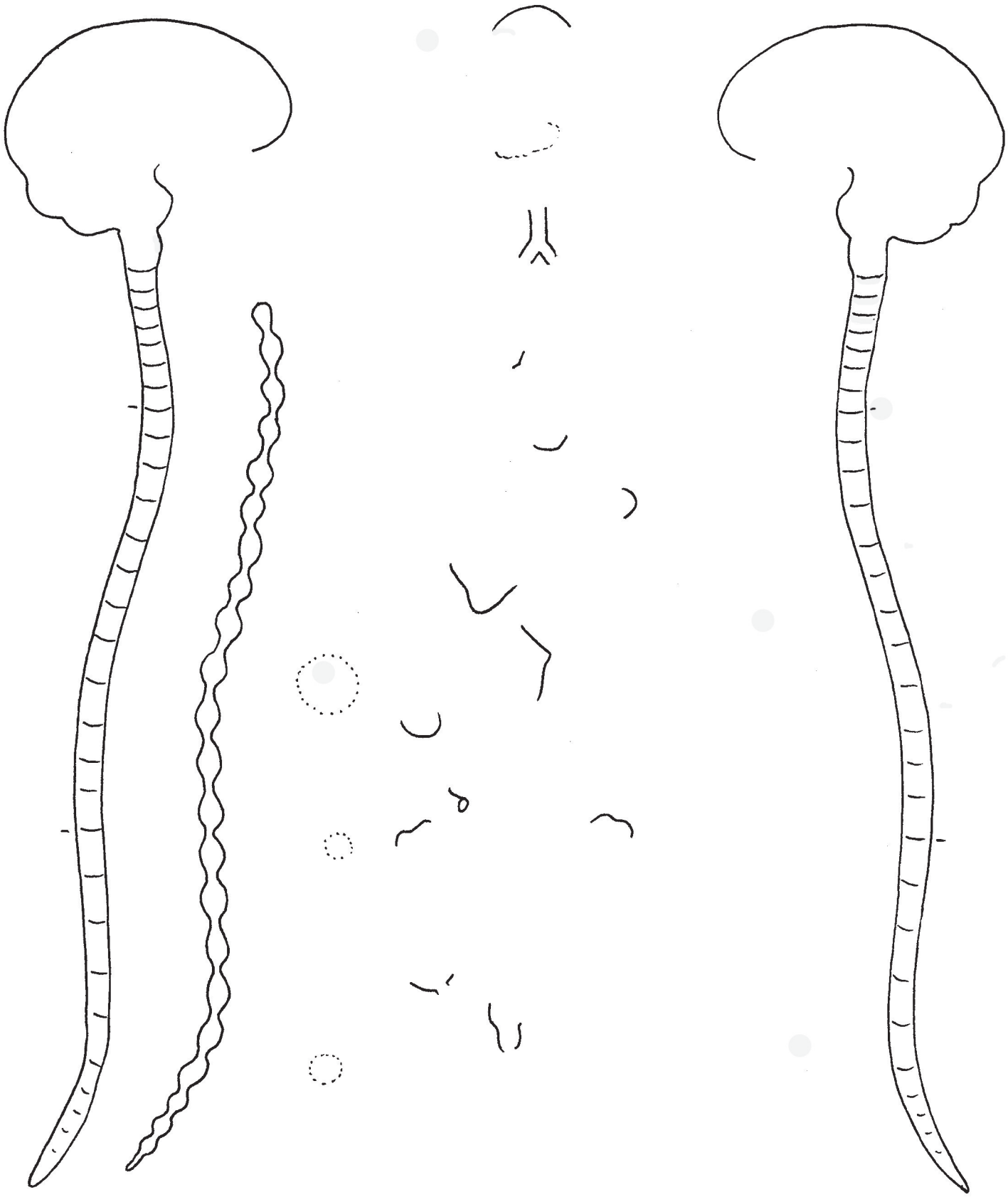


AUTONOMIC NERVOUS SYSTEM

The autonomic nervous system (ANS) is part of the peripheral nervous system (PNS) and functions automatically. Each stimulus travels a route that is made of only 2 neurons.

SYMPATHETIC

PARASYMPATHETIC



MALE REPRODUCTIVE SYSTEM

INTERESTING FACT: The testes produce ***thousands*** of sperm ***per second***.

Hypothalamus has ultimate control over the development and functioning of this system. It tells the pituitary to secrete:

1) _____

2) _____

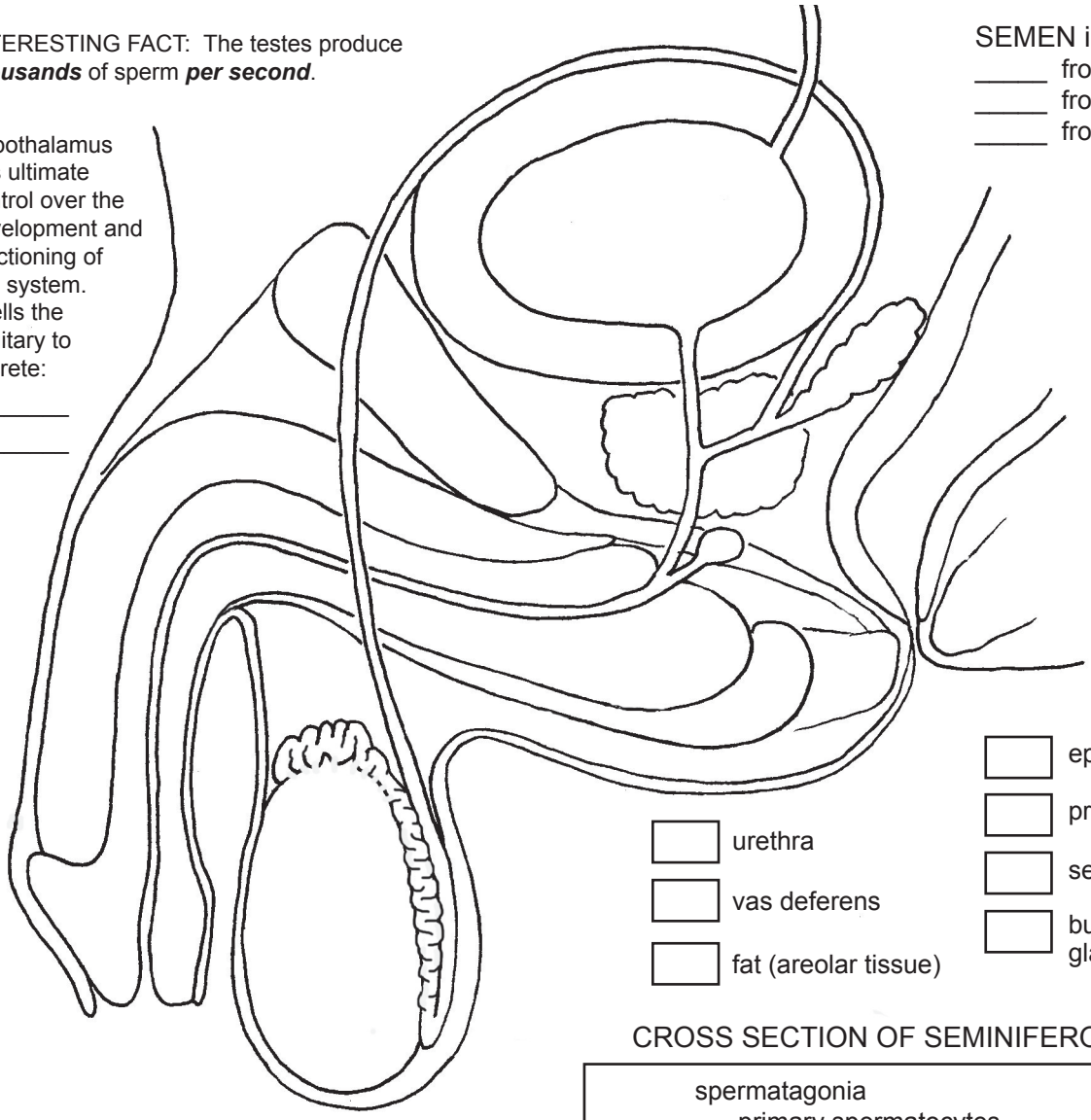
SEMEN is complicated!

_____ from prostate

_____ from sem. vesicle

_____ from bulbourethral

Contains:



☐ urethra

☐ vas deferens

☐ fat (areolar tissue)

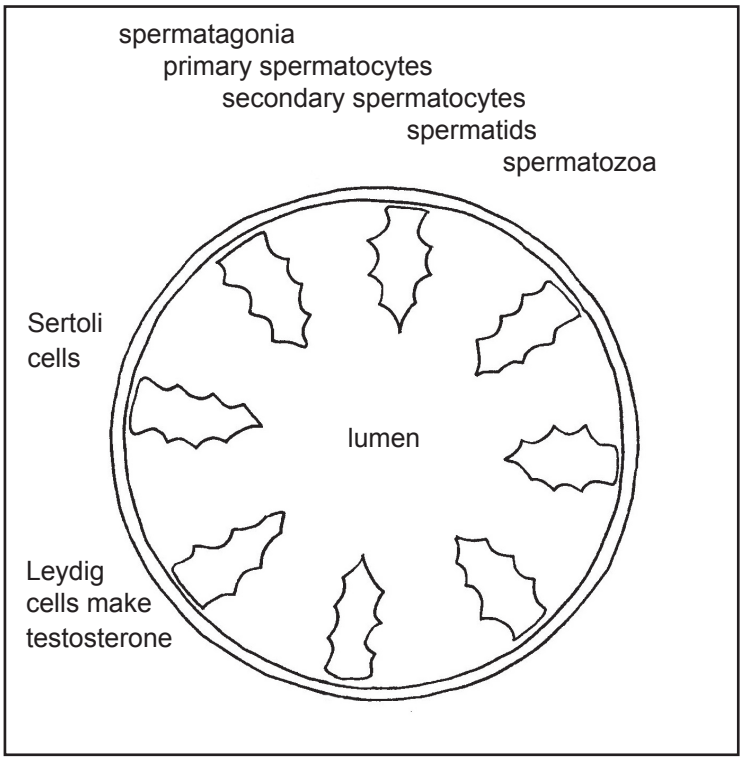
☐ epididymis

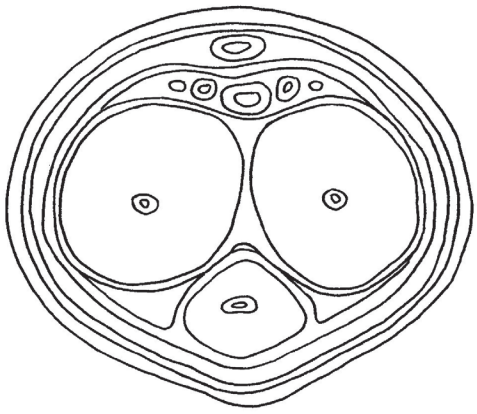
☐ prostate

☐ seminal vesicle

☐ bulbourethral gland

CROSS SECTION OF SEMINIFEROUS TUBULE





CROSS SECTION OF PENIS

☐ corpus cavernosum

☐ corpus spongiosum

☐ loose connective tissue

☐ arteries

☐ veins

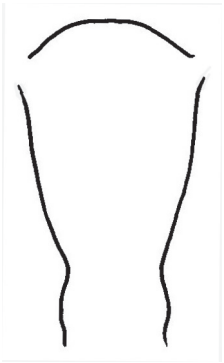
☐ nerves

☐ fascia "bags"

FEMALE REPRODUCTIVE SYSTEM

CROSS SECTION SHOWING ORGANS

FRONT VIEW: UTERUS, OVARIES



(1) Primary follicles: contain an oocyte, and they produce estrogen and progesterone
(2) Primary follicles get larger and are called **secondary follicles.**
(3) A secondary follicle turns into a **vesicular follicle** when it becomes filled with fluid and touches the ovary wall.
(4) The follicle bursts and the oocyte (egg) is released from the ovary. (**ovulation**)
(5) The folllicle turns into a **corpus luteum.** which makes estrogen and progesterone ("pro" means "for," and "gest" means "pregnancy.")
(6) The corpus luteum disintegrates.

☐ = FSH ☐ = LH (pituitary) ☐ = estrogen ☐ = progesterone (ovaries)

IN OVARY	
IN UTERUS	