

Evolution - the GUT of Biology

Grand Unifying Theory:

❑ Linnaean Classification System

- ❑ Hierarchical

❑ Kingdoms

❑ Animalia, Plantae, Fungi

- ❑ Each kingdom divided into single **Phylum**

- ❑ Anthophyta, Echinodermata, Arthropoda, Annelida, etc

- ❑ Each Phylum divided into different **Classes**

- ❑ Mammalia, Aves, Crocodilia, Amphibia, Dipnoi, etc

- ❑ Each class divided into different **order**

- ❑ Primates, Rodentia, Cetacea, Carnivora, Sirenia, etc

- ❑ Each order divided into different **family**

- ❑ Hominidae, Hylobatidae, Lemuridae,

- Tarisaie, etc

- ❑ Each Family divided into different

- Genus**

- ❑ Homo, Pan, Gorilla, etc

- ❑ Each genus divided into different **species**

❑ Domain: Eukarya, Archaea, and Bacteria

- ❑ Domb - Domain

- ❑ King- Kingdom

- ❑ Phillip - Phylum

- ❑ Comes - Class

- ❑ Of - Order

- ❑ Fairly - Family

- ❑ Good - Genus

- ❑ Stock - Species

❑ Evolution:

- ❑ Broadly: Change

- ❑ An **inheritable change** from one generation to the next in **characteristics of a individuals** in a populations

❑ The History of Life on Earth

- ❑ Living things have evolved by descent with modification from common ancestors.

❑ Natural Selection

- ❑ A functional association between individual traits and average reproductive success

❑ Observations:

- ❑ Organism differ from each other, they are variable (they don't all look the same)
- ❑ Some of the differences among organisms are inherited
- ❑ More organisms are produced than survive to reproduce in their turn (a lot more babies than you'll ever get adults)
- ❑ Some of the variations among organisms will affect their ability to survive and reproduce.
 - ❑ **Natural Selection** is when organisms with certain characteristics tend to produce more offspring than other organisms in the same population
 - ❑ Natural selection acts on a characteristic that is inherited then evolution may result.
- ❑ Evidence of evolution
 - ❑ **Fossils Record**
 - ❑ Fossils are mineralized remains of organisms
 - ❑ Evolution does not predict that there will be fossilization (geological process)
 - ❑ Evolution predicts a pattern: any fossils found will be consistent with the descent with modification from common ancestors
 - ❑ 1. Each of the billions of fossils found is a test of evolution
 - ❑ Earth formed 4 and half billion years ago
 - ❑ Oceans formed formed 4 billions years ago
 - ❑ Fossil prokaryotes formed 3 and half billion years ago
 - ❑ Oxygen in air started to build up 2 and a half years ago
 - ❑ Fossil eukaryotes formed a little more than 2 and half billion years ago
 - ❑ Fossil multicellular formals
 - ❑ Fossil animals started to formed
 - ❑ Fossil fungi
 - ❑ Plants formed
 - ❑ And then chordates - fish
 - ❑ Fossil jawless fish
 - ❑ Fossil jawed fish
 - ❑ Fossil amphibians
 - ❑ Fossil reptiles
 - ❑ Fossil therapsids
 - ❑ Fossil mammals
 - ❑ Fossil mammals
 - ❑ Fossil primates
 - ❑ Fossil apes
 - ❑ Fossil hominids
 - ❑ Fossil Homo

- ❑ Fossil Homo
- ❑ Fossil Homosapiens

❑ Fossil transitions

- ❑ We see how animals have transitioned to be the modern animals of today

❑ Biochemistry

- ❑ Pseudogenes
 - ❑ we have a pseudogenes for making vitamin C
- ❑ Universality of DNA as the genetic material
- ❑ Universality of codons
- ❑ Pattern of genetic similarity among related groups, even in non-coding DNA
- ❑ A two-ton carnivorous, aquatic whale is more genetically similar to a sheep than it is to two-ton carnivorous, aquatic fish
- ❑ A 12g insectivorous, flying bat is more genetically similar to an elephant than it is to a 12g insectivorous, flying bird
- ❑ Chimpanzees are more genetically similar to humans than they are to gorillas
- ❑ Agrees with fossil record

❑ Comparative Anatomy

- ❑ Homologous structures: demonstrate common descent
 - ❑ Structure in different species that are similar because of common ancestry
 - ❑ Vestigial structures: demonstrate descent with modification
 - ❑ A feature of an organism that is a historic remnant of a structure that served a function in the organism's ancestors
 - ❑ Whale (they still have the pelvic bone from their ancestors that had fins at the bottom but now do not have them but the bones are there, just not visible)
 - ❑ Superfluous embryonic structures: demonstrate descent with modification
 - ❑ The tail (bone that grows past anal) grows while being an embryo because of ancestor but are not born with it)
- ❑ Agrees with fossil....

❑ Human Evolution

- ❑ Humans are primates
- ❑ Prosimians (babies...), tarsiers, Anthropoids, apes,

Ardipithecus	Australopithecus	Homorectus	Homo Sapiens
4.5 million years ago in Africa	3 million years ago in Africa	1 million years ago in Africa	0.2 million years ago in old Africa, Eurasia, Australia, and Americas
Probably bipedal, tree dweller	Bipedal, terrestrial and tree dweller	Bipedal and terrestrial	Bipedal and terrestrial
Chim-size brain (325 ml)	Chim-size brain (425 ml)	About (1000 ml)	About (1350 ml)
No evidence of tools use	No evidence of tool use	Simple tools and possibly fire	A wide range of complex tools, and art

Natural Selection:

- Evolution may be defined as a change in allele frequency over time
- Natural selection does not result in evolution if the characteristic is not inherited
- If natural selection acts on a characteristic that is inherited then evolution may result. Natural selection does not necessarily result in evolution even if the characteristic is inherited
- Natural Selection is the result of different rates of reproduction
- Natural selection often acts through survival, because the individual generally must survive to reproduce

Modes of Selection:

- Directional Selection:**
 - Natural selection in which individuals at one end of the phenotypic range survive or reproduce more successfully than do other individuals
- Stabilizing (balancing) Selection:**
 - Natural selection in which intermediate phenotypes survive or reproduce more successfully than do extreme phenotypes
- Disruptive selection:**
 - Natural selection in which individuals on both extremes of a phenotypic range survive or reproduce more successfully than do individuals with intermediate phenotypes
 - Which ones do better depending on their traits. The ones with extremes may do worse or better depend

Sexual Selection:

- It is natural selection that acts through access to mates

- ❑ In sexually-reproducing organisms natural selection can also act through access to mates
- ❑ Natural selection (including sexual selection) is the only known mechanism that drives the evolution of adaptations.
- ❑ **Adaptations:**
 - ❑ Inherited characteristic of an organism that enhances its survival reproduction in a specific environment
- Evolution may also be driven by Genetic Drift

Genetic drift:

- ❑ Changes in allele frequency due to chance
- Note that evolution by natural selection is an opportunistic process.
- It is not a perfecting process - it just works with what's available

Common descent:

Speciation:

- ❑ **Species:**
 - ❑ Biological species concept
 - ❑ A group of organism that can potentially interbreed successfully
- ❑ **Speciation** is the evolution of reproductive isolation within an ancestral species, resulting in two or more descendent species
 - ❑ Starts with **geographic isolation**
 - ❑ Physically isolating one part of the species from the other
 - ❑ **Independent evolution**
 - ❑ Each group will have its **own** mutations, genetic drifts, etc
 - ❑ Will be considered **different** species
 - ❑ **Gradual reproductive isolation**
 - ❑ Speciation is often gradual
 - ❑ After many more generations, perhaps interbreeding is only rarely successful
 - ❑ After yet more generations, perhaps interbreeding is impossible

Organisms may be categorized by nutrition:

- ❑ **Autotrophs**
 - ❑ Obtain carbon from carbon dioxide (Calvin Cycle) (plants)
- ❑ **Heterotrophs**
 - ❑ Obtain carbon from organic molecules (animals)
- ❑ **Phototrophs**
 - ❑ Obtain energy from light
- ❑ **Chemotrophs**
 - ❑ Obtain energy from chemicals

Photoautotrophs

- Obtain carbon from carbon dioxide and energy from light

Chemoautotrophs

- Obtain carbon from carbon dioxide and energy from chemicals (can carry out

Photoheterotrophs

- Obtain from organic molecules and energy from light

Chemoheterotrophs

- Obtain carbon from organic molecules and energy from chemicals

Organism may be categorized by type of reproduction:

Sexual

- Haploid cells (gametes) fuse together to form a zygote

Asexual reproduction

- There is no fusion of haploid cells (gametes)

Bacteria

Cyanobacteria: Anabaena - Photoautotrophs - Blue-green Algae

- Most bacteria are chemoheterotrophic
- Spherical shape - coccus
- Rod-shaped - bacilli
- Spiral - spirilli

Bacteria reproduction?

- Binary fission (asexual reproduction)
- Conjugation

Archaea

- Prokaryotes
- Thrive in water

Eukaryotes

- Cytoplasm
- DNA
- Ancestral prokaryote
- Plasma membrane
- Infolding of plasma membrane that produce nucleus
- Cell with nucleus and endomembrane system
- Eukaryotic cell started from a prokaryotic cell
- Bacterial cell was able to survive in a eukaryotic cell and was able to share energy and it eventually became ATP but ATP is no longer bacteria
- Know process of how it became a eukaryotic cell

Example of Eukaryotes

Giardia - chemoheterotroph

- Feeds on intestines after feeding it some water and starts growing

- It used to have mitochondria but not anymore

Trichomonas

- Chemoheterotrophs
- Causes vaginitis

Trypanosoma

- Causes sleeping sickness
- Chemoheterotroph

Euglena

- Photoautotroph / chemoheterotroph
- Eukaryotic cell
- Does Not have a cell wall, has a pellicle instead (soft)
- Has light detector
- Swims around with not light but swims in circle if finds light
- Has a contractile vacuole - pumps water out of cell
- Euglena is hypertonic to its environment
- It has a problem where it takes in too much water
- Typically lives in water and water is hypotonic to its environment

Dinoflagellate

- Photoautotroph

Plasmodium

- Causes malaria
- Feeds on red blood cells
- Chemoheterotroph

Paramecium

- Don't need to know anything sp
- ingest food by endocytosis with food vacuoles
- Live in water
- Reproduces by conjugation

Fungi

Diatoms

- Photoautotroph
- Testa (shell) of diatom
- Golden algae - photoautotroph
- Brown algae - photoautotrophs

Ameoba

- Chemoheterotroph
- Have false feet - pseudopodia
- They are masters of endocytosis
- Smile mould - haploid to diploid when reproduces

Plantae

- Photoautotroph**
- Bryophytes (non vascular plants) - Moss
- charophyceans
- Seed plants
- Angiosperms
- Gymnosperms
- Know the rest of what's in this plantae

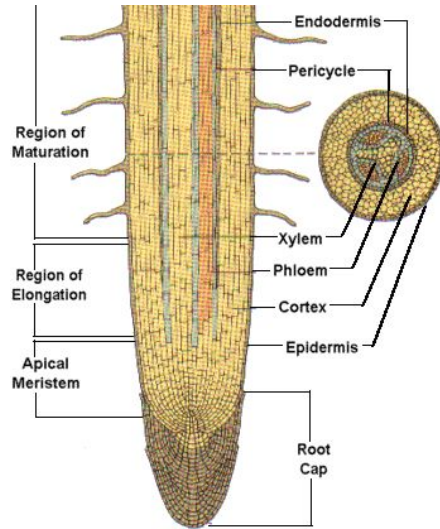
Kingdom Plantae

- Multicellular photoautotrophs
- Cell > tissue > organ > organism**
- Tissue:**
 - A group of similar cells that perform a particular task in an organism
- Group of tissues make an organ
- Organ:**
 - A group of tissues integrated to perform one or more functions in an organism
- Basic tissue types**
 - Meristem tissue:**
 - Unspecialized cells capable of dividing
 - Dermal tissue:**
 - Protection and exchange with environment
 - Ground tissue:**
 - Several types
 - Variety of functions
 - It is a "filler"
 - Vascular tissue:**
 - Transport of substances in the plant
 - Two types
 - Phloem**
 - Transport sugar in the plant
 - Two types of cells** found in Phloem
 - Sieve-tube members**
 - At maturity cells lose their nuclei and most organelles
 - Companion cells**
 - Maintain sieve-tube members
 - Xylem:**

- Transport water and minerals from roots
- Two types of cells**
 - Vessel elements and tracheids
 - At maturity cells die, leaving a tube of cell walls

- Plant organs**

- Roots** (are organs)
 - Absorbs water and minerals
 - Anchors the plant
 - Stores food
 - Root has:
 - Root cap
 - Apical meristem: Zone of cell division
 - Zone of elongation
 - Zone of maturation
 - Cortex
 - Epidermis
 - Root hair
 - Vascular tissue
 - Etc..
 - Know anatomy of root



☐

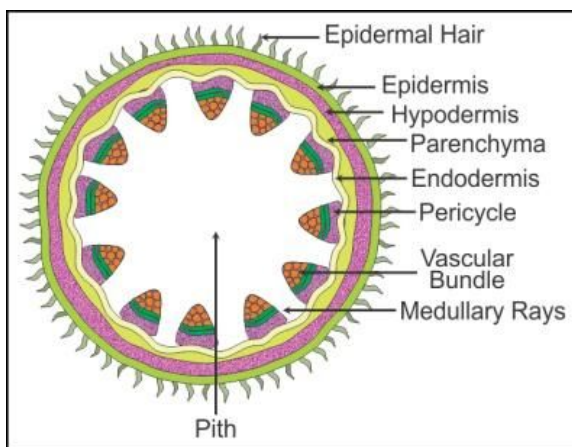
ROOT ANATOMY

- Root cap
- Region of cell division
- Region of elongation
- Region of differentiation or maturation

☐ Stem

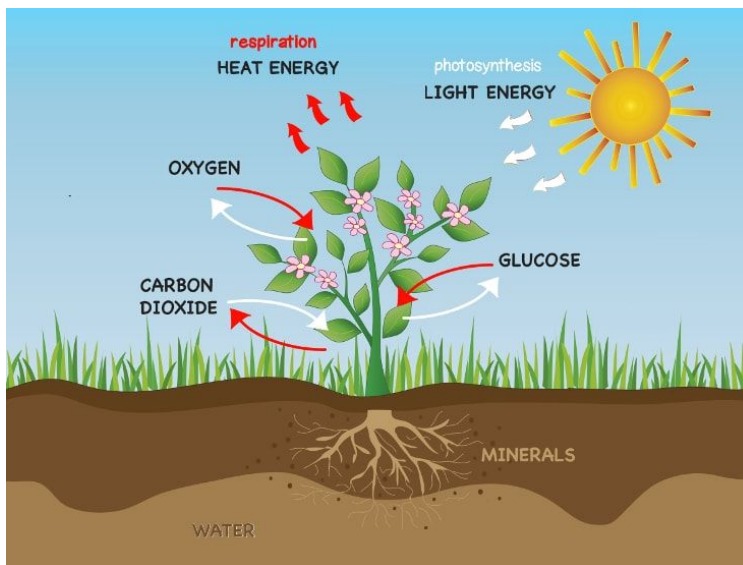
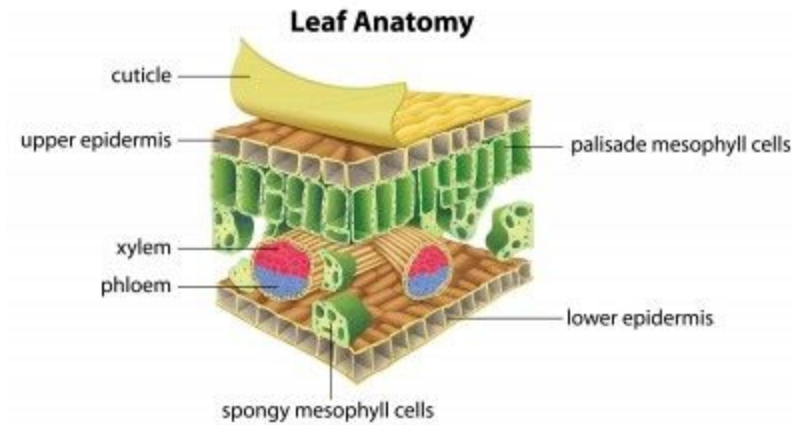
- ☐ Hold leaves up
- ☐ Transport between leaves and roots
- ☐ Photosynthesis
- ☐ Stores food
- ☐ **Anatomy:**
 - ☐ Leaf primordia
 - ☐ Apical meristem
 - ☐ Axillary bud meristems
 - ☐ Cortex
 - ☐ Epidermis
 - ☐ Vascular bundle

- Phloem
- Fibres
- Xylem
- Vascular cambium
- Pith
- Primary tissues mature from apical meristem
 - Primary Xylem
 - Primary Phloem
- Secondary tissues mature from cambium
 - Secondary Phloem
 - Secondary Xylem



Leaf

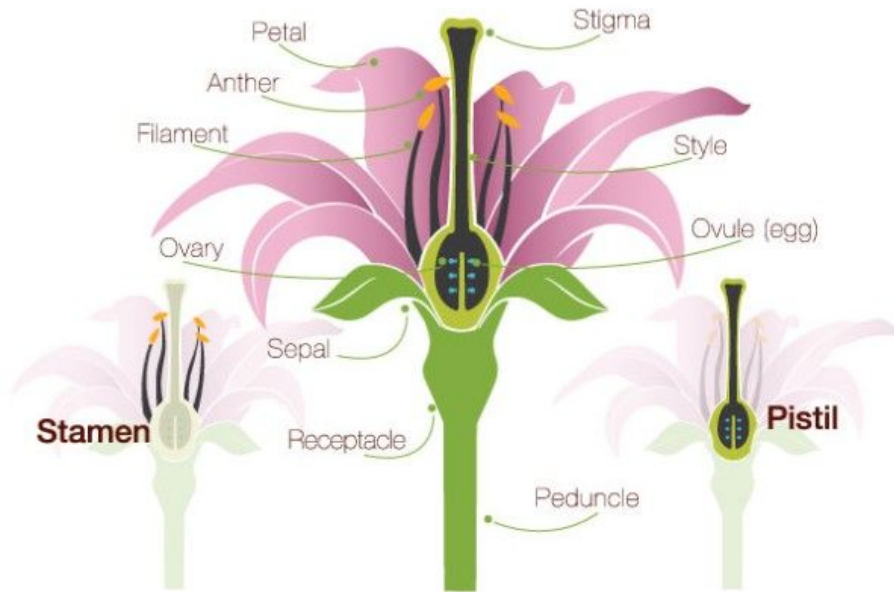
- to collect sunlight and make food by photosynthesis
- Anatomy:
 - Guard cells
 - Guard cells and close and open the stomata while transporting things but at the same time making sure that it is not dry
 - Stoma
 - Cuticle
 - Upper epidermis
 - Lower epidermis
 - Spongy Mesophyll
 - Palisade mesophyll
 - Mesophyll is usually where there is a lot of photosynthesis
 - They are packed with chloroplast
 - Vein
 - Go through the plant



❑ Flower

- ❑ Sexual reproduction
- ❑ Receptacle
- ❑ Sepal
 - ❑ Covers the flower before it blooms
- ❑ Inside the sepal = **petals**
 - ❑ Brightly colored
 - ❑ Attracts insects
- ❑ **Stamen**
 - ❑ “Male part of the flower”, so people say but may be wrong
 - ❑ **Filament**
 - ❑ **Anther** (filament holds it up)
 - ❑ Made up of 2 pollen sacks
- ❑ **Carpel**
 - ❑ “Female part of the flower”
 - ❑ **Stigma**
 - ❑ Held up by a long part of the carpel called the style

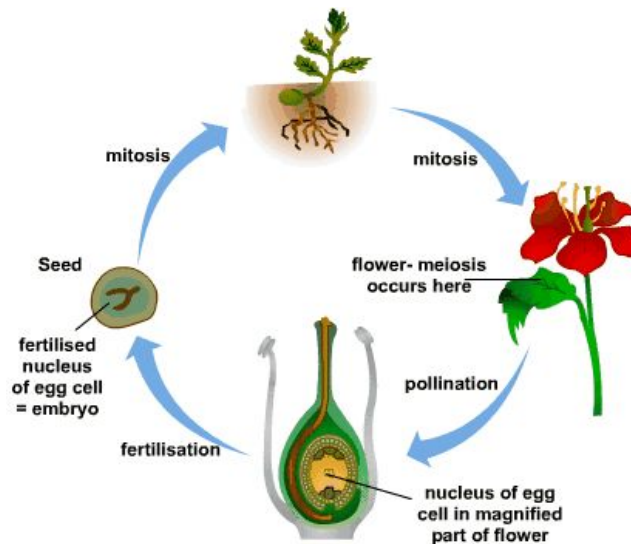
- ❑ **Style**
- ❑ **Ovary**
 - ❑ The base of the style
 - ❑ Inside ovary there are **Ovules**



❑ **Plant life Cycle**

- ❑ Flowers produce **Sporophyte**
- ❑ Made of diploid cells
- ❑ Starts in pollen sack, pollen sack goes through Meiosis and Produce spores, and the spores then, Mitosis happens and grows into Male gametophyte
- ❑ For females spore produces in ovule and ovule grows into female gametophytes
- ❑ **Work on reproduction**

- ❑ The function of the seed is to protect the embryo



❑ Differences

❑ MonoCot

- ❑ Only have a single cotyledon
- ❑ Vascular cylinder is bigger
- ❑ Arrangement of tissues
- ❑ The vascular bundles are spaced out
- ❑ They don't have cambium in the roots and in the stems which means that they don't have secondary growth
- ❑ The leaves are just straight up on branching from each other
- ❑ Flower: Parts in three

❑ Dicot

- ❑ Two cotyledons
- ❑ The stem: The vascular bundles are close together
- ❑ The seem to branch from each other
- ❑ Flower: Parts of fours and fives
- ❑ The vascular cylinder is smaller

❑ Fungi

- ❑ Eukaryotic
- ❑ Chemoheterotrophic
- ❑ Absorb nutrients directly from the environment
- ❑ Typically multicellular
- ❑ Typically made up of filaments called hyphae
- ❑ Mushroom Anatomy:
 - ❑ Mycelium
 - ❑ Reproductive structure

❑ Zygomycota (life cycle)

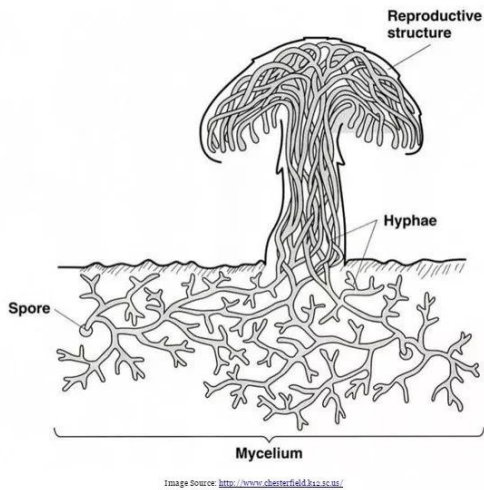
❑ Sexual life cycle

- ❑ Only if conditions are not that good
- ❑ Mating, young zygosporangium, Diploid, Meiosis, dispersal and germination
- ❑ They can reproduce without sexual bit
 - ❑ By hyphae producing spores

❑ Basidiomycota (life cycle)

- ❑ Sexual reproduction: under right conditions
- ❑ Mating, Haploid mycelia, Dikaryotic mycelium, basidiocarp (dikaryotic), Meiosis, produces haploid spores, basidium with four appendages, etc

❑ Work in this



Kingdom Animalia

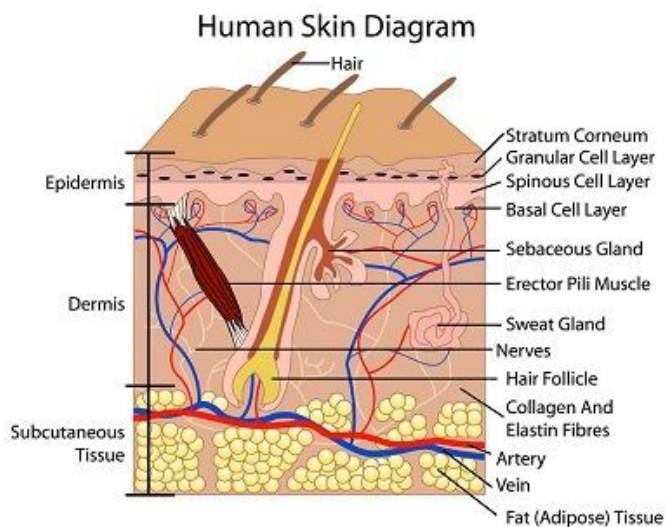
- Chemoheterotrophic
- Multicellular
- Cells arranged into tissue and tissues arranged into organs
- Organs founded into organ systems
- Maintain homeostasis
 - ◆ The steady-state physiological condition of the body

- ◆ The body maintains the internal environment within the narrow limits required for life
 - Temperature
 - Acidity (PH, body fluid)
 - Osmotic potential
 - Concentration of O₂, CO₂, food, wastes,.....
- Homeostasis is typically maintained by organ systems
- Organ systems are made up of organs
- Organs are made up of tissues
- There are four basic animal tissue types:
 - ◆ **Epithelial tissue** - Surface/covering (covering the outside)(ex: lining your lungs, etc)
 - Cuboidal epithelium
 - Squamous epithelium
 - Columnar epithelium (long like a column)
 - Simple tissue (single layer of cells) squamous epithelium
 - Stratified (multiple layers of cells) squamous epithelium
 - ◆ **Connective tissue** - Cells in matrix
 - Loose connective tissue (elastic) (loose skin)
 - Fibrous connective tissue
 - Bone
 - Cartilage
 - Adipose tissue (storage of fat)
 - Blood - plasma (circulatory system) (used to transport materials from one part of your body to another)
 - ◆ **Muscle tissue** - Contracting
 - Skeletal muscle
 - Muscular system is mostly made of
 - Rigged appearance
 - Have some type of control
 - Cardiac Muscle
 - Long fibers that have a bit of a rigged appearance like skeletal

- Has branches
- No conscious control
- In your heart
- Smooth muscle
 - Each cell has a single nucleus
 - Around digestive system mostly
 - We don't have control of it
- ◆ **Nerve tissue** - Conducting
 - Mucosa
 - Submucosa
 - Muscularis
 - Serosa

Integumentary System (SKIN)

- Protection from mechanical injury
- Immunity (protecting body from infection)
- Osmoregulation (regulation of osmosis)
 - ◆ regulating water concentration on body)
- Thermoregulation
- Sensing the environment



Muscular System

- Movement
- Protection from mechanical injury
 - ◆ Something hitting you or you bumping into something
- Thermoregulation
- About 650 muscles in humans
- Tendons attach muscle to bone
- Muscles cannot pull they only contract

Skeletal System

- Protection from mechanical injury
- Provides support
 - ◆ (for other organs)
 - ◆ Ex: When your breathing, your ribs give your lungs space
- Leverage for movement
- Storage of minerals (e.g., Calcium)
 - ◆ If your calcium level gets too low you die
- Production of blood cells
 - ◆ Particular bones generate blood for cells
- Ligaments allow limb to bend
- Ligaments attach bones to bones

Animal Phyla

- Porifera
 - ◆ Animals known as sponges
- Filter food from water
- Their skeleton is very spongy (for some)
- Cnidaria

- ◆ Sea anemone, Sea jella, coral, hydra

→ Platyhelminthes

- ◆ Flatworm

- ◆ Platy (flat) helminths (worm)

→ Mollusca

- ◆ Snail, slug, limpet, chiton, clam, mussel, scallop, squid, octopus, cuttlefish, nautilus

→ Annelida

- ◆ Segmented Worm

- ◆ Earthworm, sandworm, leeches

→ Nematoda

- ◆ Roundworm

→ Arthropoda

- ◆ Centipede, millipede, insect, spider, scorpion, crustacean

- ◆ Arthropoda = jointed legs

→ Echinodermata

- ◆ Sea star, sea urchin

- ◆ Means spiny skin

→ Chordata

- ◆ Tunicate, fish, amphibian, reptile, bird, mammal, vertebrate

Nutrition

→ Unicellular chemoheterotrophs obtain molecules from their environment

- ◆ Active transport

- ◆ Passive transport

- ◆ Endocytosis

- ◆ Intracellular digestion

- Digestion happening inside the cell

- ◆ Extracellular digestion

- Digestion taking place outside the cell

Digestive System

1. Starts with ingestion of food
2. Digest the food
3. Extract **nutrients**
4. Elimination of waste

→ **Nutrients:**

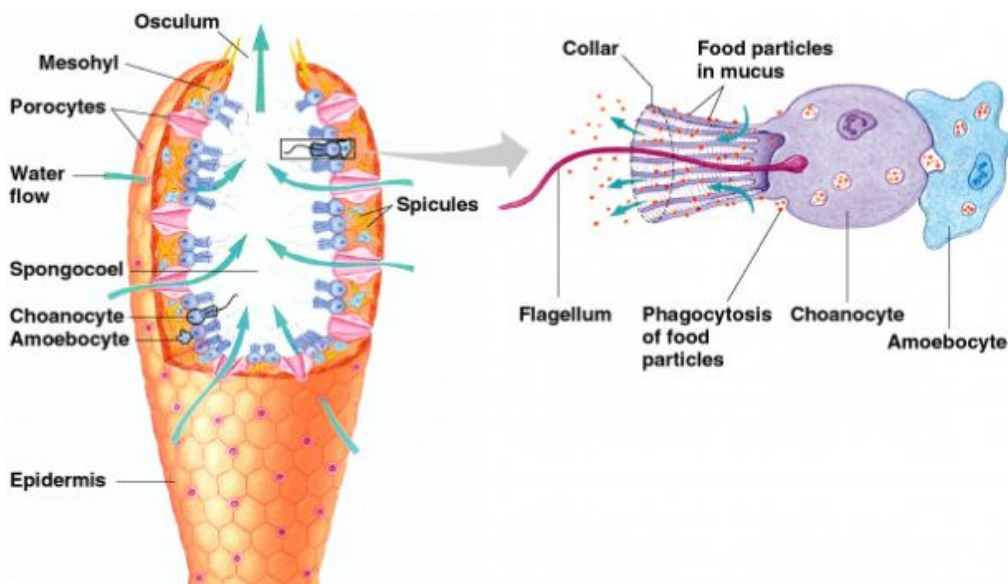
◆ Chemical energy

- Carbohydrates
- Lipids
- Proteins
- Vitamins
 - Organic molecules that your body needs but can't make
- Minerals
 - Inorganic material that your body needs

◆ Ex: Iron

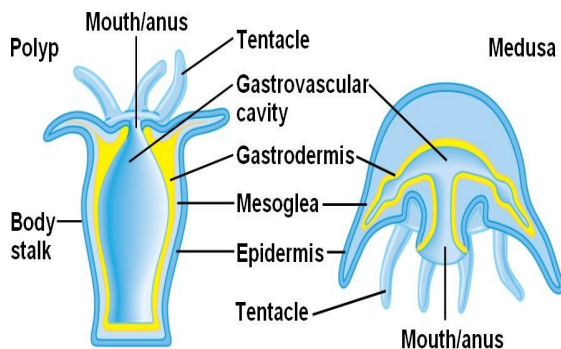
→ Porifera

- ◆ Do not have a digestive system
- ◆ Intracellular digestion
- ◆ Cells that get together to form a current and

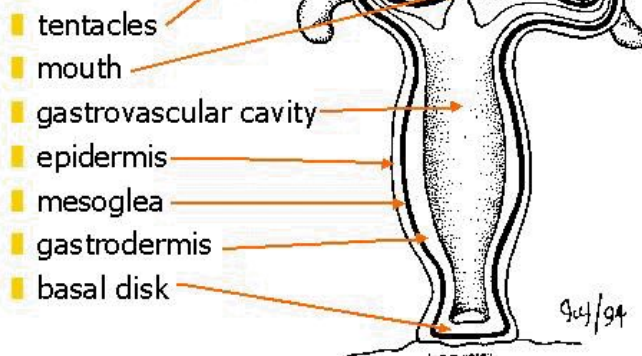


→ Cnidaria

- ◆ Polyp form and medusa form
- ◆ 1. Trap prey through tentacles and suction into mouth which then goes into a big bag
- ◆ Bag (**gastrovascular cavity**) - where food is brought
- ◆ 2. **Gland cells**:
 - Release enzyme into the gastrovascular cavity that break down the food
- ◆ **Intracellular digestive** breaks it down even more
- ◆ Goes back up the mouth (mouth is also anus)
 - This is an incomplete digestive system
 - Food enters and waste through the same opening
- ◆ **Intracellular and extracellular digestion**

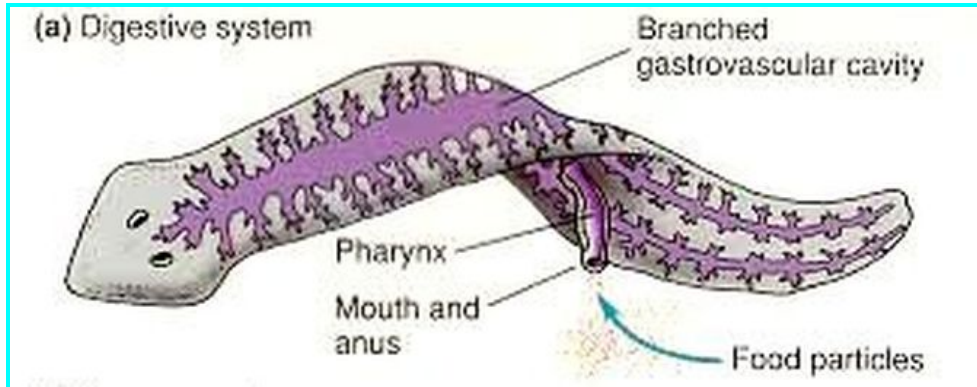


Hydra



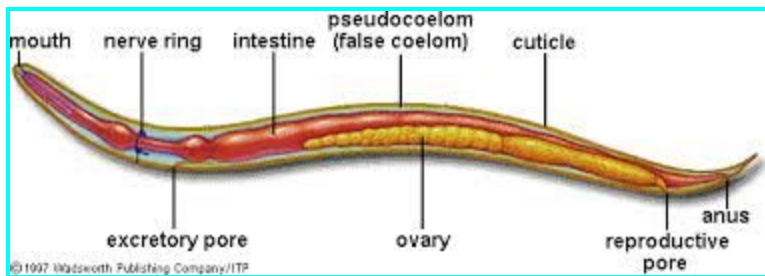
→ Platyhelminthes

- ◆ Gastrovascular cavity
- ◆ Single opening - Mouth/opening
- ◆ Food gets in through mouth and
- ◆ Incomplete digestive system
- ◆ Intracellular and extracellular digestion



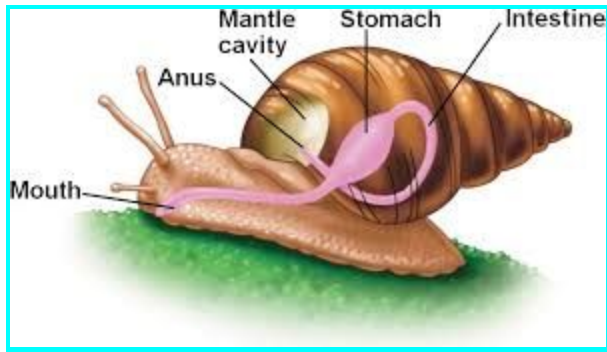
→ Nematoda

- ◆ Goes in through Mouth
- ◆ Gut
- ◆ Alimentary canal
- ◆ Anus
- ◆ Complete digestive system
- ◆ Extracellular digestion



→ Mollusca

- ◆ Complete digestive system
- ◆ Extracellular digestion



- Echinodermata
 - ◆ Complete digestive system
 - ◆ Extracellular digestion
- Annelida
 - ◆ Complete digestive system
 - ◆ Extracellular digestion
- Arthropoda
 - ◆ Complete digestive system
 - ◆ Extracellular digestion
- Chordata
 - ◆ Complete digestive system
 - ◆ Extracellular digestion

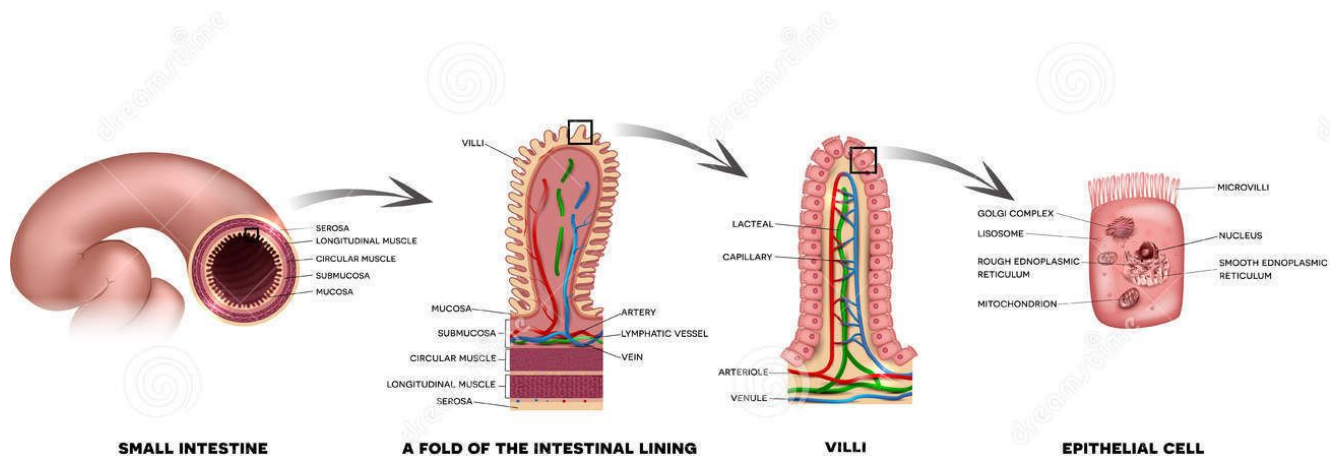
The Human Digestive system

- Oral Cavity
- Salivary Glands
 - ◆ Saliva
 - Hold lump of food together
 - Lubricate lump of food
 - Enzymes for digestion
- Teeth
- Mouth
- Tongue
- Pharynx
 - ◆ Chamber of space behind the oral cavity

- ◆ It connects to the navel cavity
- Nasal Cavity
- Glottis
- Esophagus
- Epiglottis
 - ◆ Directs food into esophagus rather than the glottis
- Peristalsis
 - ◆ Pattern of contraction and relaxation that moves food down the esophagus and dumps it into the stomach
- Sphincter
 - ◆ Closes off and prevents the food from going past the stomach
- Stomach
 - ◆ Folds of epithelial tissue
 - ◆ Gastric glands
 - Makes mucus
 - To protect the stomach from digesting itself
 - ◆ Interior surface of stomach
 - ◆ enzymes
 - ◆ Cells release HCL (hydrochloric acid)
 - Breaks down food and activates enzyme
 - ◆ The stomach
 - Stores food
 - Digests food
 - Kills bacteria
 - ◆ The stomach does not:
 - Absorb nutrients
 - ◆ Sphincter then releases Acid
 - ◆ The pancreas
 - Produces pancreatic juice
 - Neutralizes acidity
 - It goes into the small intestine
 - Pancreatic juice has bicarbonate

- Enzymes
- ◆ Liver
 - Releases Bile
 - **Bile**: Emulsifies fats
 - Stores bile in gallBladder
- ◆ Gallbladder
- Small intestine
 - ◆ Digests food
 - ◆ Absorbs nutrients
 - Produces enzymes
 - Inside:
 - Muscle layers
 - Villi
 - ◆ Epithelial cells
 - Large circular folds
 - Intestinal wall

SMALL INTESTINE



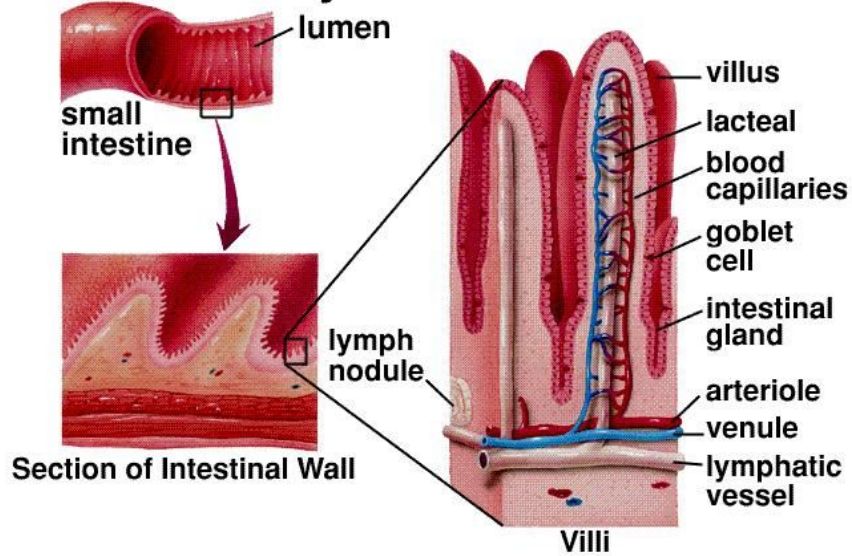
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Anatomy of Small Intestine



→ Large intestine

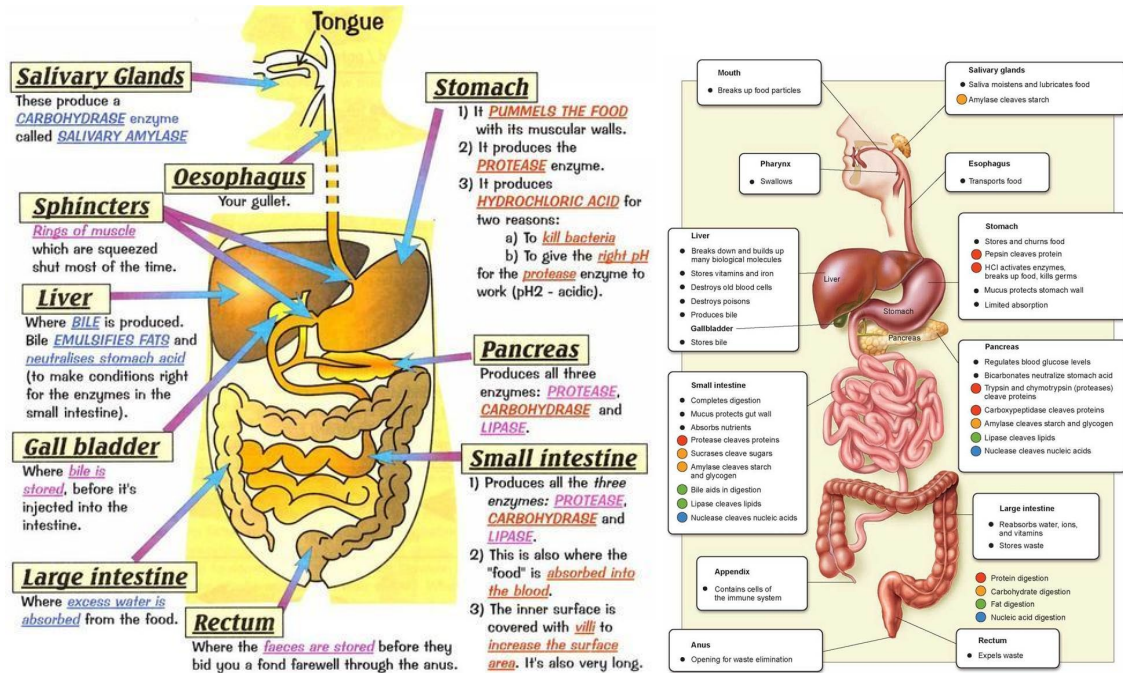
- ◆ Absorb water and minerals
- ◆ Appendix

→ Rectum

- ◆ Stores the waste until it's time to get rid of it

→ Anus

- ◆ Move other stuff through the system



Respiratory System

→ Functions;

- ◆ Absorption of oxygen
- ◆ Elimination of carbon dioxide

→ Porifera (sponges)

- ◆ No respiratory system

→ Cnidaria

- ◆ No respiratory system

Cnidaria: Respiratory System

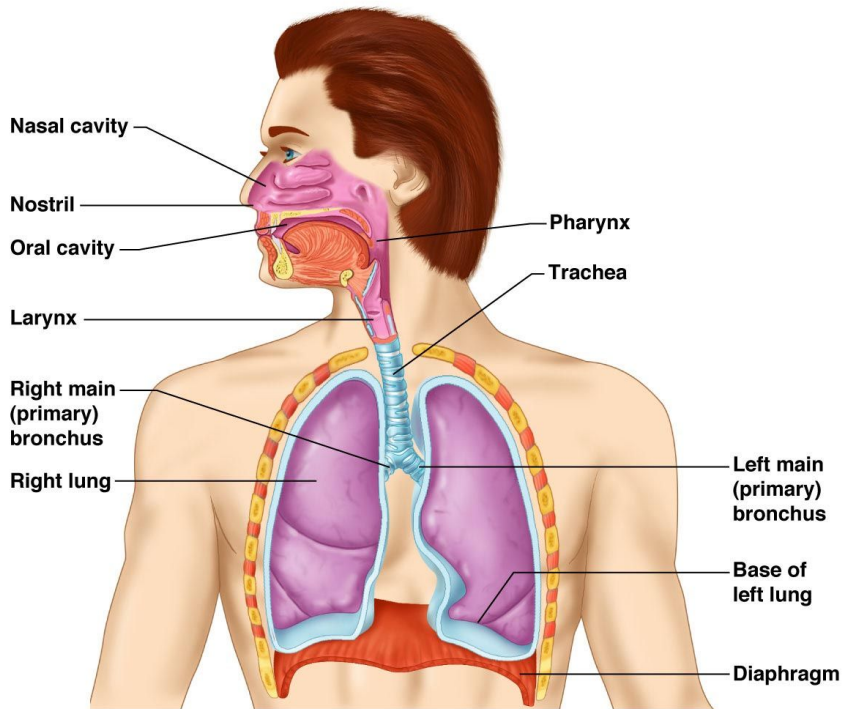
- No respiratory organs
- Oxygen is absorbed through both layers of skin
- Carbon dioxide is expelled through both



→ Platyhelminthes

- ◆ No respiratory system
- Nematoda
 - ◆ No respiratory system
 - Gills allow gas exchange
 - ◆ Works well its wet
- Echinodermata
 - ◆ Have gills
 - ◆ In addition Tube feet also allow gas exchange
- Annelida
 - ◆ Have gills
 - ◆ Cannot exchange gas and may die if gills aren't moist or wet
- Mollusca
 - ◆ Have gills
 - ◆ Mantle cavity
 - ◆ Since gill in chamber, it's easier to keep gills moist
 - ◆ lungs
- Arthropoda
 - ◆ Have gills
 - ◆ Spiders: Internal gill
 - Breath through abdomen
 - ◆ Lung
 - ◆ trachea
 - ◆ Insects:
 - Spiracle
 - Trachea
 - ◆ Air goes in and out through there
- Chordata
 - ◆ Gills
 - ◆ Lungs

Human Respiratory system



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- Nostril
- Nasal cavity
 - ◆ Hollow chamber
- Oral cavity
- Pharynx
- Glottis
 - ◆ Opening between pharynx and larynx
- Larynx
 - ◆ Surrounded by cartilage
- Trachea
- Bronchus
 - ◆ Two bronchi
 - ◆ Bronchial tree
 - ◆ Bronchial tree
 - Bronchioles at the end
 - Alveoli
- Lung
- Heart

→ Diaphragm

→ Respiratory system (except alveoli and bronchioles)

◆ Conduct air

◆ Filter

◆ Warm

◆ Humidity

→ Alveoli and bronchioles

◆ Adjust air flow

◆ Gas exchange

→ Typical volume of air in lungs (ml)

◆ Typical inspiration 2,700

◆ Typical expiration 2,200

◆ Forced expiration 1,200

Distribution

Unicellular organisms move materials through cyclosis and along the cytoskeleton

Circulatory system

→ Distribution of materials in the body

→ Closed circulatory systems:

◆ have the blood **closed** at all times within vessels of different size and wall thickness. In this type of **system**, blood is pumped by a heart through vessels, and does not normally fill body cavities.

→ Open circulatory systems:

◆ (evolved in crustaceans, insects, mollusks and other invertebrates) pump blood into a hemocoel with the blood diffusing back to the **circulatory system** between cells. Blood is pumped by a heart into the body cavities, where tissues are surrounded by the blood.

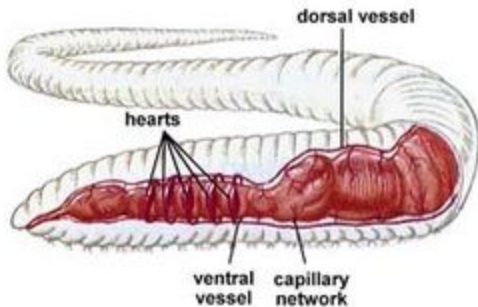
◆ Porifera

- Don't have a circulatory system

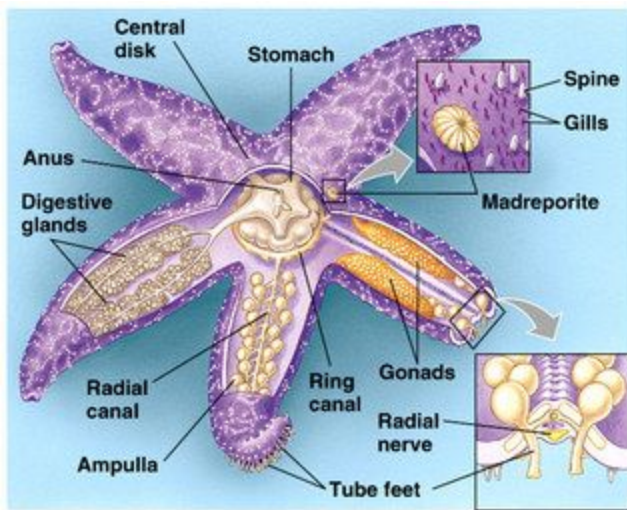
◆ Cnidaria

- No circulatory system
- Gastrovascular system = distribution of materials

- ◆ Platyhelminthes
 - Don't have a circulatory system
- ◆ Nematoda
 - No circulatory system
- ◆ Annelida
 - Closed circulatory system : blood remains enclosed within the system



- ◆ Arthropoda
 - Open circulatory system
- ◆ Mollusca
 - Usually open circulatory system but some don't like squid, etc...
- ◆ Echinodermata
 - Open circulatory system
 - And Water vascular system



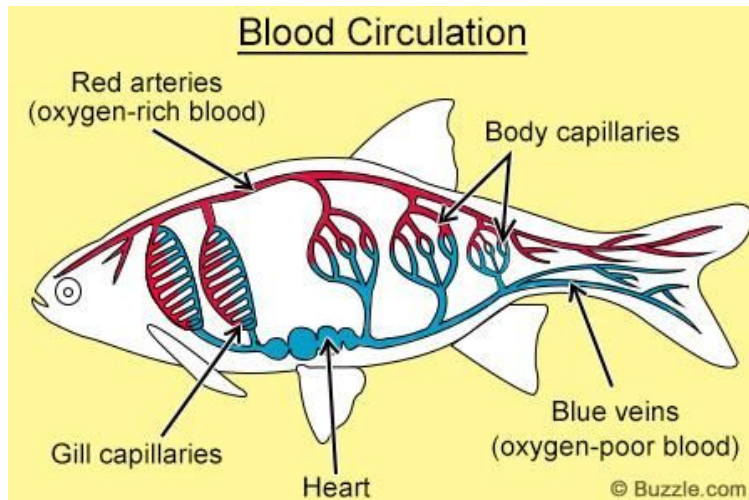
- ◆ Chordata

- Closed circulatory system

Pattern of Circulation : Chordata

→ Fish

- ◆ 2 chambers in heart
 - Atrium & ventricle
- ◆ Atrium
 - Pumps blood into ventricle
- ◆ Ventricle (more muscular)
 - Contracts to push blood out into the rest of the body
- ◆ Blood that is low in oxygen is blue (not actually)



→ Amphibians

- ◆ Two separate heart
- ◆ Three chambers
 - 2 atrium & 1 ventricle
- ◆ Goes to lungs and skin (frogs can breathe for long underwater)

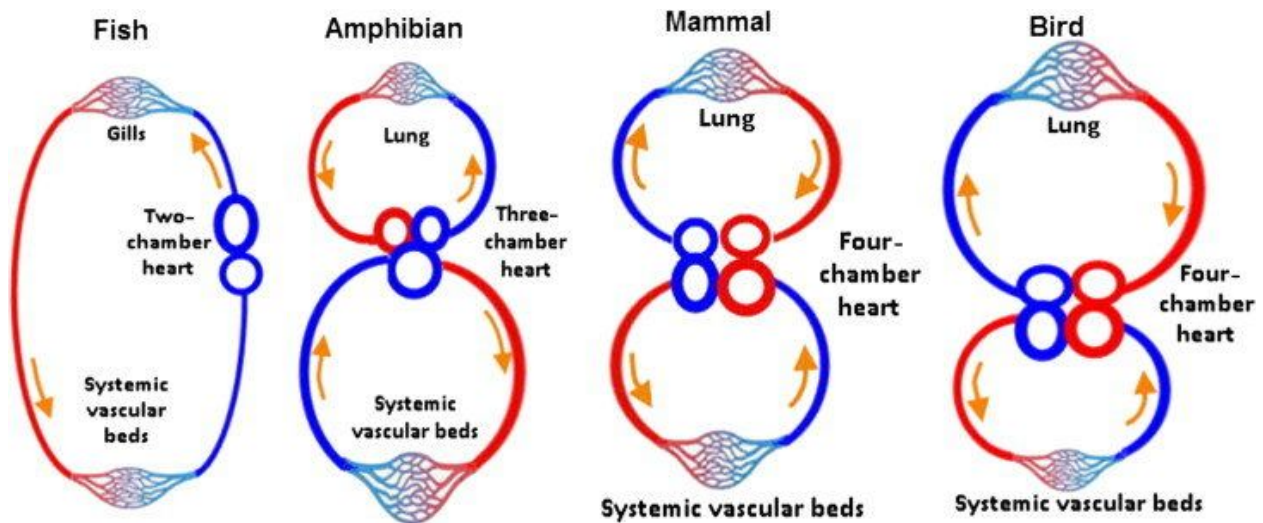
→ Reptile (excluding birds)

- ◆ Two main blood circuits
- ◆ 3 chambered heart
- ◆ Right and left side are partially separated
- ◆ Two atria and something between 1-2 ventricles
- ◆ Fall between 3-4 chambered heart

- ◆ (When body has low temperature, metabolism slows down and breathing slows down and eventually stops breathing)

→ Mammal or Bird

- ◆ (warm blood)
- ◆ High metabolic rate, can't hold breath for very long
- ◆ 2 atria & 2 ventricles



The human circulatory system

→ Heart

- ◆ 4 chambers
- ◆ Pumps blood into arteries

→ Arteries

- ◆ Carry blood from the heart
- ◆ To capillaries

→ Capillaries

- ◆ Exchange (blood) with other tissues happens
- ◆ Into veins

→ Veins

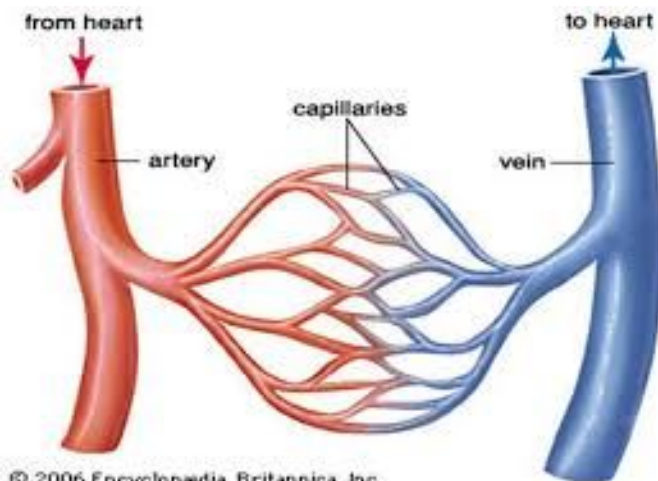
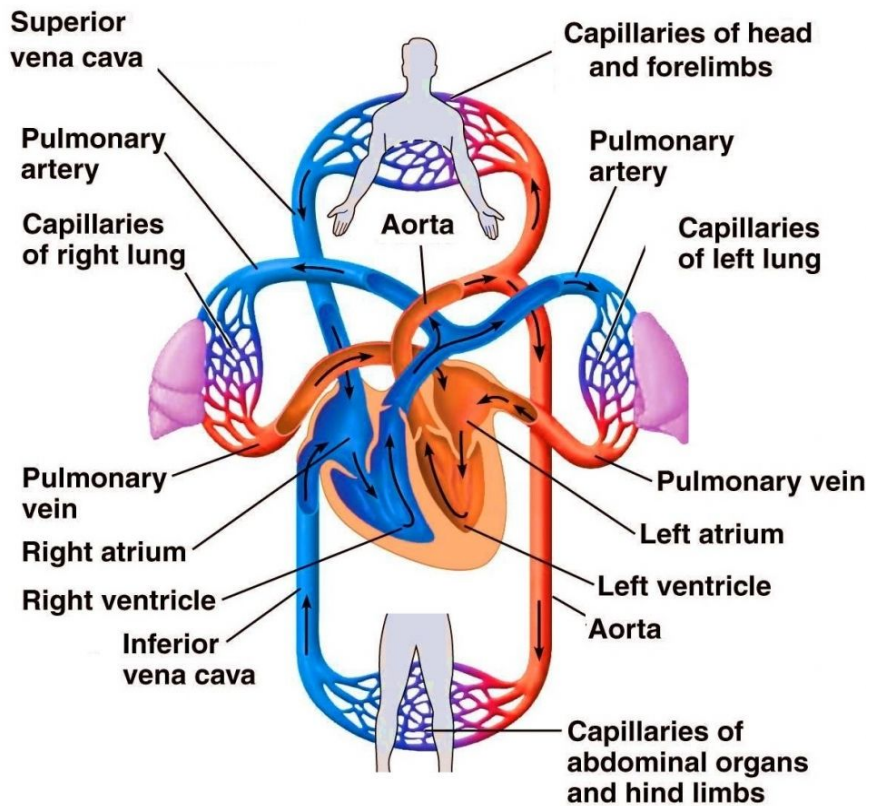
- ◆ Carry blood back to the heart

→ <https://kidshealth.org/en/teens/heart.html>

→ https://www.youtube.com/watch?v=f9ONXd_-anM

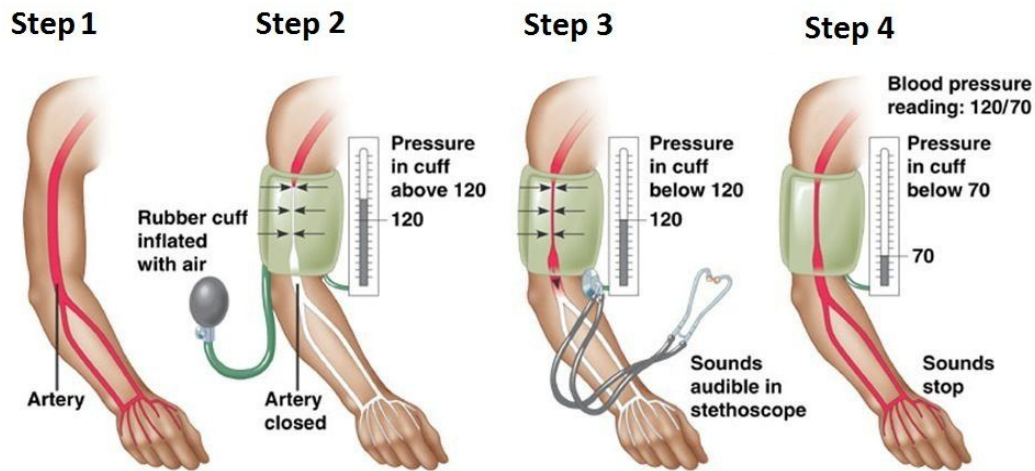
- Speed in capillaries is slowest
- When ventricles contract, pressure gets higher and then slows that as blood flows away
- Diastolic & Systolic pressure

Circulatory System



→ Measurement of blood pressure

Measurement of blood pressure



→ Epithelial tissue is the tissue that lines the artery

◆ Blood is in direct contact with it

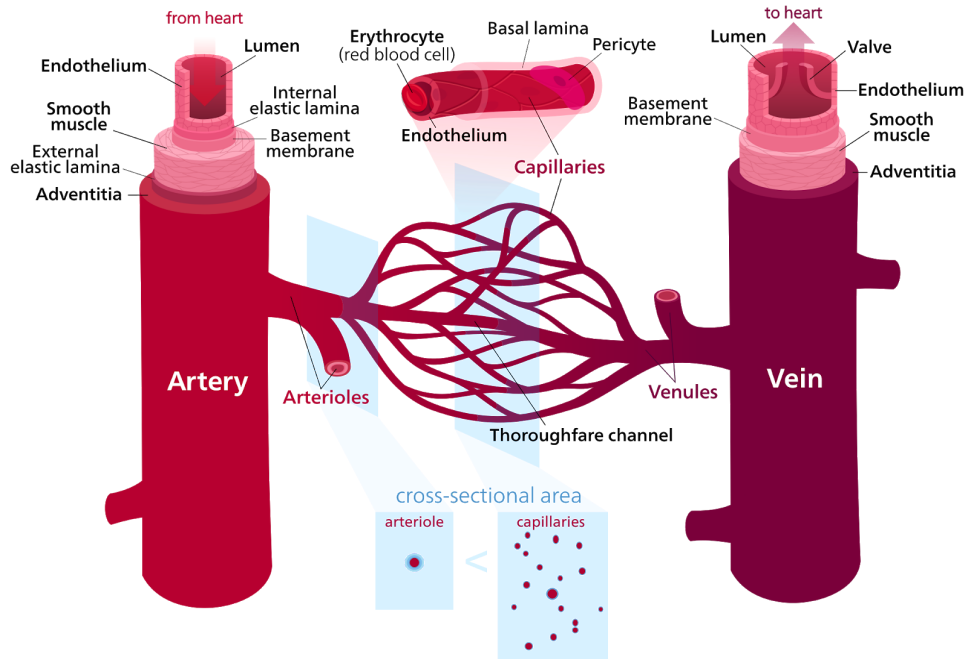
→ Around that: **smooth muscle**

◆ Helps to control blood pressure and its directions

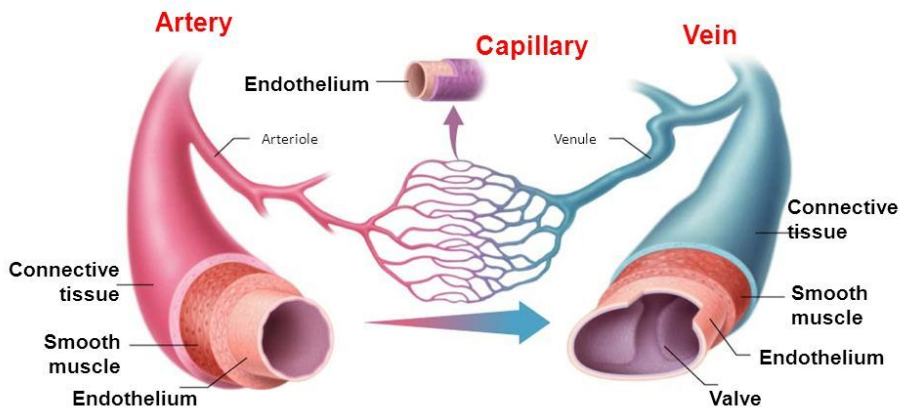
→ Connective tissue (elastic)

◆ Allows artery to expand

→ Veins have one way valves



Structure of Blood Vessels



392 2/8/11

→ Normal body movements are important for the heart

→ Blood:

◆ Plasma:

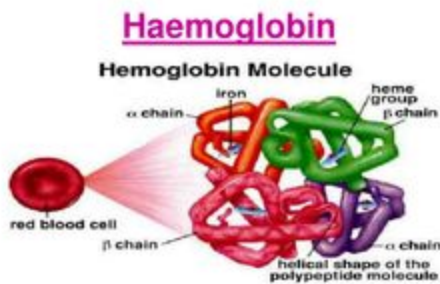
- 55%
- Mostly water
- Acts as a solvent for carrying other substances

- Dissolved in that water:
 - Ions (blood electrolytes) - important in osmotic balance
 - Plasma **Proteins** - osmotic balance
 - Substances transported by blood - sugar, hormones, CO₂, etc...

◆ **Red blood cells (erythrocytes)**

- 44%
- What gives blood its red color
- Transport of oxygen and carbon dioxide
- Haemoglobin

New AQA AS Biology

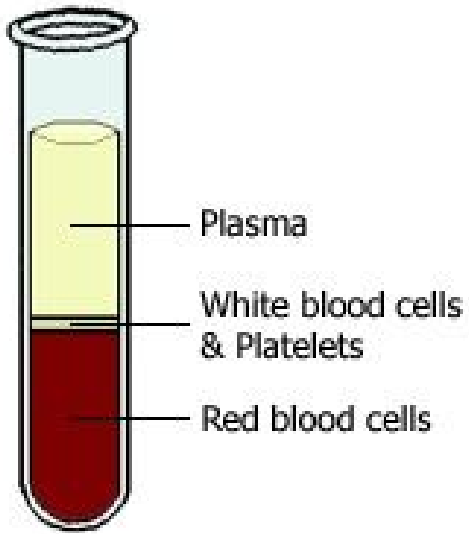


◆ **White blood cells**

- Leukocytes (white blood cells)
 - Defense and immunity

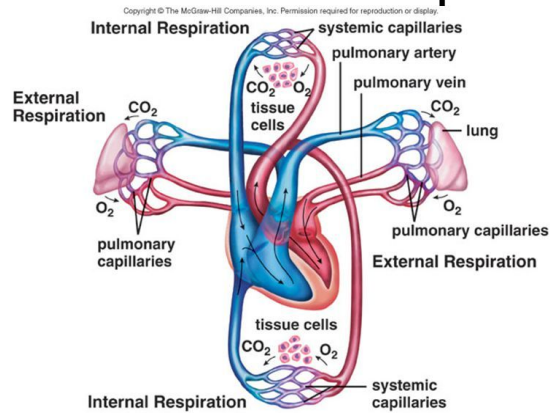
◆ **Thrombocyte (platelets)**

- Surrounded by plasma membrane
- Fragment of cell
- **Initiate blood clotting**
- White blood cells & platelets = 1%



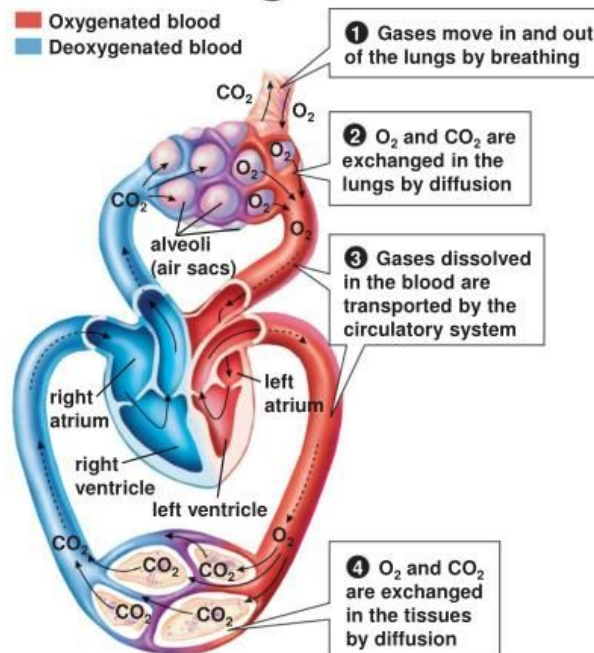
Gas Exchange

External and internal respiration



15-30

Gas Exchange in Mammals

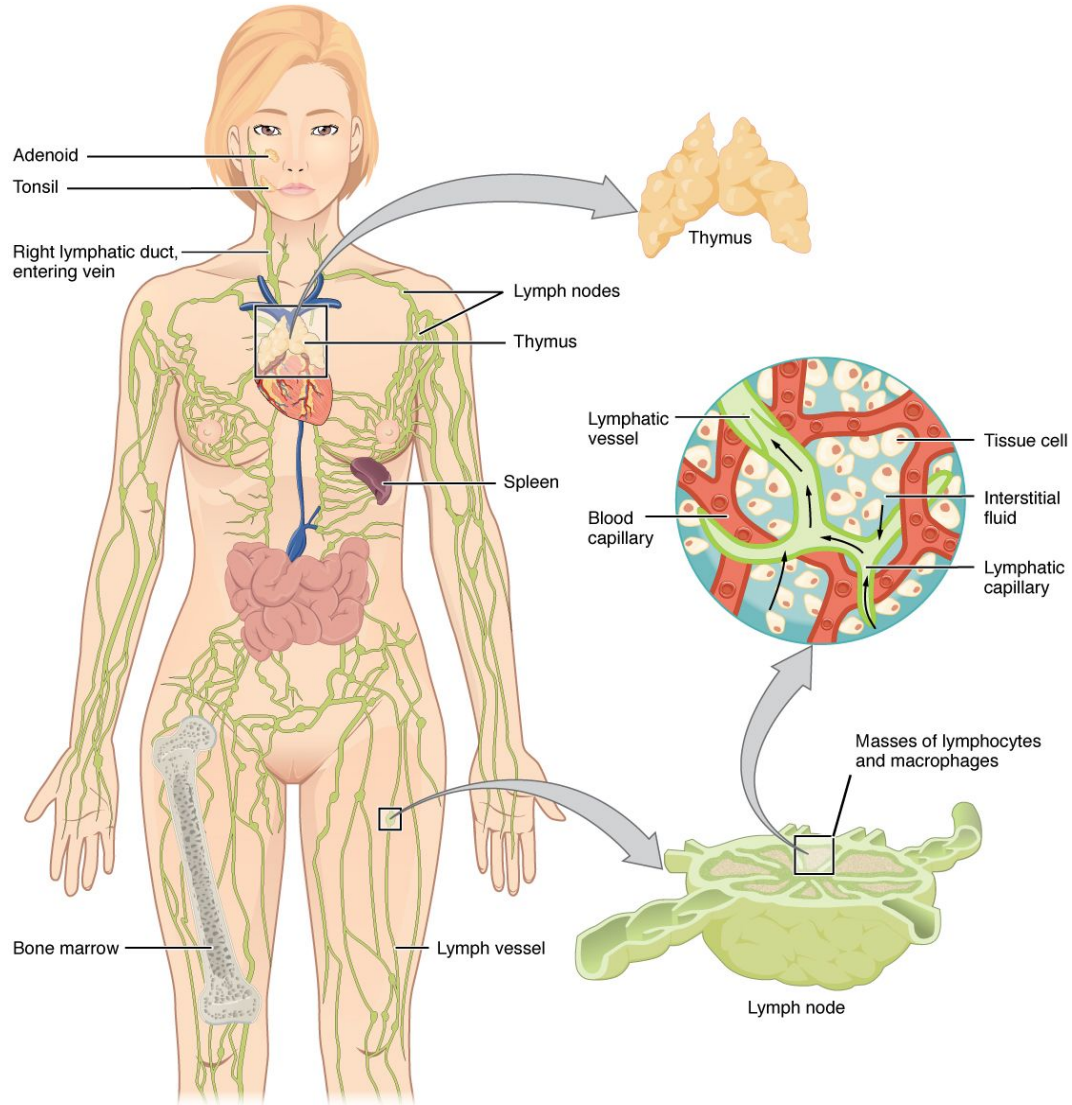


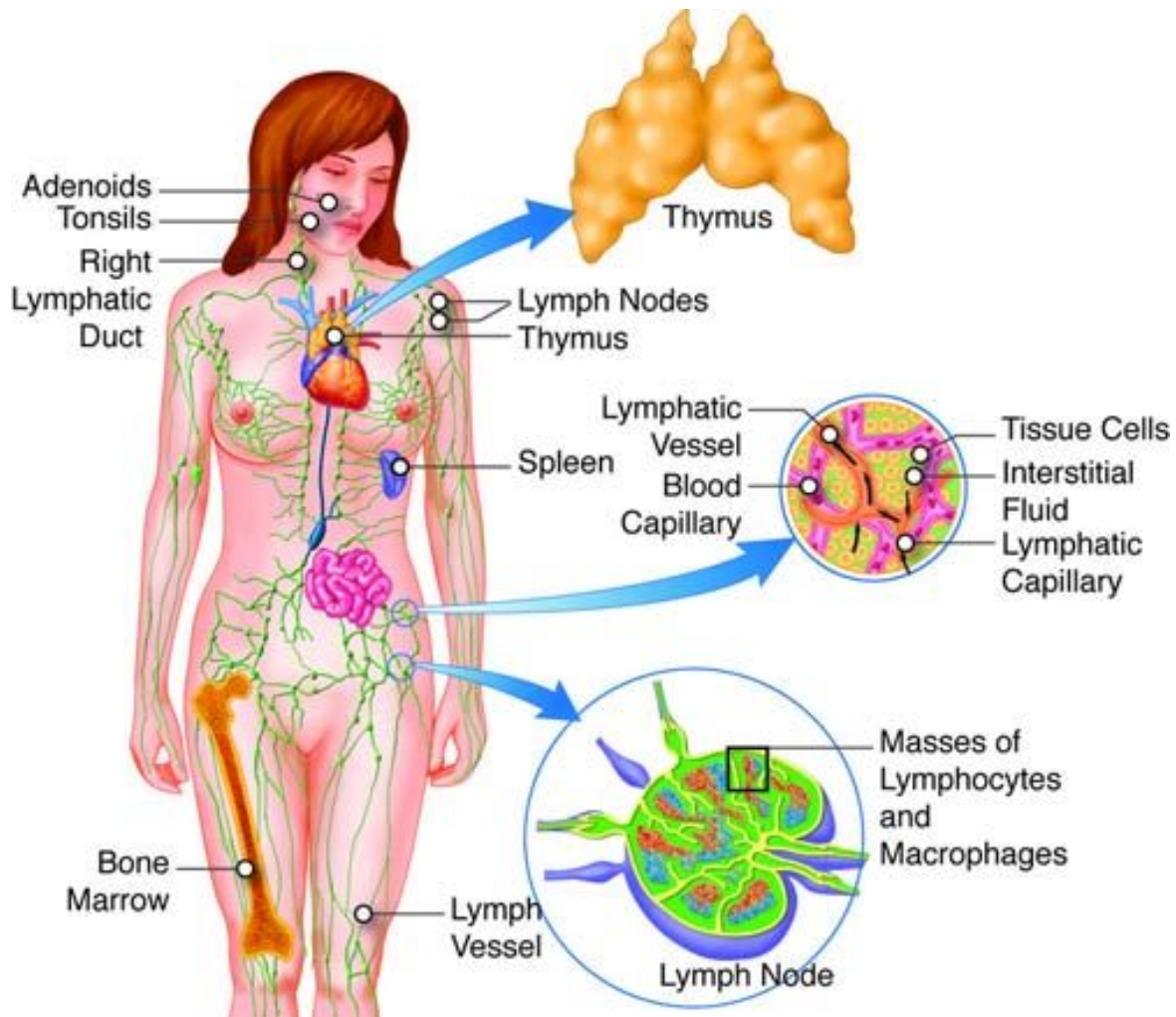
Defense against attack

→ Unicellular organism may produce chemicals that are toxic to other organisms

Immune (and Lymphatic) system

- Defense against infection
- Returning fluid to blood





→ Spleen

- ◆ Like a giant lymph node, but for blood
- ◆ clearing worn-out red blood cells and other foreign bodies from the bloodstream to help fight off infection.
- ◆ Removes old erythrocytes from the blood

→ Immune system

→ Invading microbes (pathogens)

◆ **INNATE IMMUNITY**

- responses to a broad range of microbes
 - External defenses
 - ◆ Skin
 - ◆ Mucous membranes

◆ secretions

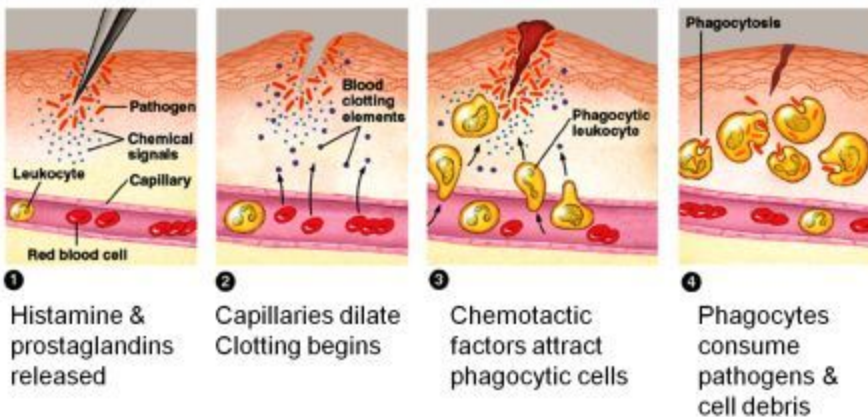
○ Internal defenses

◆ Inflammatory response

◆ Histamine

◆ First step:

- Increased blood flow
- Increased permeability
- Signs of inflammation:
 - Redness
 - Heat (feels warmer)
 - swelling



◆ ACQUIRED IMMUNITY

- Slower responses to specific microbes
 - Humoral response

→ B cells that differ in antigen specificity

→ Antigen molecules

→ Antigen receptor

→ Some become clone memory cells

→ Some become clone plasma cells

- Produces and release antibodies
- Antibodies a released into the lymph

→ Memory cells:

- ◆ Allow you to respond much more quickly

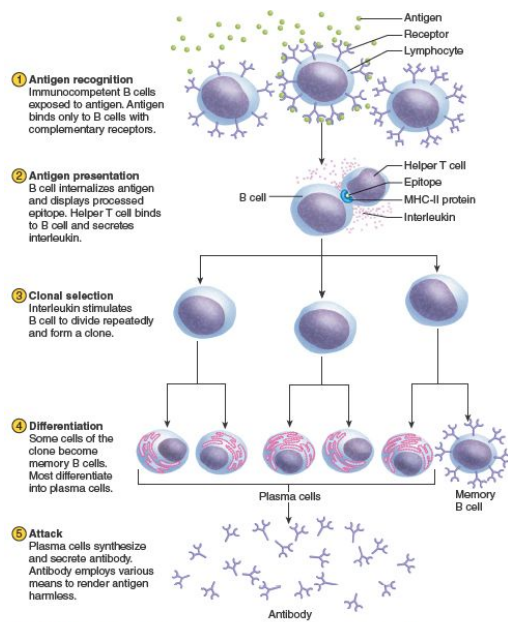
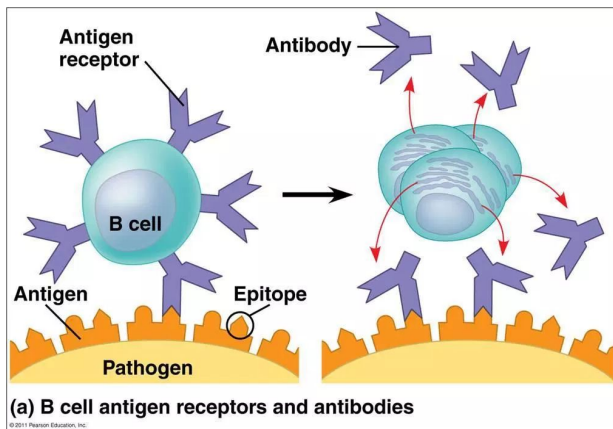
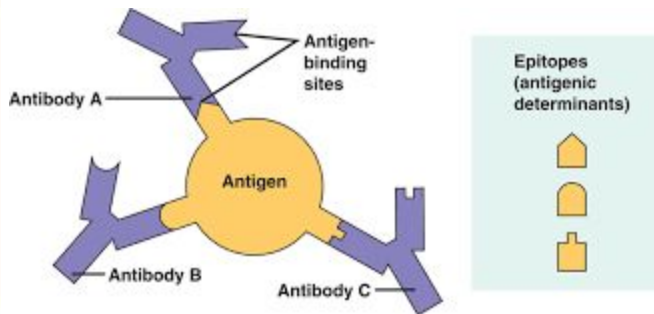
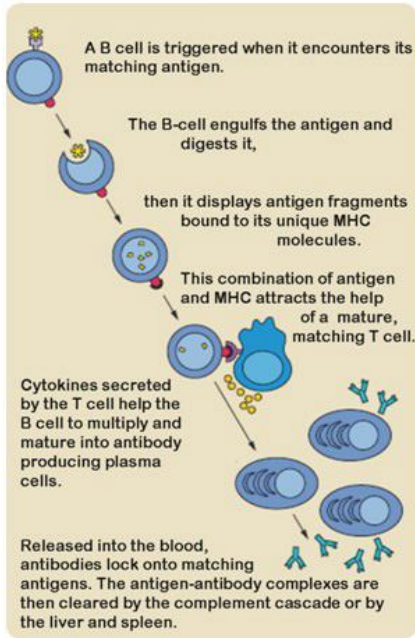
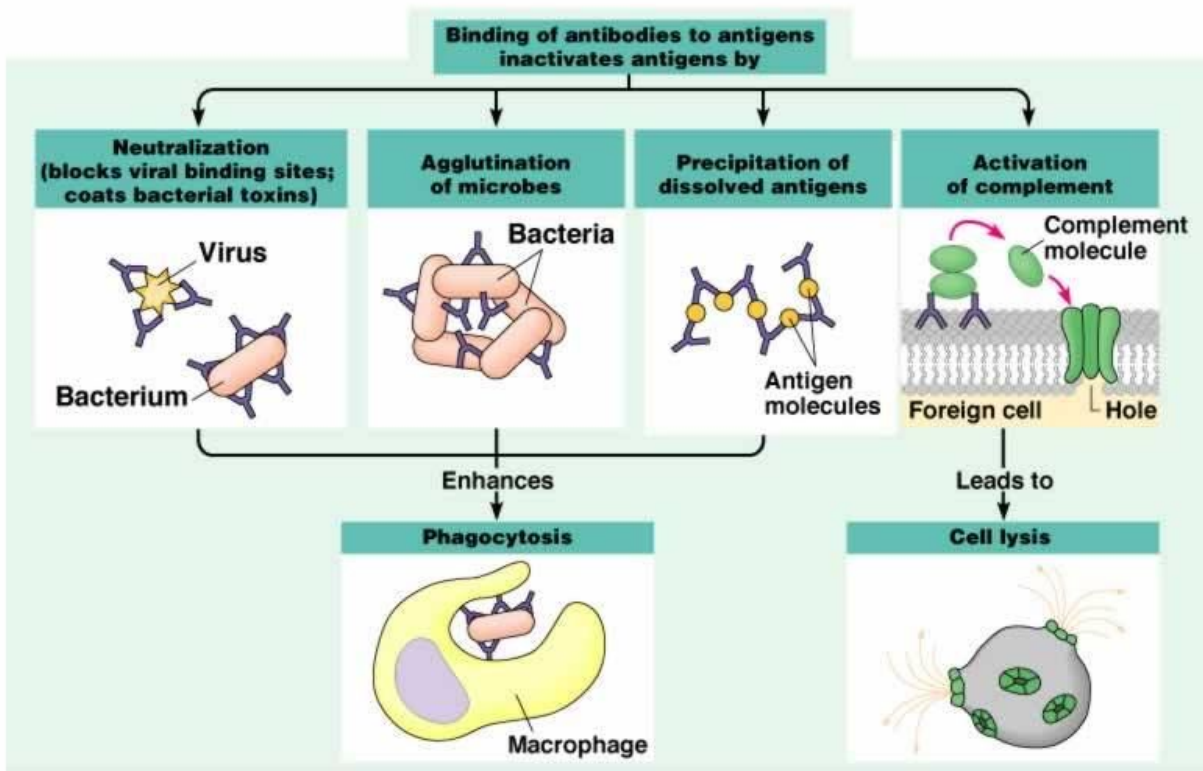
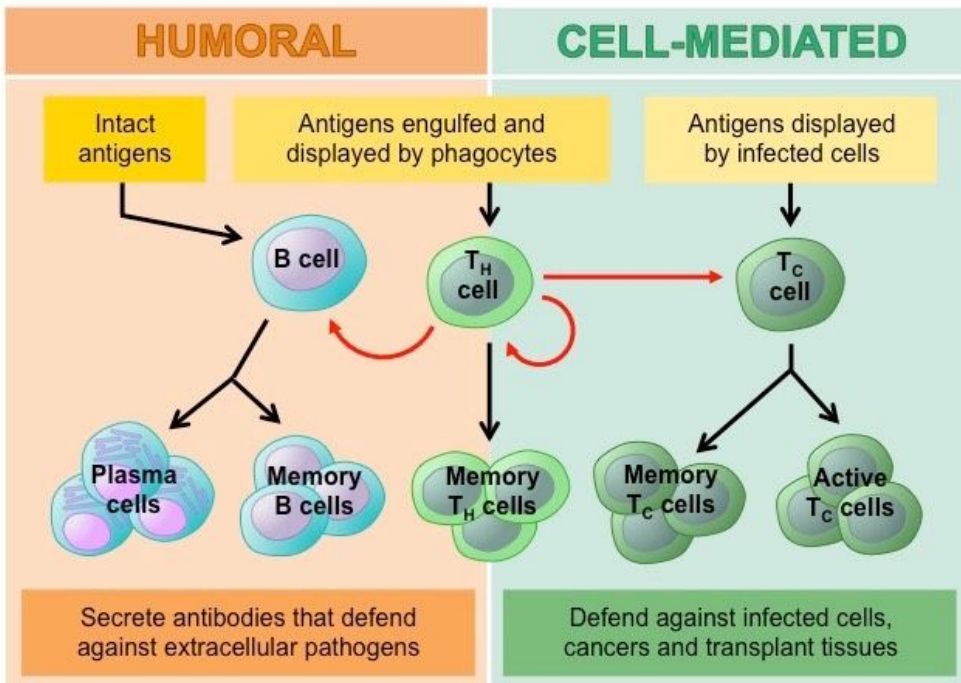


FIGURE 21.25 Clonal Selection and Ensuing Events of the Humoral Immune Response.



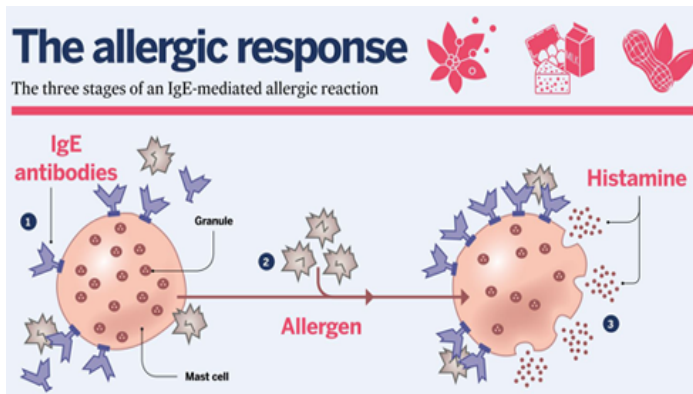
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Related to the immune system:

◆ **Allergy**

- An exaggerated response to a certain antigen
- IgE

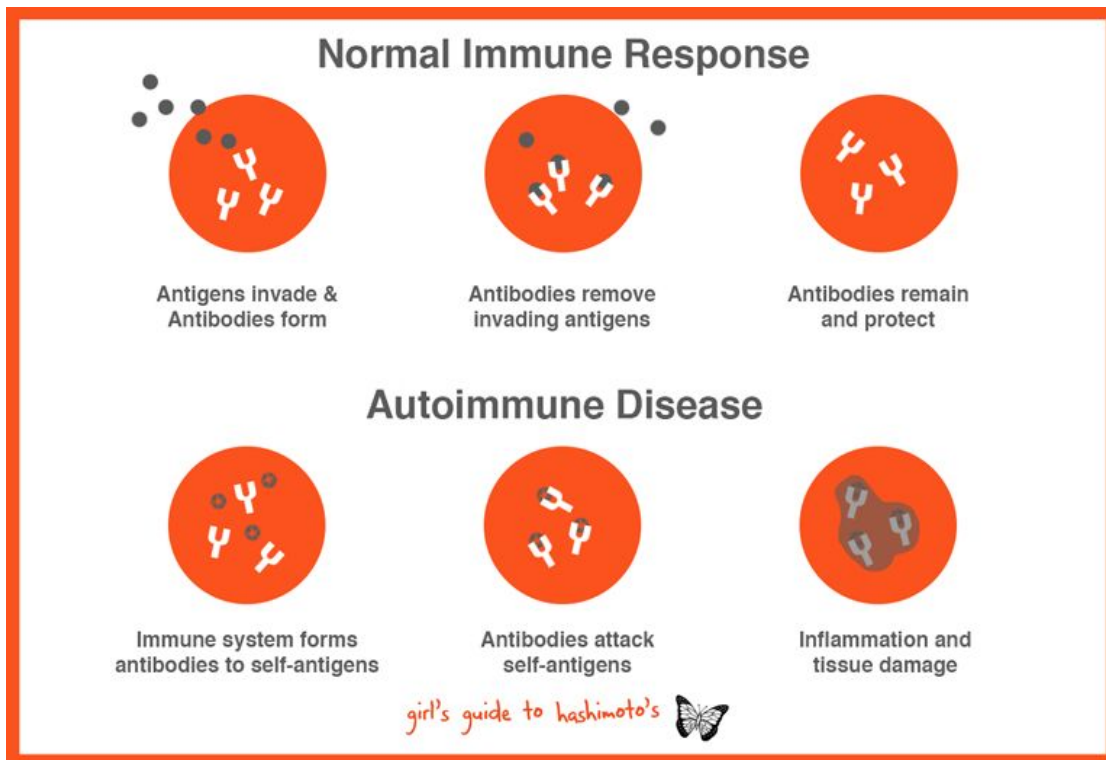


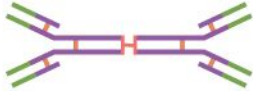



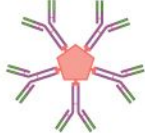
◆ **Tissue rejection**

- Normal immune response to transplanted tissue

◆ **Autoimmune disease**

- Immune response to the body's own tissue



Name	Properties	Structure
IgA	Found in mucous, saliva, tears, and breast milk. Protects against pathogens.	
IgD	Part of the B cell receptor. Activates basophils and mast cells.	
IgE	Protects against parasitic worms. Responsible for allergic reactions.	
IgG	Secreted by plasma cells in the blood. Able to cross the placenta into the fetus.	
IgM	May be attached to the surface of a B cell or secreted into the blood. Responsible for early stages of immunity.	

Disposal of Ammonia

- Organisms do not general store proteins or nucleic acids
- Usually stores lipids, sugar, etc...
- Excess proteins and nucleic acids are broken down into acids and nitrogenous bases respectively
- Excess amino acids and nitrogenous bases are converted into carbohydrates by the removal of the amino group, which produces ammonia (NH₃)
- Ammonia is highly toxic
- Unicellular organisms loose ammonia by diffusion

Excretory System

- Function:
 - ◆ Disposal of ammonia and other metabolic wastes

→ Also important in **Osmoregulation**:

◆ Regulation of solute concentrations and water balance

→ Many unicellular organisms live in an environment that is isotonic to their cytosols

→ Those that do not must osmoregulate

→ **Ammonia**

◆ Flushed out in dilute solution

- **Most aquatic animals** (washes out with lots and lots of water)

◆ Some animals convert ammonia to **Urea**

- Requires energy to produce
- Tolerated at higher concentration
- **Mammals and others**
- (animals that don't really live in water)

◆ **Uric acid**

- Requires more energy to produce
- Insoluble in water
- **Reptiles, birds, insects, and others**

→ Porifera

◆ No excretory system

→ Cnidaria

◆ No excretory system

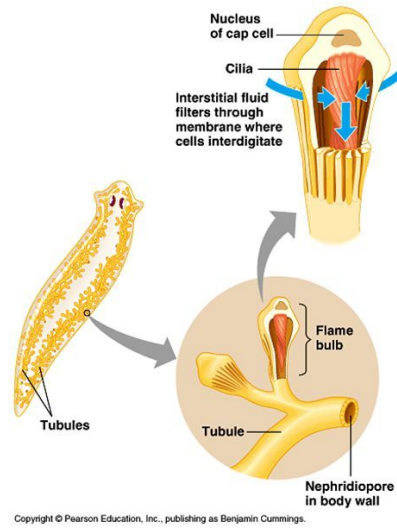
→ Platyhelminthes

- ◆ Diffusion, Protonephridia
- ◆ Pump body fluid
- ◆ Reclaim useful molecules
- ◆ osmoregulation

Features common to all flatworms

- **protonephridia for osmoregulation (water balance)**

- for the flatworms – influx of water into their bodies from their environment
- this excess water is removed through **protonephridia**
- comprised of **flame cells or flame bulbs** that draw the water in and expel it back to the outside



→ Annelida

◆ Metanephridia

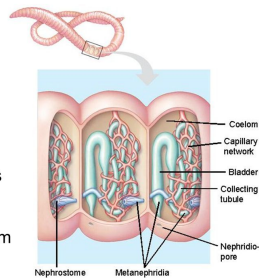
◆ Pump body fluid out

◆ Reclaim useful molecules

◆ Excretion and osmoregulation

Phylum: Annelida
Class: Oligochaeta
earthworms

- well-developed excretory system with repeated structures, two per segment
- **metanephridia** (primitive kidney)
 - excretory tubule open at both ends
 - network of small blood vessels closely associated
- **nephrostome** at one end of tubule
 - ciliated funnel collects fluid from coelom
- **excretory pore** (nephridiopore) at other end of tubule
 - dilute urine (**urea**) exits to outside body



→ Mollusca

◆ Metanephridia

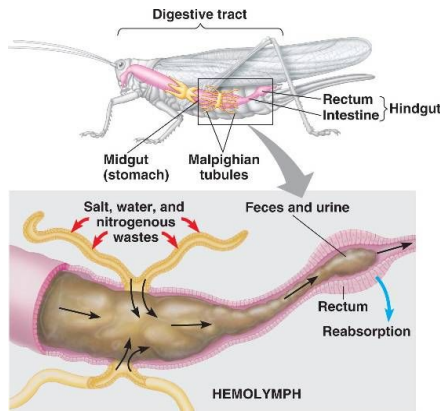
→ Arthropoda

◆ Metanephridia

◆ Malpighian tubules

◆ Wastes pumped out lost with feces

◆ Excretion and osmoregulation



→ **Nematoda**

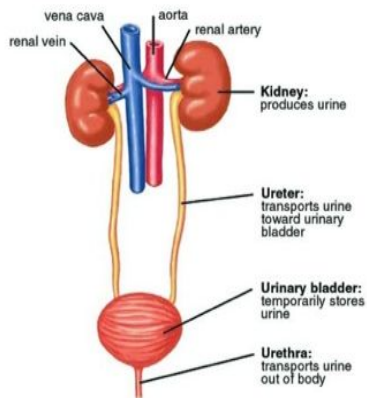
- ◆ Diffusion, glands

→ **Echinodermata**

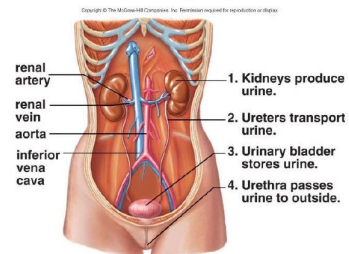
- ◆ Water vascular system

→ **Chordata**

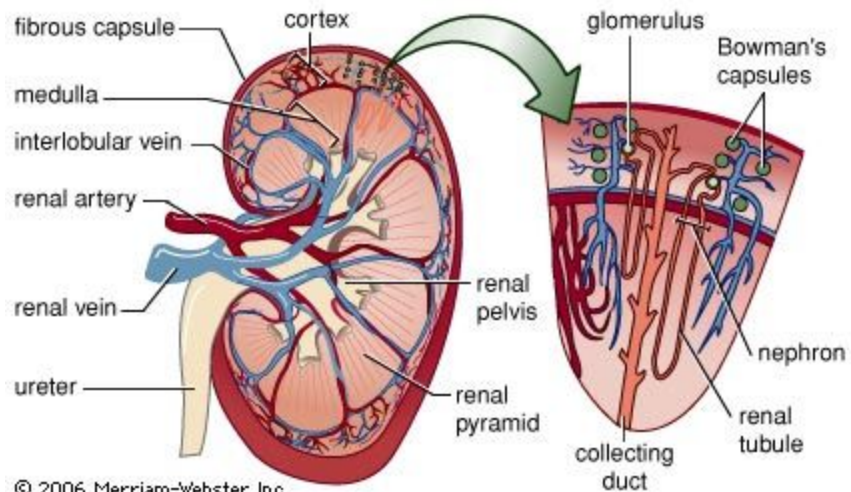
- ◆ **Nephridia**
- ◆ **Excretory system**



The urinary system

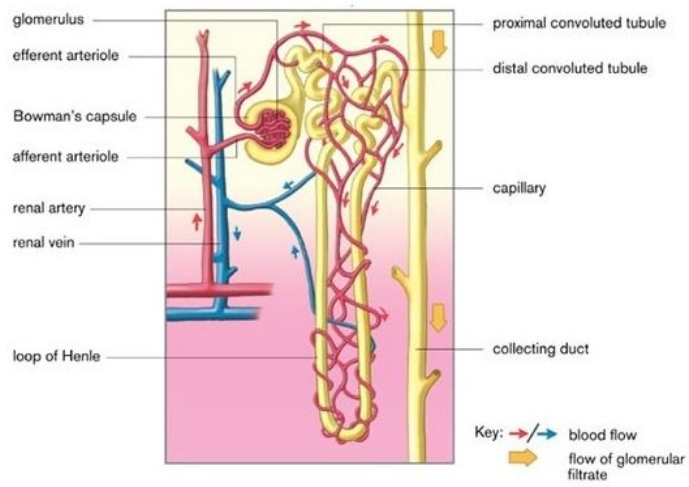


→ The kidney



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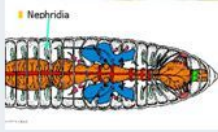
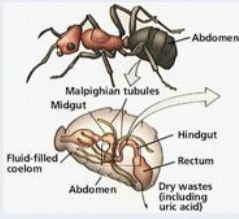
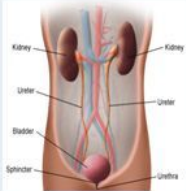
→ Nephron



Excretory System

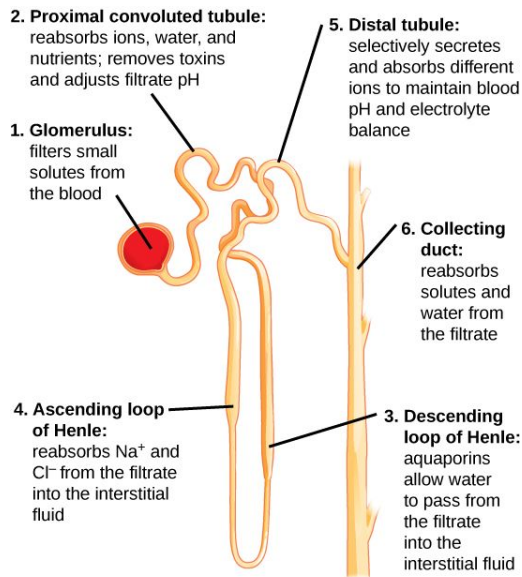
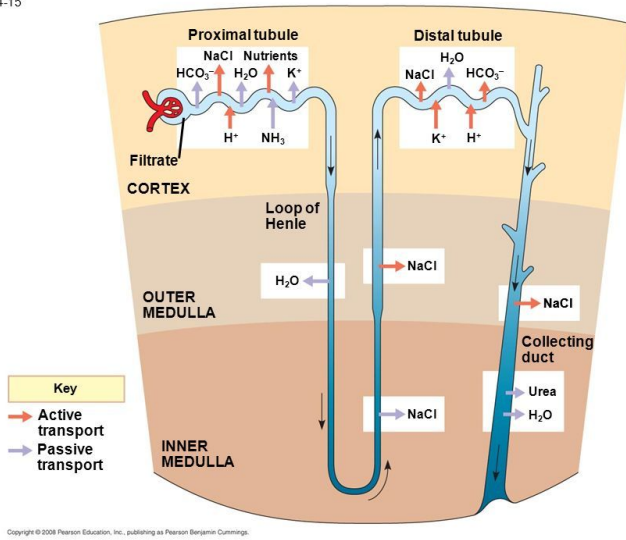
Evolutionary Trends in Excretion

Simple \longrightarrow Complex

Animal Taxon	Aquatic Invertebrates	Worms and Mollusks	Insects	Vertebrates
Release Wastes By...	<i>diffusion</i> to remove waste across their cell membranes directly into the water	Use of nephridia- tiny pores along the body excrete waste	Using malpighian tubules to collect and excrete wastes	Use of kidneys, ureters, and a bladder to collect and excrete waste
Picture of system				
Examples	Sponges, jellyfish, planaria	Earthworm, clam, octopus	Grasshopper, ants, bees	mammals, birds, reptiles, fish, amphibians

\rightarrow What happens in nephron

Fig. 44-15



Cell signalling

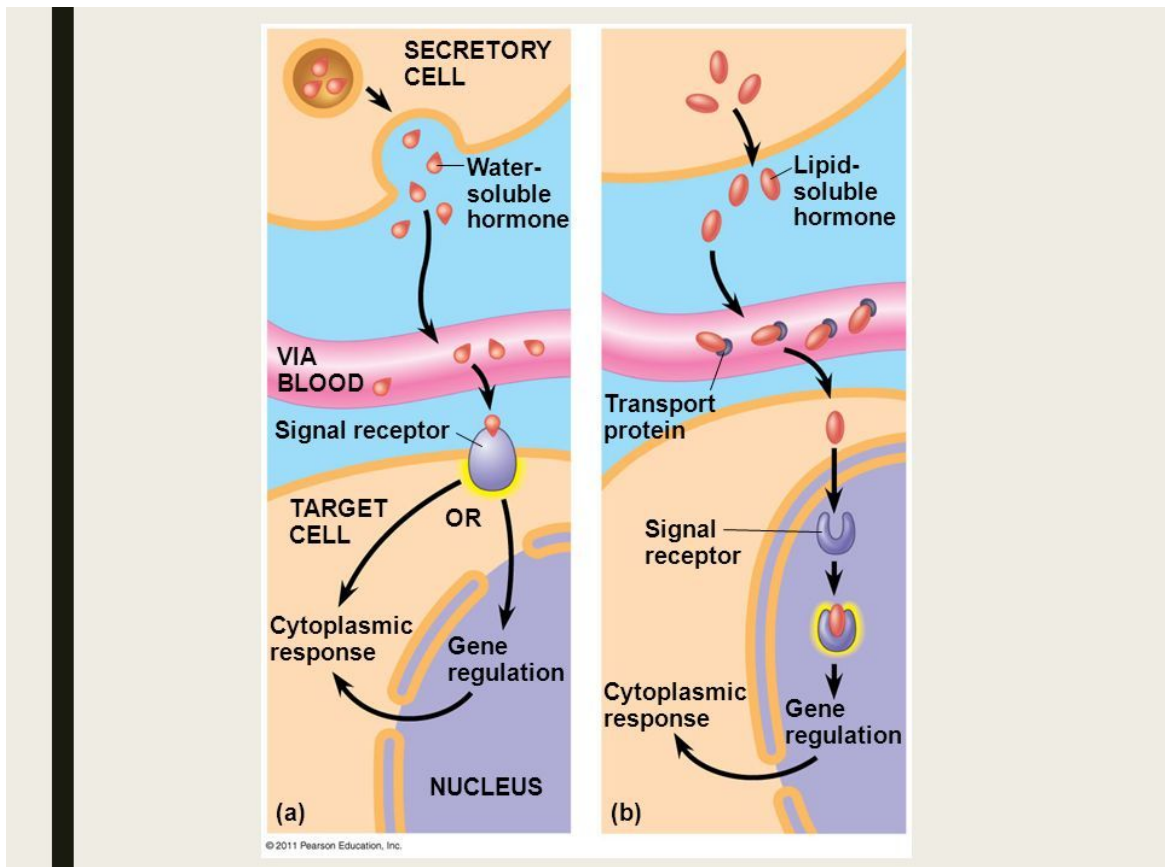
- ◆ Chemical signals influence processes in a unicellular organism
- ◆ Ca^{2+} triggers movement in amoeba
- ◆ Unicellular organisms respond to chemical signals in their environment
- ◆ Yeast cells exchange chemical signals to initiate mating

Endocrine System

→ Coordination of the body activities

→ Hormone

- ◆ A chemical messenger produced by cells that influence the function of cells elsewhere in the body
- ◆ From secretory cell to blood and then to signal receptor then the hormone is released to target cell and then cell or DNA



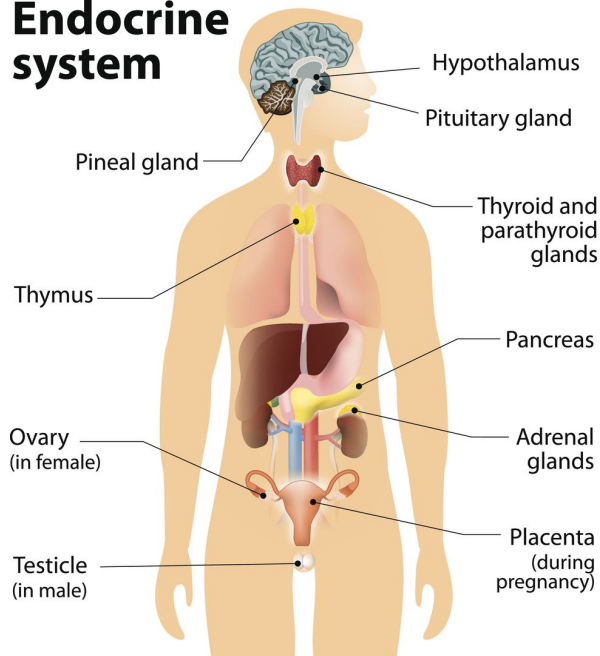
→

→ Epinephrine

- ◆ Intestinal blood vessel
- ◆ Skeletal muscle blood vessel
- ◆ Liver cell

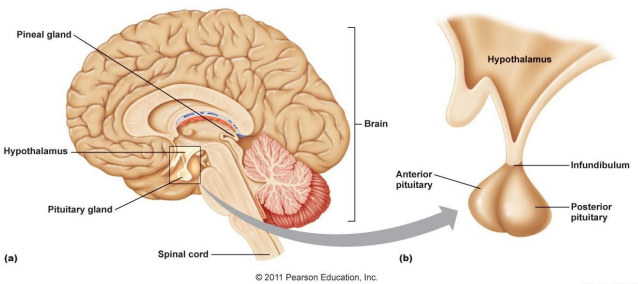
Human Endocrine system

Endocrine system



→ Pituitary gland

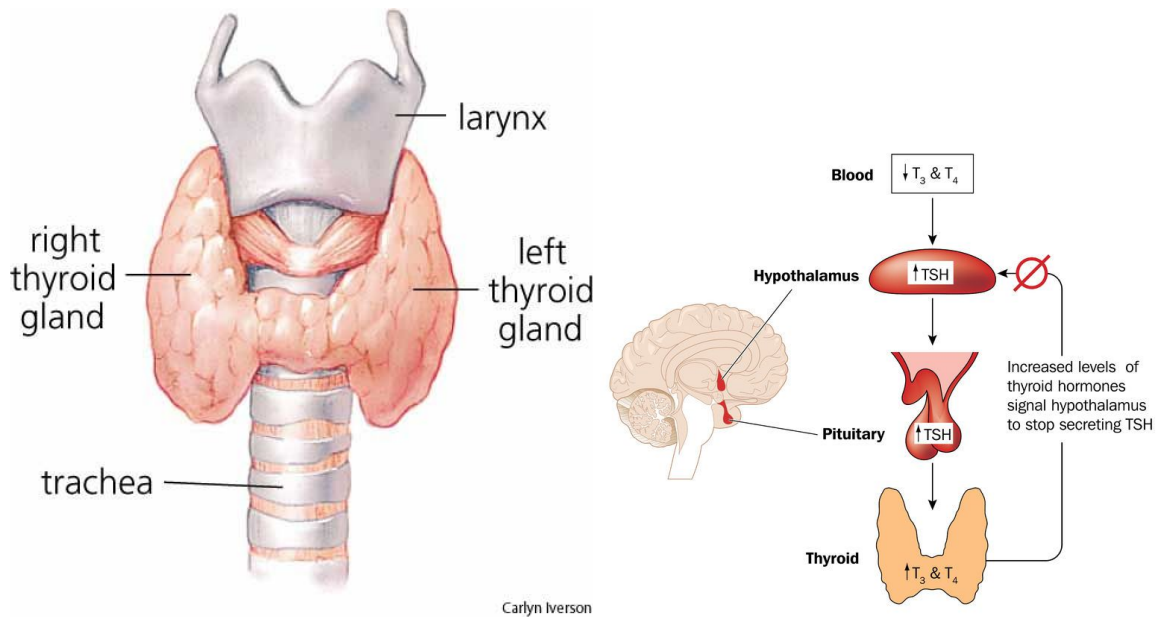
- ◆ “Master” endocrine gland
- ◆ Extension of nervous system
- ◆ Releases many hormones
- ◆ Some influence other endocrine glands
- ◆ Hormones it releases:
 - GH: Growth Hormone
 - Bone growth
 - TSH: Thyroid Stimulating Hormone
 - Stimulates the thyroid



→ Thyroid Gland:

- ◆ Releases thyroxine

- ◆ Increases metabolic rate
- ◆ Blood levels controlled by **negative feedback**
 - A form of regulation in which accumulation of an end product of process slows the process
- ◆ Releases thyroxine under the influence of TSH
- ◆ Thyroxine inhibits the release of TSH
- ◆ Negative feedback process;
- ◆



→ **Pancreas**

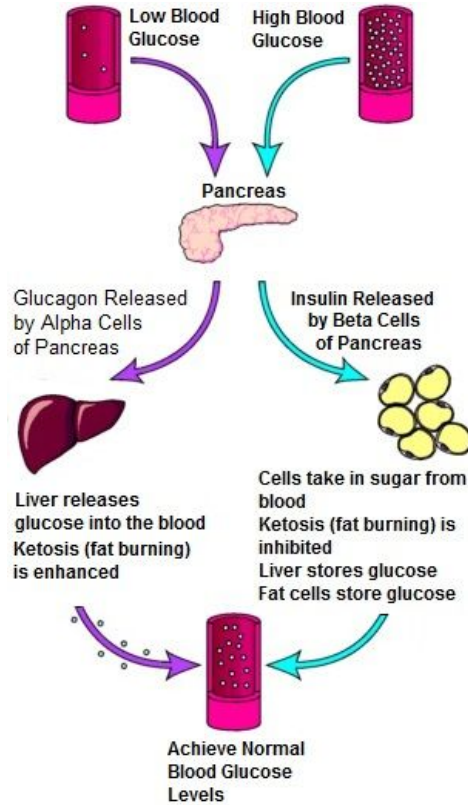
Releases insulin

- Lowers blood sugar

Releases glucagon

- Increases blood sugar concentration

High = Diabetes



Reproduction:

- cellular divisions
- Unicellular organisms may also reproduce sexually, through fusion followed by meiosis

Reproductive system:

- Sexual reproduction
- Sexual organs may be present or absent
- Sexes separate or hermaphroditic
- Internal or external fertilization

Porifera:

- Asexual reproduction
 - ◆ Settle somewhere else and grow a new sponge
- Sexual reproduction
 - ◆ Hermaphroditic
 - ◆ No sex organs
 - ◆ Internal fertilization

Cnidaria

- Asexual reproduction
- Sexual reproduction
 - ◆ Hermaphroditic
 - ◆ **Most** have sex organs
 - ◆ External fertilization

Platyhelminthes

- Sexual reproduction
 - ◆ Hermaphroditic
 - ◆ Internal fertilization (mate with each other and may try and get each other pregnant at the same time)

Mollusca

- Sexual
 - ◆ External
 - ◆ Separate sexes

Annelida

- Sexual
 - ◆ Internal
 - ◆ Hermaphroditic

Nematoda

- Sexual
 - ◆ Internal
 - ◆ Separate sexes

Arthropoda

- Sexual
 - ◆ Internal
 - ◆ Separate sexes

Echinodermata

- Asexual
 - ◆ Sexual
 - ◆ External
 - ◆ Separate

Chordata

- Sexual
- Internal separate

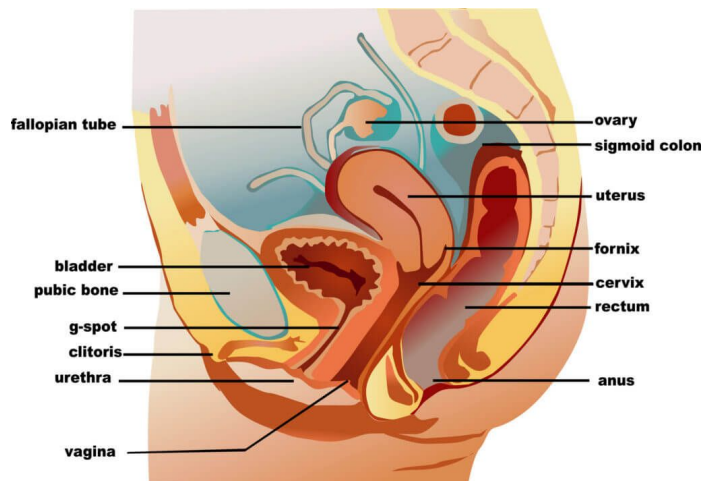
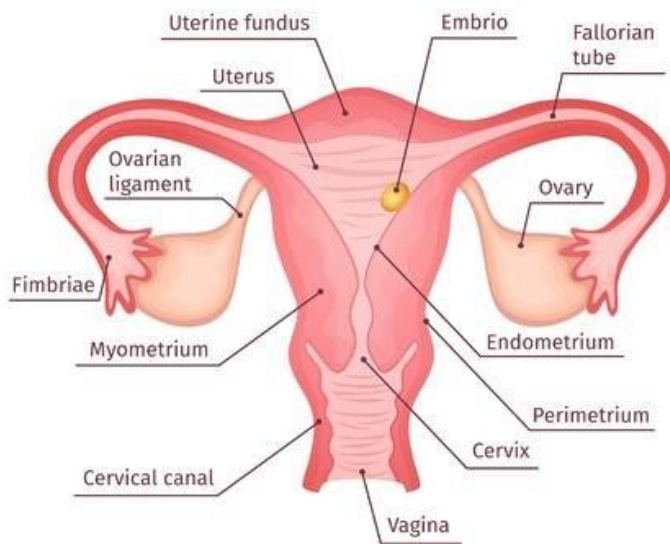
Separate sexes

- Secondary sexual characteristics
 - ◆ Differences between the sexes that are not directly involved in reproduction

Human reproductive system

- **Female:**
- **Ovaries are where oogenesis starts**

FEMALE REPRODUCTIVE SYSTEM



Female sex hormones

FSH

Follicle develops

Estrogen

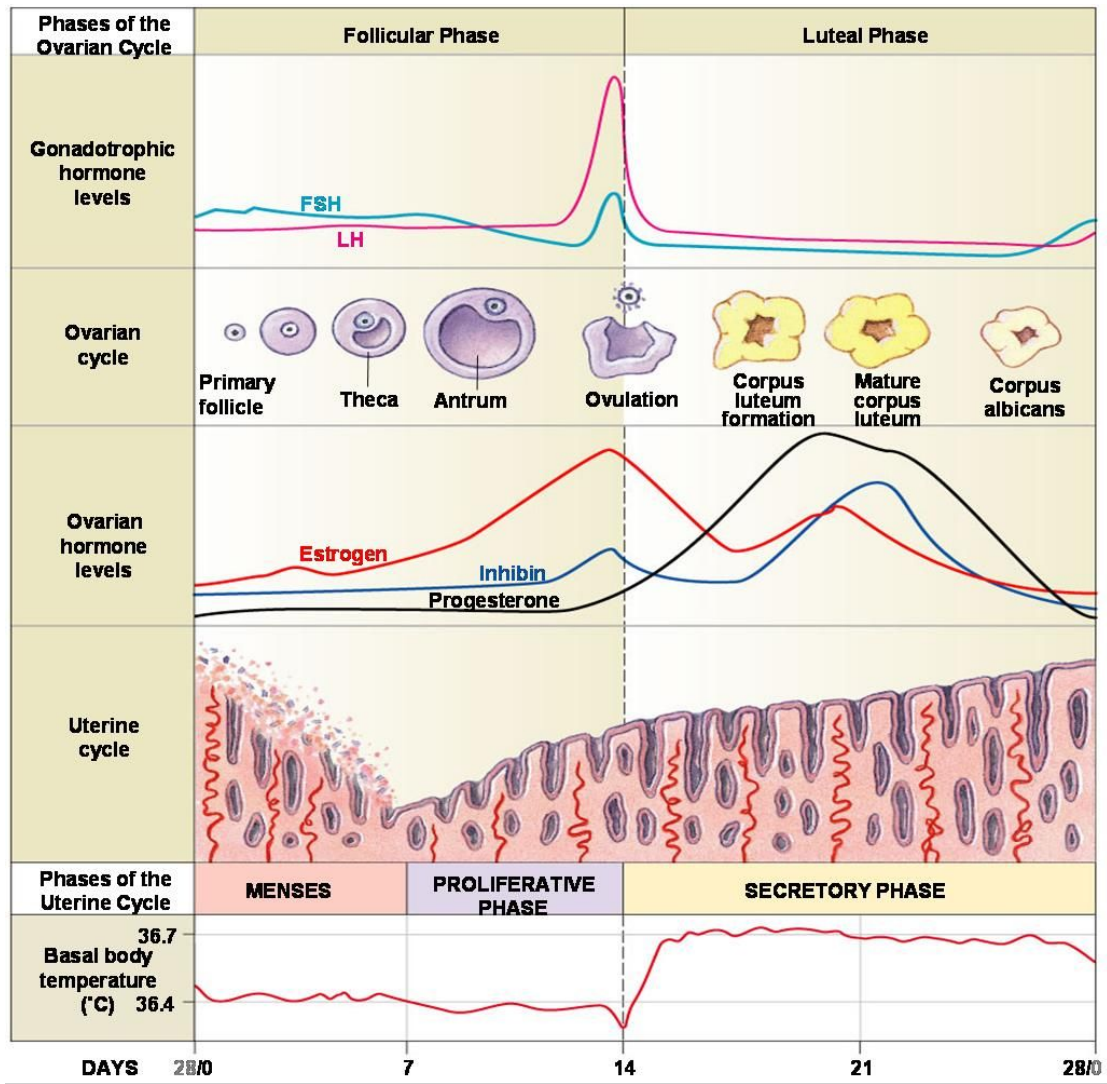
Pituitary

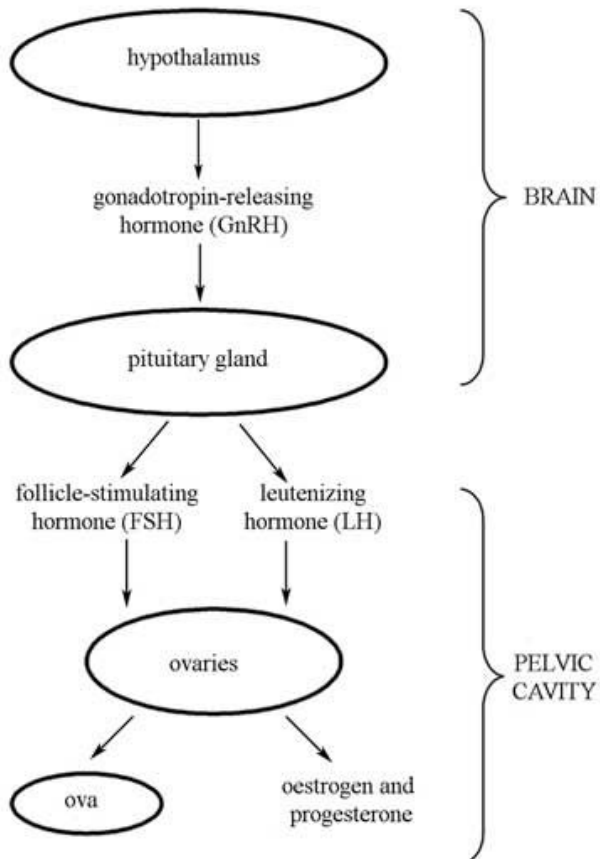
LH

Progesterone

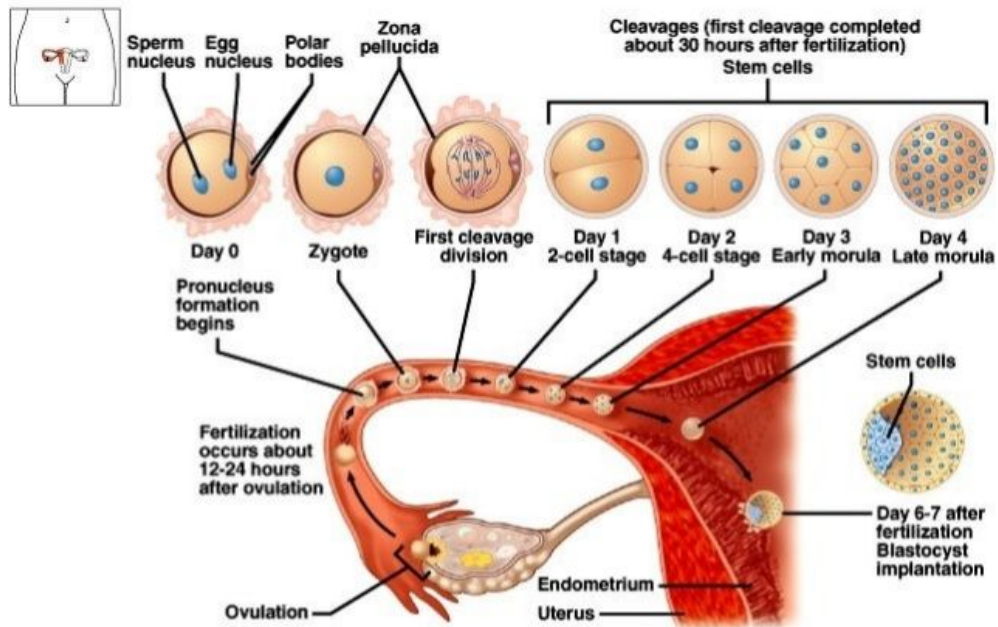
Ovulation - corpus luteum

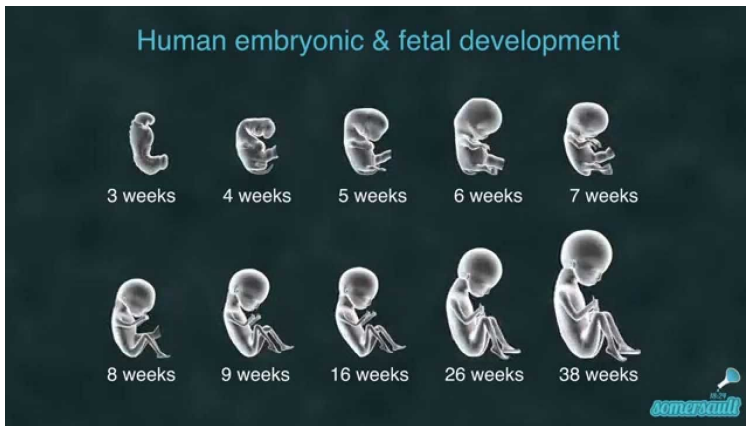
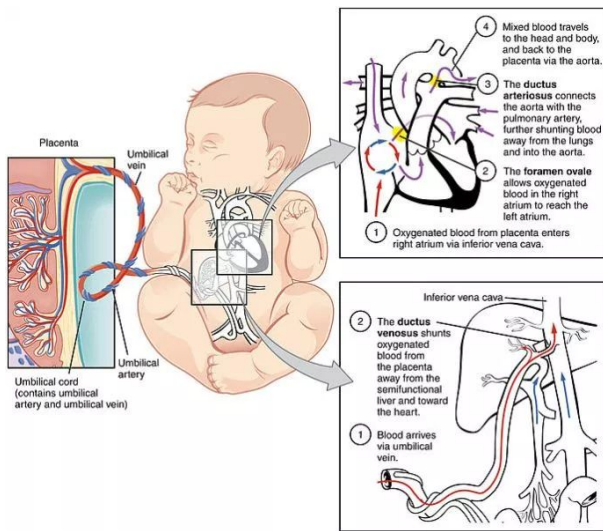
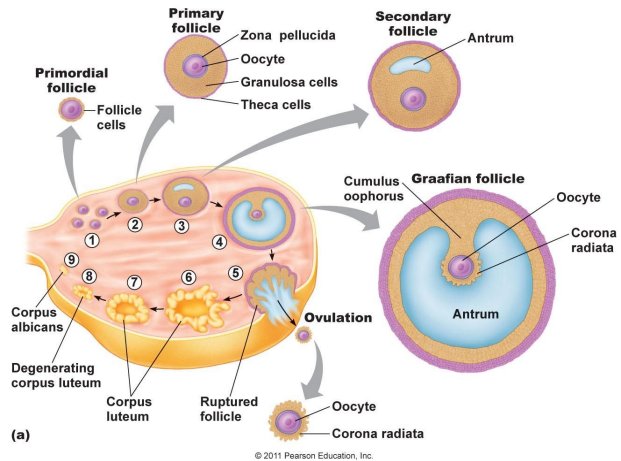
endometrium

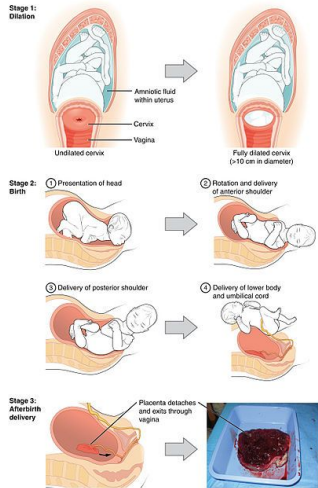




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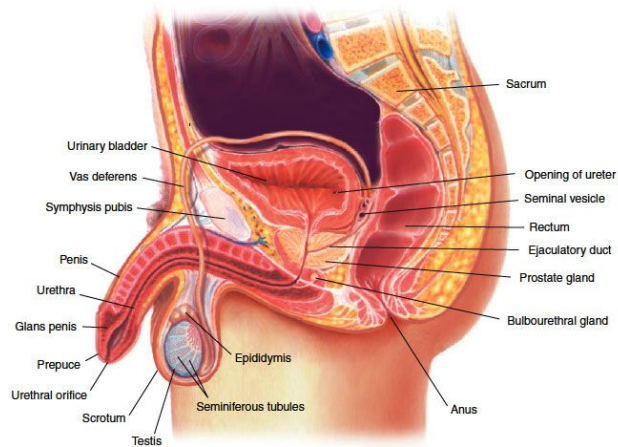
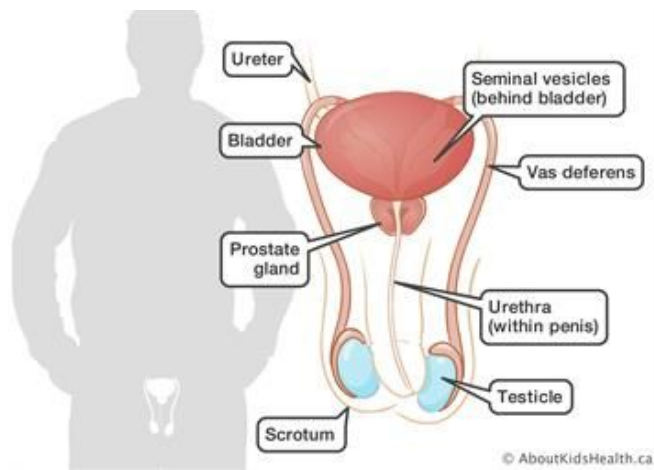




→ Male reproductive system

◆ In testis

- Seminiferous tubules



Ecology

★ The study of how organisms interact with their environment

★ Organism -

- An individual living system

- Type of ecology: **Organismal ecology**

- Including evolutionary ecology and behavioural ecology, focuses on how an organism's anatomy, physiology, and behaviour meet the challenges imposed by its environment

- **Behavioural Ecology:**

- The study of the ecological and evolutionary basis for animal behavior

- An animal's responses to external and internal stimuli

- A type of behaviour: **Innate Behaviour**

- Behavior that is developmentally fixed

- Simplest innate behaviour: **Fixed Action pattern**

- A sequence of unlearned acts directly linked to a simple stimulus

- Ex: A male stickleback fish attacks other male sticklebacks that approach them (they don't know why and it was not taught), any blob that has a red bottom

- It is built in them

- More complex signals and responses

- Migration

- Communication

■ **Learned Behavior**

- Behavior that is modified based on experience
- Kind of learned behavior:

Imprinting

- The formation at a specific stage in life of a long-lasting behavioural response
- Something that you do at some point in your life and then it sticks with you for life
- More complex behaviours:
 - Spatial learning
 - Associative learning
 - Problem solving
- Behaviours are part of the phenotype
- Behaviours may be influenced by genotype
- If a behaviour can be inherited, then it may evolve

★ Population

- A group of organisms of the same species living in an area
- **Population Ecology:**
 - Focuses on factors that influence population size
 - **Exponential growth:**
 - No limit to resources, food, water, space, environment, etc
 - **Carrying Capacity**
 - The maximum population size that can be supported by the available resources
 - Logistic growth:

★ Community

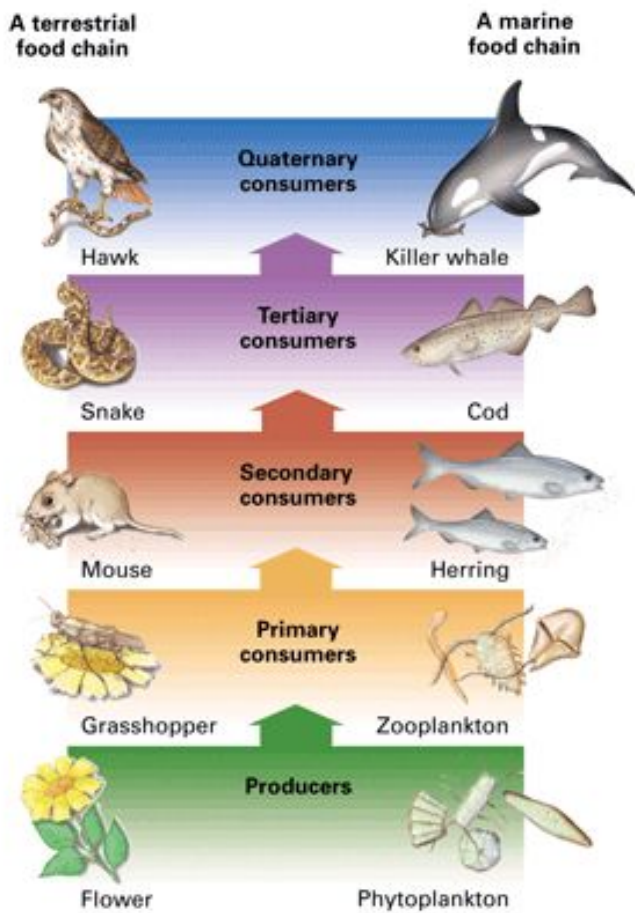
- A group populations in an area
- **Community Ecology:**
 - Focuses on how interactions between species influence community structure
- (-/-):
 - Competition:
 - Has a negative impact on both populations
 - Members of two species compete for a resource
 - In a simple competition, one species may drive the other to local extinction
 - Competitive exclusion
- Natural selection may favour avoidance of competition
- (+/-):
 - Predation:
 - Members of one species (predators) eat members of another species (prey)
 - Parasitism:
 - Members of one species (parasites) live in or on members of another species (hosts) while feeding on the hosts.
 - Herbivory:
 - Members of one species (herbivores) eat parts of plants or algae
 - Disease:
 - Microscopic parasites
- Natural selection favours traits that allow prey to avoid predators
- Predation may prevent a prey population from reaching its carrying capacity
- Predation may reduce competition among prey populations
- (+/+):
 - Mutualism
- **Symbiosis:**

- A long-term intimate association of organisms of two different species
- Ex:
 - When you have a tapeworm in your body
 - (together all the time)

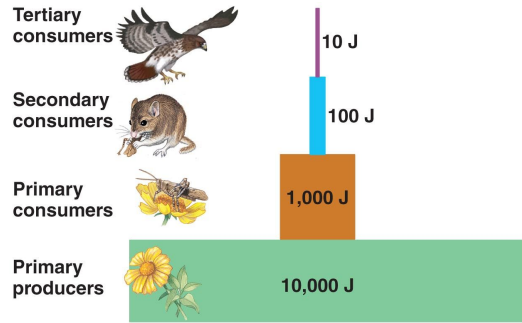
Interaction	Effects on interacting species
Competition (-/-)	<ul style="list-style-type: none"> ● the interaction can be detrimental
Predation (+/-) Parasitism (+/-) Herbivory (+/-) Disease (+/-)	<ul style="list-style-type: none"> ● Interaction is beneficial to one species and detrimental to the other
Mutualism (+/+)	<ul style="list-style-type: none"> ● The interaction is beneficial to both species
Commensalism (+/0)	<ul style="list-style-type: none"> ● One species benefits from the interaction, and the other species is unaffected by it.

★ Ecosystem

- A community plus the nonliving environment in which it lives
- **Ecosystem Ecology:**
 - Focuses on energy flow and nutrient cycling
- **Trophic levels:**



- **Niche:**
 - The sum of species' use of the biotic and abiotic resources in its environment.
- **Biomass:**
 - The amount of organic matter in a group of organisms
- **Primary production:**
 - The rate at which new biomass is generated in an ecosystem
- Calvin cycle
- A bit less biomass at each stage



○ 1,000,000 J of sunlight

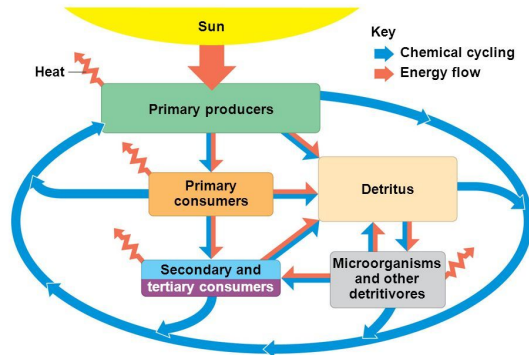
○ Detritus

○ Decomposers:

- Feeding on detritus

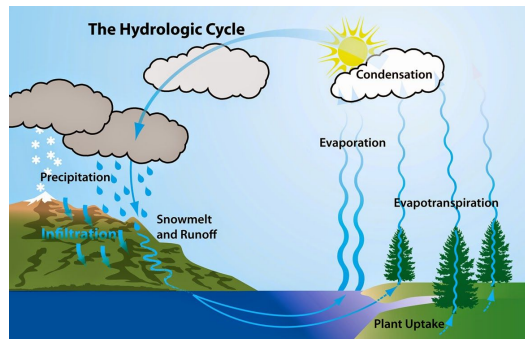
○ Energy movement in ecosystem:

Figure 55.4

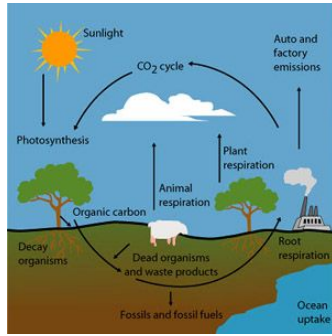


○ Arrows represent energy flow so they go from prey TO predator

○ Water cycle:

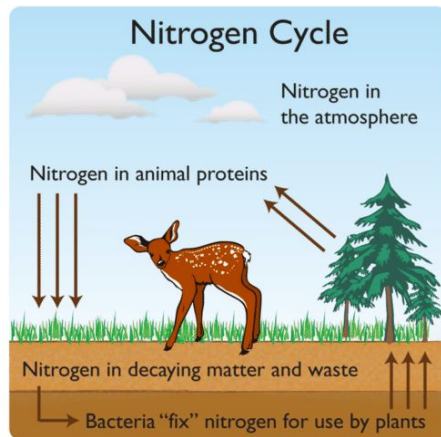


○ Carbon cycle:



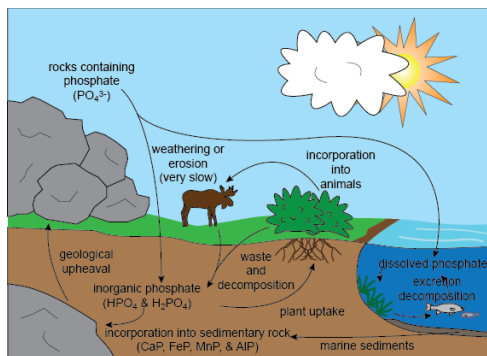
○

○ Nitrogen cycle:



○

○ Phosphorus cycle:



○

○ **Limiting nutrient**

- The nutrient that must be added to increase primary production in an ecosystem
- Nitrogen would be the limiting nutrient in the soil

★ **Landscape**

- A mosaic of connected ecosystems
- **Landscape Ecology:**

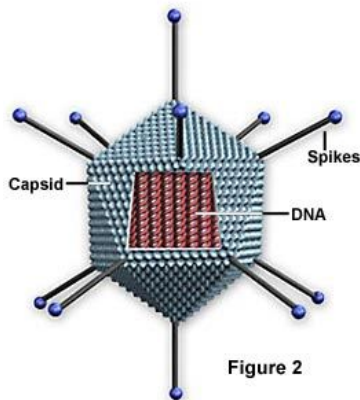
- Focuses on exchange of energy, materials, and organisms among ecosystems

★ **Biosphere**

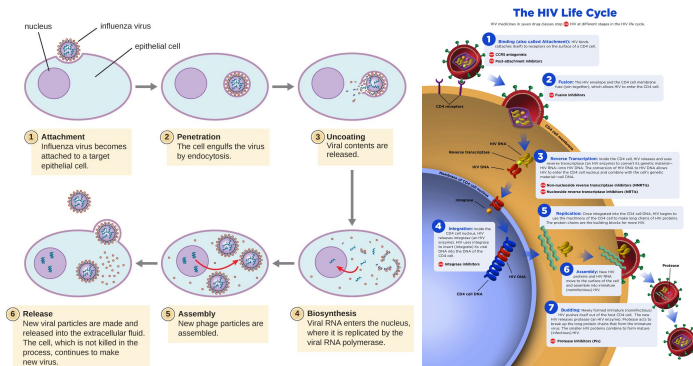
- The sum of all the planet's landscapes
- **Global Ecology:**
 - Focuses on the distribution and functioning of ecosystems across the biosphere

★ **Virus:**

Animal Virus Structure



- Capsid:
 - Protein
- Genetic material (inside capsids)
 - Could be DNA or RNA
- Virus life cycle:



- **Viroid:**
 - A circular RNA molecule that infects certain plants
- **Prion:**

- Responsible for many disease (mad cow disease, etc)
- An infectious misfolded protein
- Widely accepted hypothesis:
 - A normal protein is misfolded (has an abnormal tertiary structure)
 - This molecule tends to misfold any similar protein that it come in contact with
- **Cancer:**
 - The cell cycle is controlled, particularly in a multicellular organism
 - Several genes are involved in various aspects of this control of cell division
 - A mutation in one of these genes may result in uncontrolled cell division
 - Daughter cells inherit this uncontrolled cell division
 - Cells tend to be unspecialized
 - If cells that are growing out of control remain in the same location, it is considered a benign tumour
 - If the cells spread in the body (metastasis), starting new tumours, it is considered cancer
 - Cancer is difficult to treat because the cancerous cells are part of the body

Human Nervous system

➤ **Functions**

- Coordination of body
- Sensing environment
- Responding to environment

➤ **Excitable tissue**

- Tissue made up of cells that may rapidly alter their membrane potential

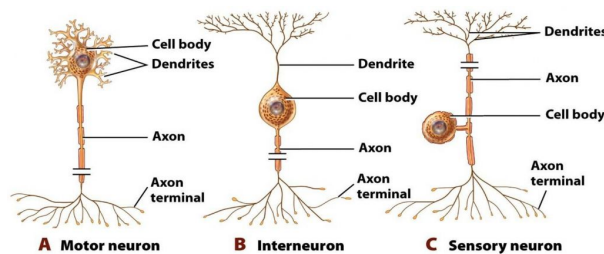
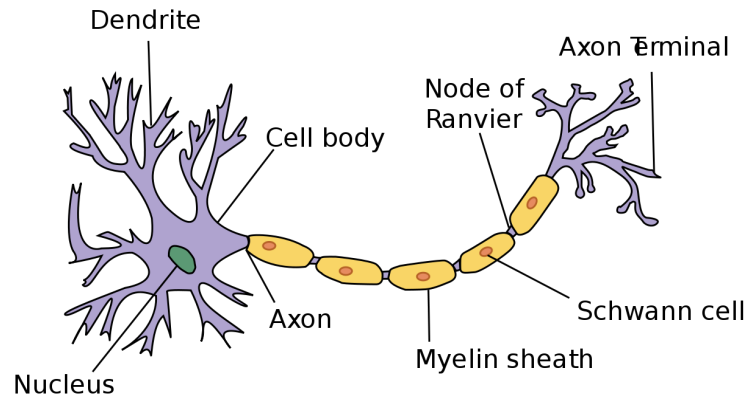
➤ Nerve Nets

➤ 2 systems:

- Central Nervous system (CNS)
- Peripheral Nervous system (PNS)
- What makes up the nervous system?

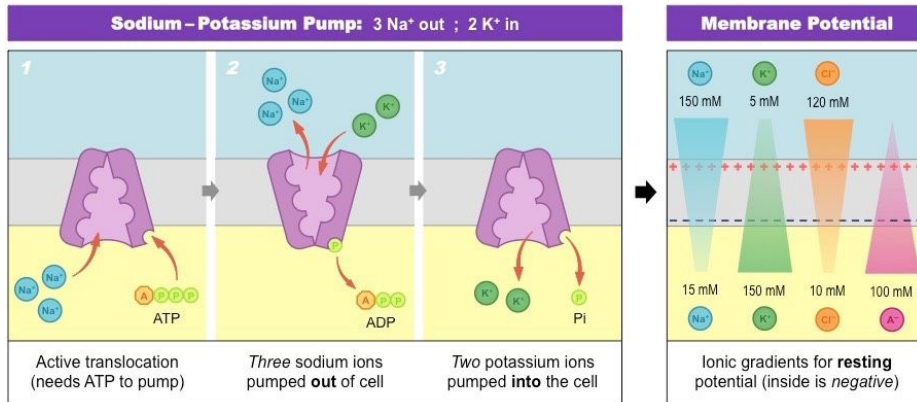
- **Neurons**

- Nerve cell that transmits signals
- Its structure and properties allow it to conduct signals
- Different sizes (long, short)



- **Resting potential**

- Electrochemical tension across neuron plasma membrane
- Different things of ions
- **Inside the neuron** (relative to outside)
 - Negative electric charge
 - High concentration of potassium ions (K^+)
 - Low concentration of sodium ions (Na^+)
- Sodium potassium pump



➤ Types of neurons

○ Sensory neurons

■ Transmit information from

● **external stimuli and send to brain**

- Chemoreceptors: Smell, taste
- Mechanoreceptors: Pressure, touch, sound
- Thermoreceptors: Heat and cold
- Photoreceptors: Light
- Nociceptors: Pain

● **internal stimuli and send to brain**

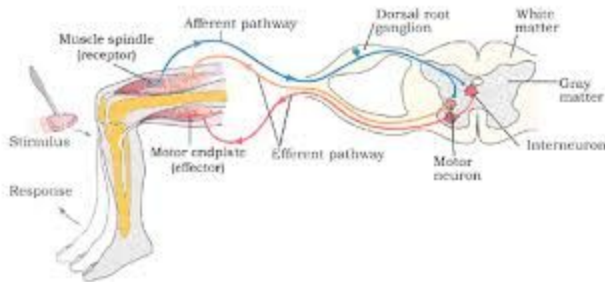
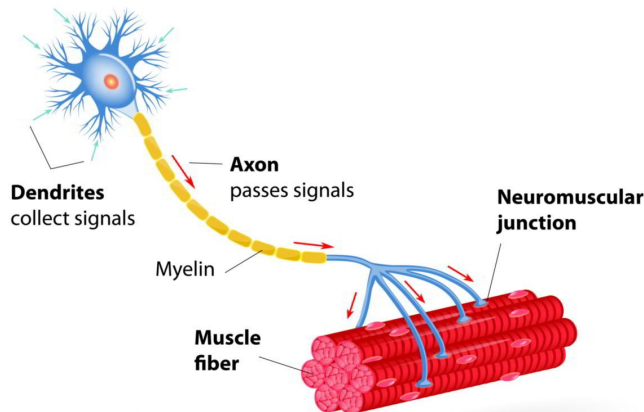
- Blood pressure
- Muscle tension

○ **Motor neurons**

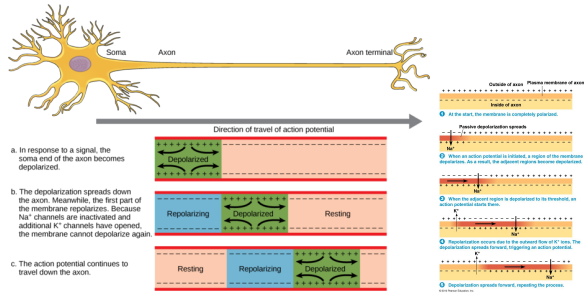
■ Transmit signals from brain or spinal cord to muscle cells or signals

■ Nerve cells within central nervous system that forms synapses (connections) with sensory and/ or motor neurons and integrates sensory input and motor input

MOTOR NEURON



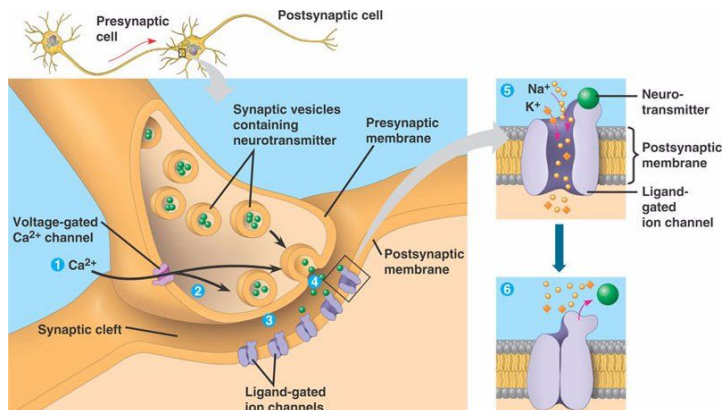
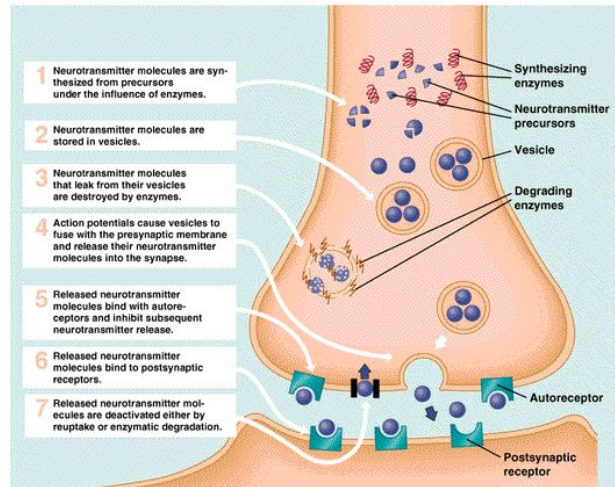
- The signals that they are sending are called **action potential**
 - An electrical signal that propagates (travels) along the membrane of a neuron or other excitable cell as a nongraded (all-or-nothing) depolarization
- **Action potential:**
 - Sudden release of resting potential
 - Steps:
 - **1)** sodium (Na^+) gates open
 - **2)** sodium (Na^+) diffuses into neuron
 - Inside of neuron becomes (+)
 - **3)** potassium (k^+) gates open
 - Sodium (Na^+) gates close and lock
 - **4)** potassium (k^+) diffuses out of neuron
 - Inside of neuron becomes (-) again
 - **5)** potassium (Na^+) gates unlock



➤ **Synapse**

- The junction where a neuron communicates with another cell
- **Electrical synapse**
- **Chemical synapse:** involves the release of neurotransmitters
 - Majority of synapses in the human brain

▶ **Seven Processes in Neurotransmitter Action**



➤ **Action potentials travel fast**

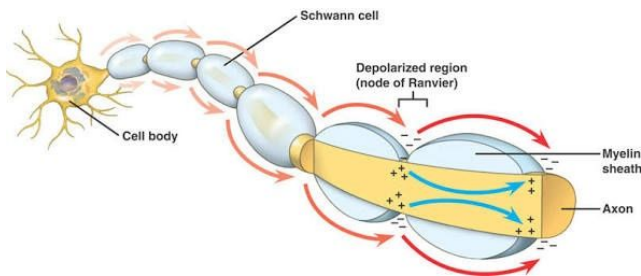
- Diameter of the axon affects the speed at which an action potential is conducted

➤ **Insulating axons help action potentials to travel faster**

- Insulation surrounding vertebrate axons is called Myelin sheath
- Myelin sheath is formed by 1 of 2 types of glial cells
- CNS - oligodendrocytes
- **PNS** - They are formed by **Schwann cells**
- **Nodes of Ranvier** are the gaps in the myelin Sheath
- Voltage gated ion channels restricted by

➤ **Saltatory Conduction**

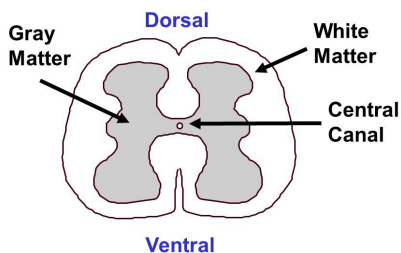
- Occurs in myelinated axons
- Axons potential jumps from node to node



➤ **Spinal cords**

- Myelinated axons
- Grey matter
 - Cell bodies, dendrites, unmyelinated axons

Spinal Cord

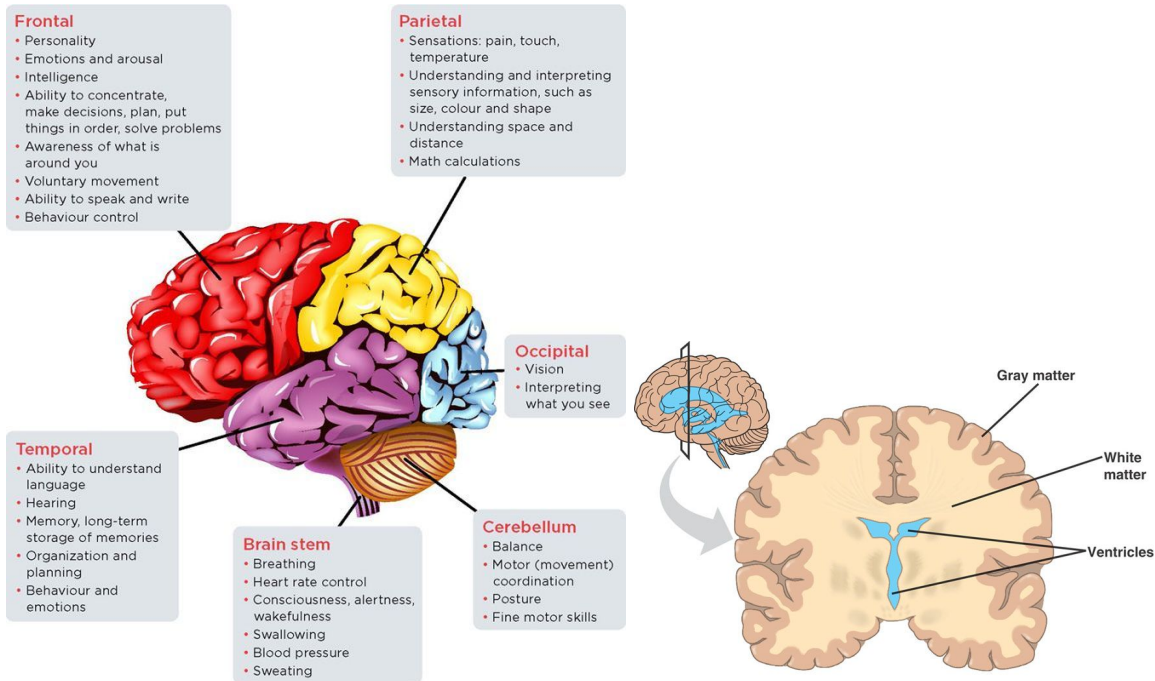


➤ **The Brain**

- Bundle of Neurons
- Divided into distinctive structures and regions
- Deals with information processing

- Gray and white matter

➤ **Brain regions**



- **Brainstem**

- Alertness
- Appetite
- Breathing
- heart rate

- **Cerebrum**

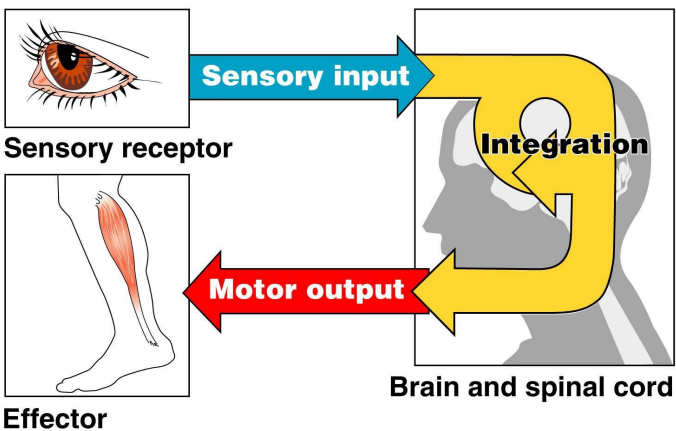
- Controls skeletal muscle contraction
- Divided into 2 cerebral sections/hemispheres (Left & right)
- Cerebral cortex
 - Vital for perception, voluntary movement, and learning

- **Cerebellum**

- Coordinates movement and balance
- Helps in learning and remembering motor skills
- Hand eye coordination
- Muscular coordination

- **Diencephalon**

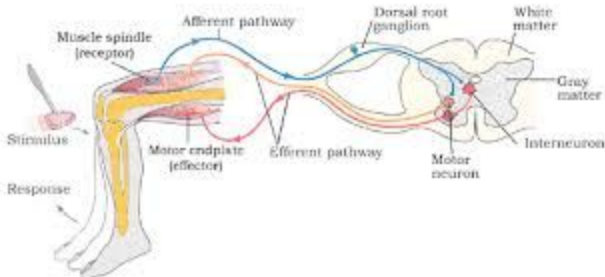
- Connections
- Pituitary glands
- **Gray and White matter**
 - **Gray matter:**
 - Neuron cells bodies and dendrites
 - **White matter:**
 - Bundled axons that have myelin sheaths. Where signals between neurons in the brain occur



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➤ Integration

○



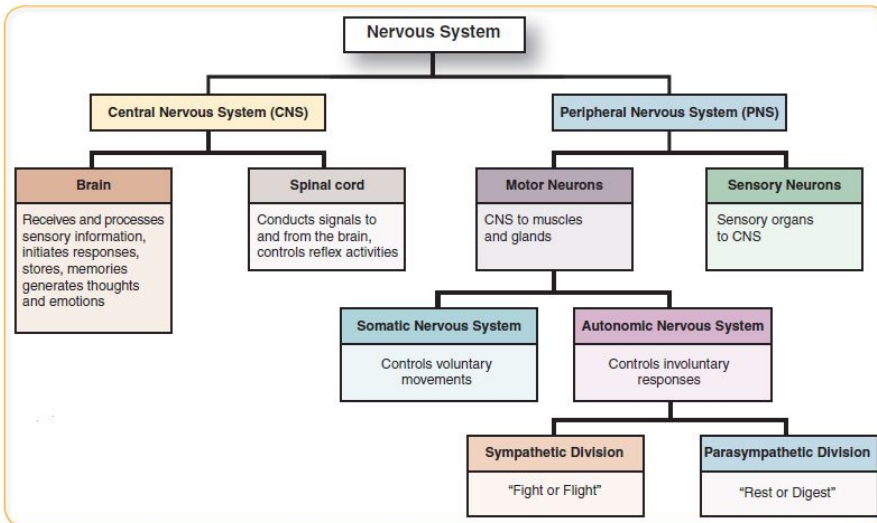
➤ Central Nervous system

- **Information processing**
- Portion of the nervous system where signals integration occurs
- Composed of the brain and spinal cord (vertebrates)

➤ Peripheral Nervous system

- Signal transmission

- Composed of the sensory and motor neurons that connect to the central nervous system
 - **Motor system:**
 - **Efferent neurons**
 - **Somatic nervous system:**
 - controls skeletal muscle
 - **Autonomic system:**
 - Smooth muscle, cardiac muscle, glands
 - Sympathetic
 - Activates the “Fight or flight response”
 - Increased muscle blood flow and tension
 - Dilates pupils
 - Accelerates heart rate and respiration
 - Increased perspiration
 - Increases arterial
 - Parasympathetic
 - Generally enhances body activities that gain and conserve energy, such as digestion and reduced heart rate
 - “Rest and digest”
 - Enteric
 - Networks of neurons in the digestive tract, pancreas, and gallbladder; normally regulated by the sympathetic and parasympathetic nervous system
 - Regulates the internal environment
 - Generally involuntary
- **Afferent neurons**
- **Efferent neurons**



➤ Important points

- Neuron structure reflects function in information transfer
- Action potentials are the signals conducted by axons
- Neurons communicate with other cells at synapses
- Central and peripheral nervous systems
- Vertebrate brain is regionally specialized

➤ Membrane potentials

- Unicellular organisms may change their behaviour in response to changes in membrane potential (unique to animals)

➤ Porifera

- No nervous system

➤ Cnidarian

- Nerve net
- Sensory neurons (touch) but not sense organs

➤ Platyhelminthes

- Net like, but have a brain & nerve cords
- Simple eyes

➤ All the rest have brains and nerve cords

➤ **Ganglia**

- Collections of nerve cell bodies out of the nervous system

- a structure containing a number of nerve cell bodies, typically linked by synapses, and often forming a swelling on a nerve fiber. (only for some)

Senses

➤ Initiating action potential in response to specific stimuli

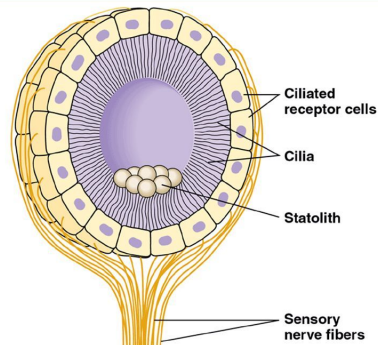
➤ Mechanoreceptors

- Respond to mechanical force

- Ex: statocyst

■ Sense organ of balance

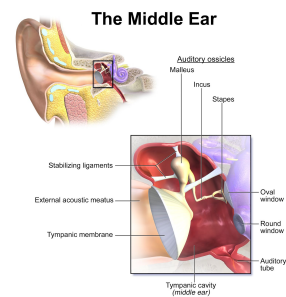
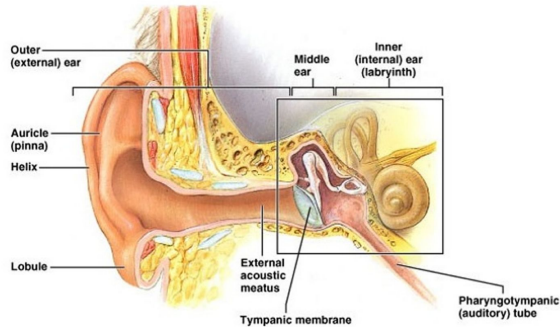
Figure 49.21 The statocyst of an invertebrate



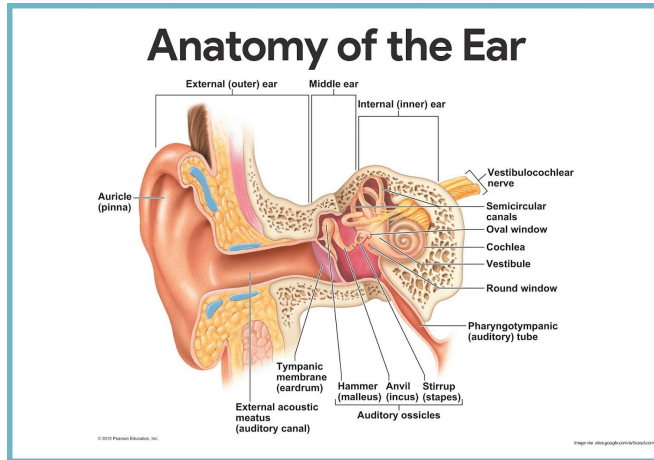
- HUMAN HEARING:

- Eustachian tube:
- Tympanic membrane
- Ossicle of middle ear
- Basilar membrane

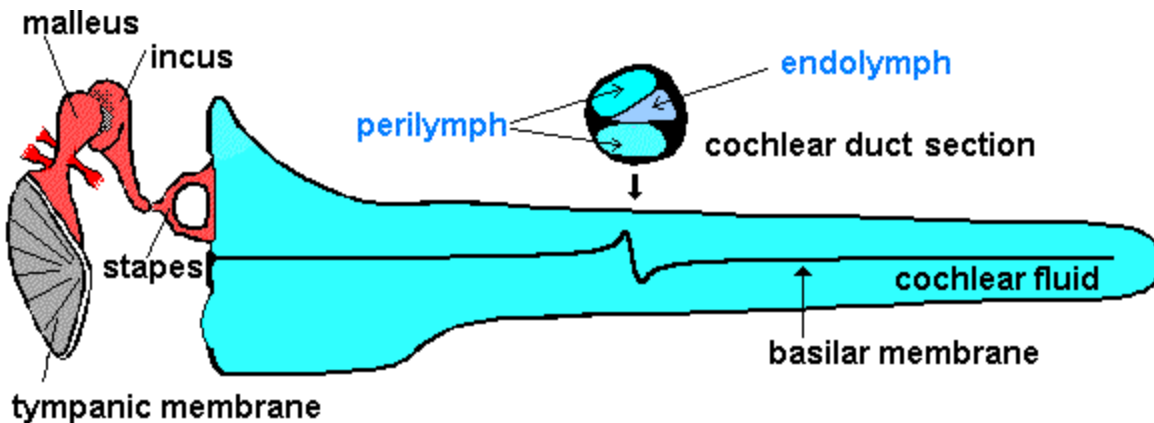
The Outer (External) Ear



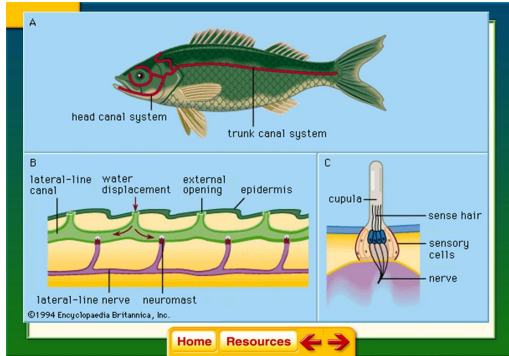
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-
- **Basilar membrane** (how to distinguish between high pitch and low pitch)

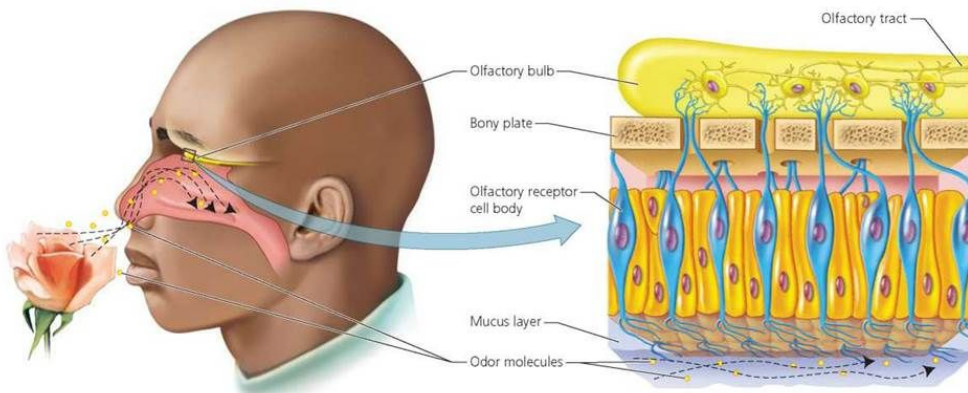


- Vestibule
 - direction
- Semicircular canals
 - Form a complete loop
 - Tell brain about rotational motion
 - Lateral line system
 - Give fish about movement of currents through the water



➤ Chemoreceptors

- Respond to specific chemicals
- Found in mouth, on tongue
- Taste
 - Sweet, sour, salty, bitter, umami (responds to certain amino acids)
- Human smell:

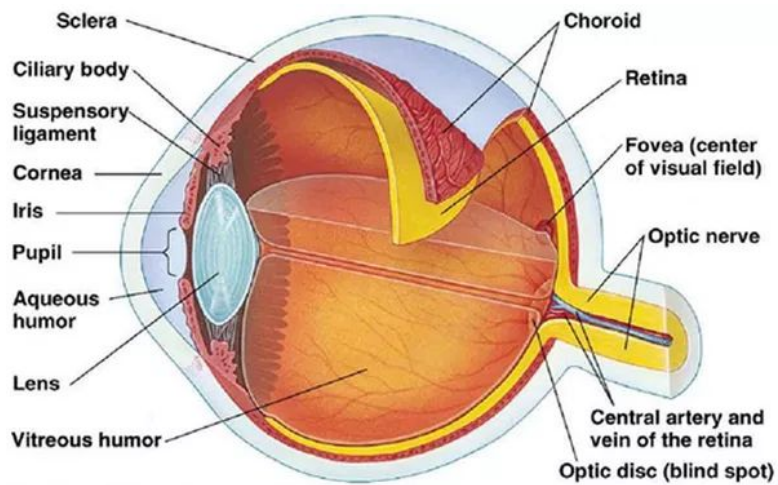


➤ Electromagnetic receptors (photoreceptors)

- Respond to electromagnetic energy
- (light)
- Electromagnetic radiation
- Platyhelminthes:
 - can't actually form images because of screening (protection from light) but can sense which side the light is coming from
- Flies:
 - Have multiple eyes and can form images

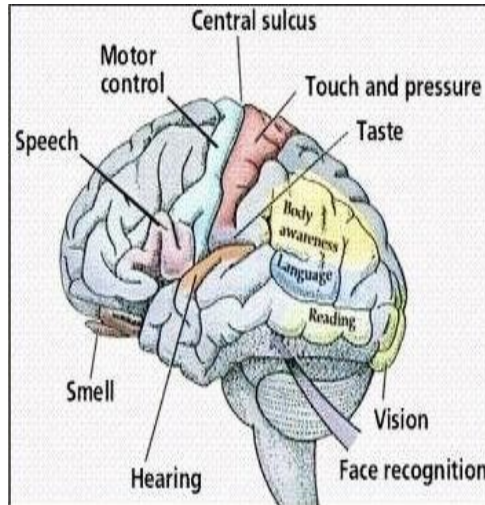
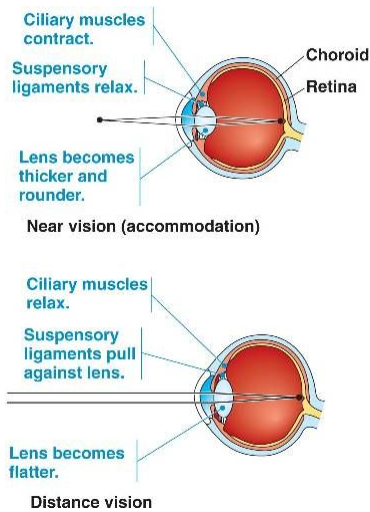
- They can see things that we can't see

- **HUMAN EYE:**

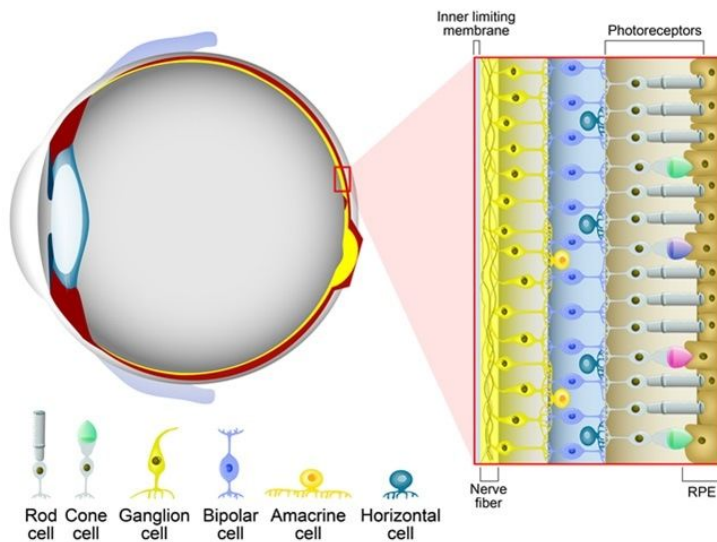


- Vitreous
 - Inflates eye
- Retina
 - **Photoreceptors**
 - Rods
 - Respond to wide range of colours
 - Black and white vision (grey too)
 - Very sensitive to light
 - 125 million
 - Cones
 - Three kinds:
 - Respond to green, red, or blue light
 - Allows colour vision
 - Relatively insensitive to light
 - 6 million
- Choroid
 - Feed the retina and block light from entering the eye
- Sclera
 - White part in eyes

- Thick connective tissue that protects the eye and gives shape
- Cornea
 - Bends the light and begins the process of **focusing the light**
- Aqueous humor
 - Feeds cornea and lens
- Iris
- Pupil
 - Controls amount of light getting in to the eye
- Lens
 - Adjusts focus
 - Changes shape to adjust focus
- Optic nerve
- Occipital lobe
 - Where we see in brain



RETINAL CELLS



➤ Thermoreceptors

- Respond to temperature

➤ Pain receptors

- Respond to damaged tissue