جامعة أم القرى
UMM AL-QURA UNIVERSITY

General Biology
Lecture (10) & (11)
Animal Form and Function

College of Science

Biology Department

OUTLINE

- Basic Principles of Animal Form and Function
- Animal Nutrition
- Circulation and Gas Exchange
- The Immune System
- Animal Reproduction
- Animal Development
- Animal Behavior



How do animals regulate their internal state even in changing or harsh environments?

Adaptations in form, function, and behavior help maintain an animal's internal environment. For example, three adaptations that help penguin stay warm :

Form (anatomy): An insulating layer of fat (blubber) reduces heat loss from most of the penguin's body (blue body areas in this thermal image).





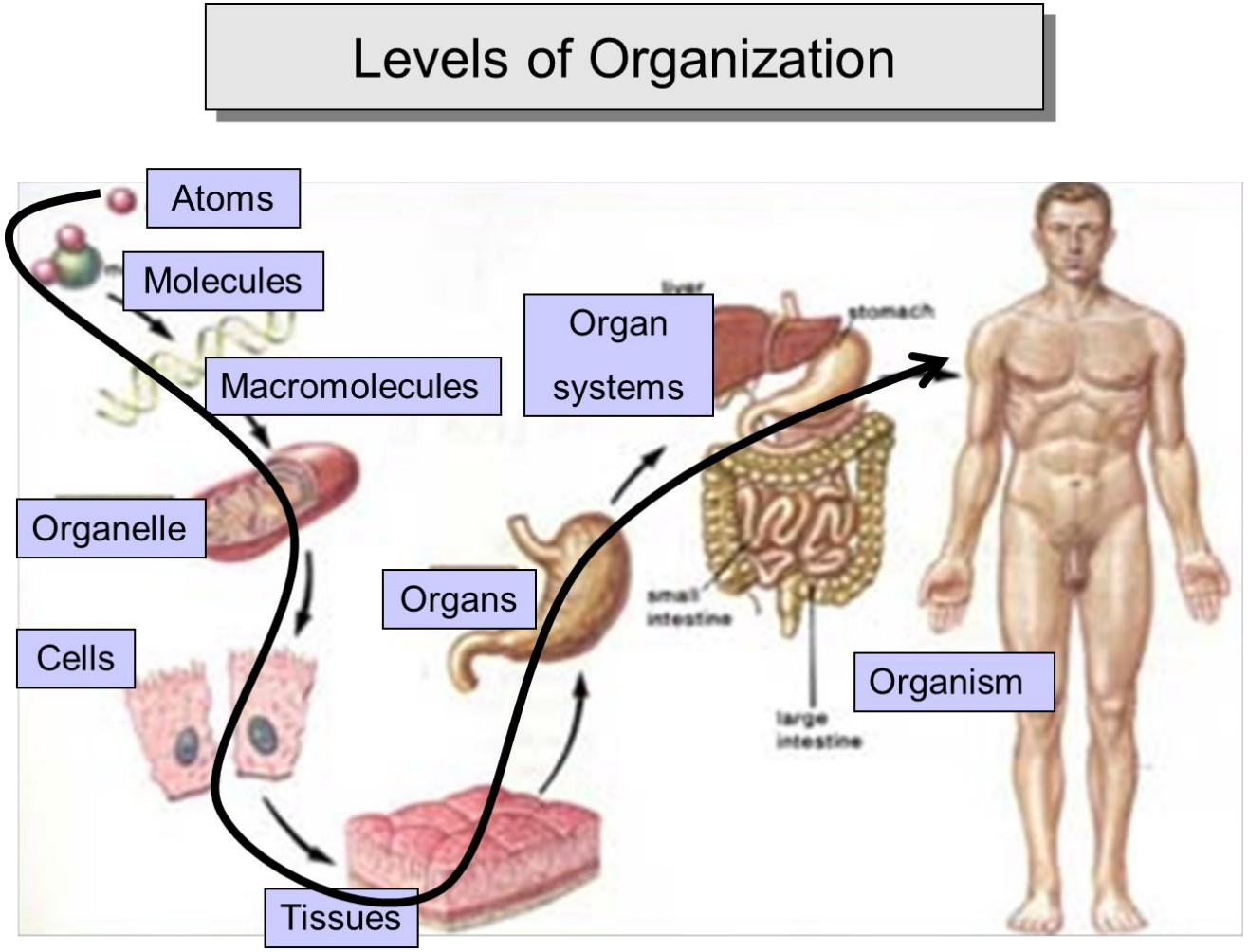
Function (physiology): Rapid cycles of muscle contraction and relaxation during shivering produce heat at a cellular level



Behavior: By packing together in groups of up to several thousand, Emperor penguins greatly reduce their exposure to wind and cold.

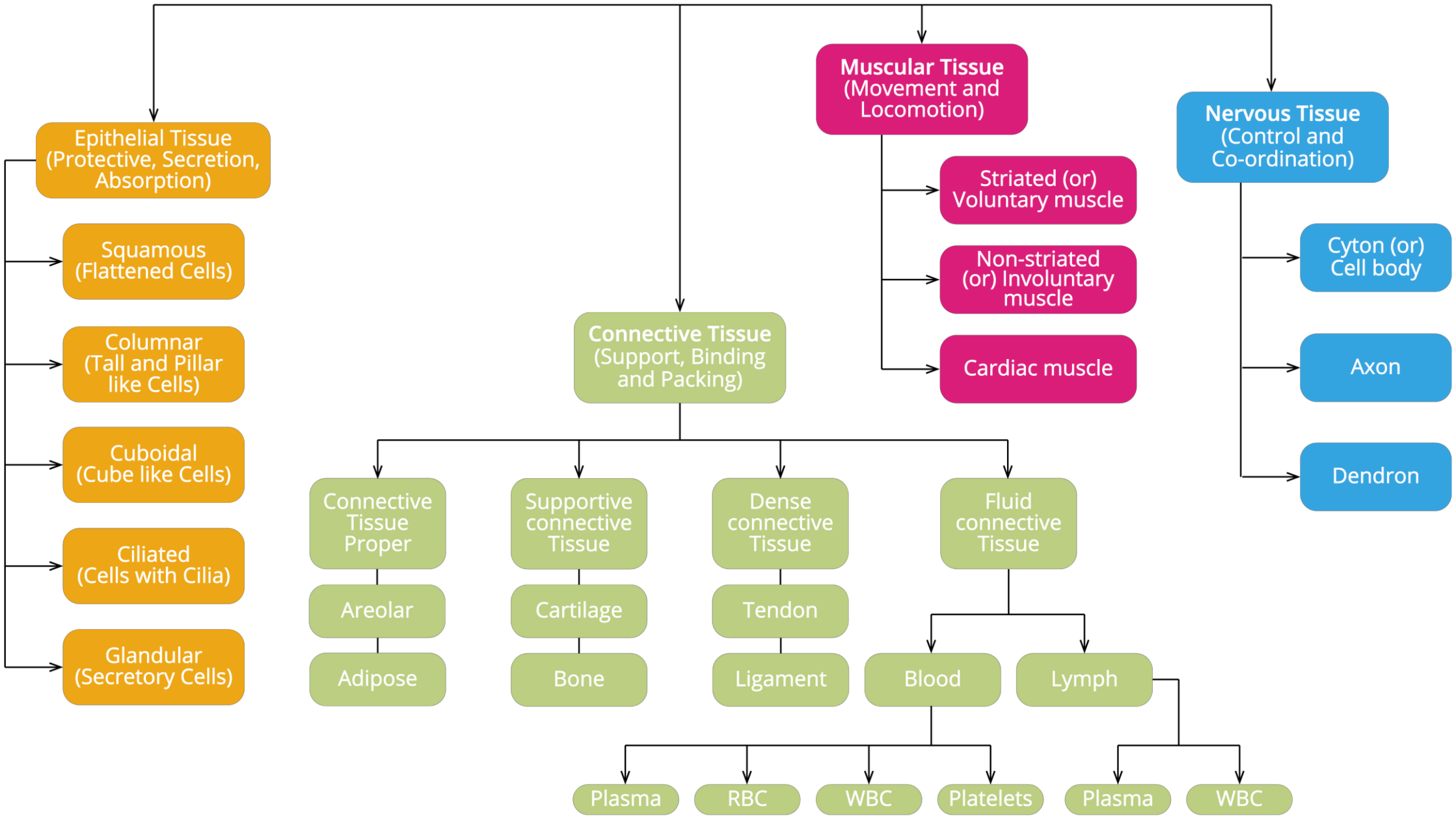
Hierarchical Organization of Body Plans

- In vertebrates, *the space between cells* is filled with *interstitial fluid*, which allows for the movement of material into and out of cells.
- A complex body plan helps an animal in a variable environment to maintain a relatively stable internal environment.
- Most animals are composed of specialized cells organized into tissues that have different functions.
- Tissues make up organs, which together make up organ systems.

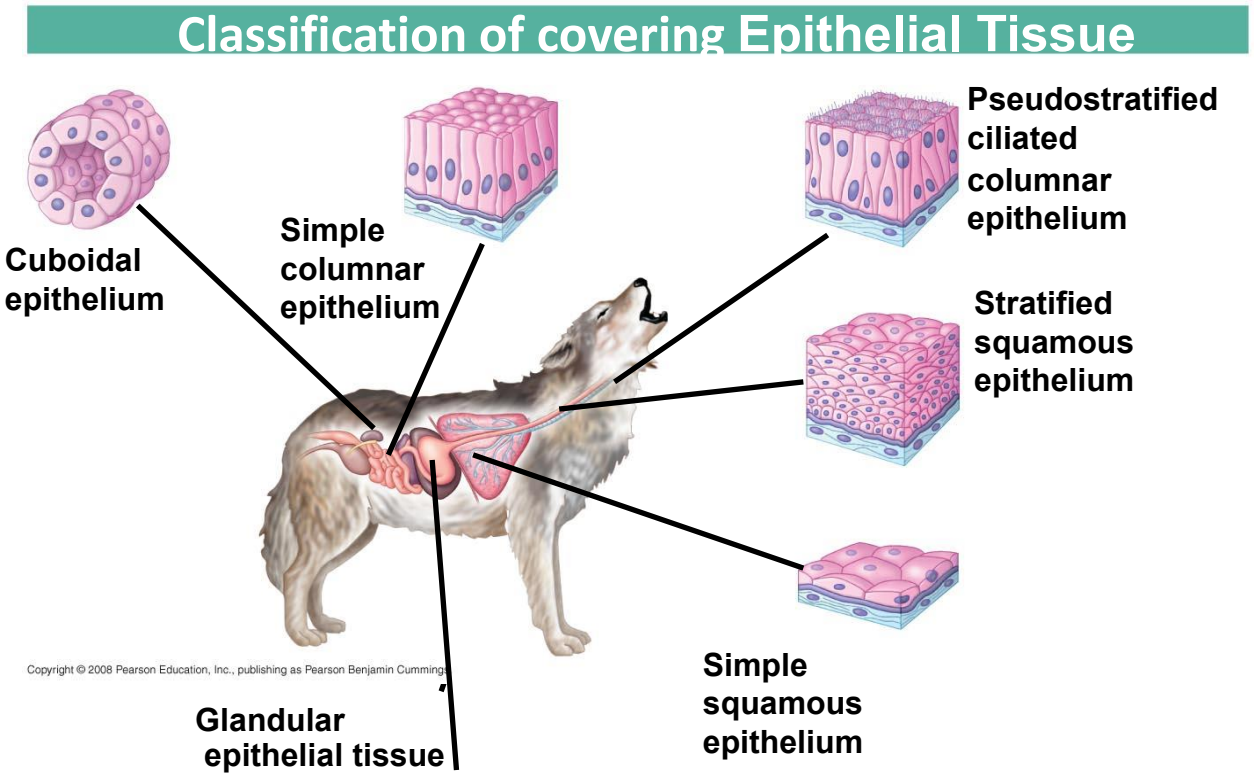


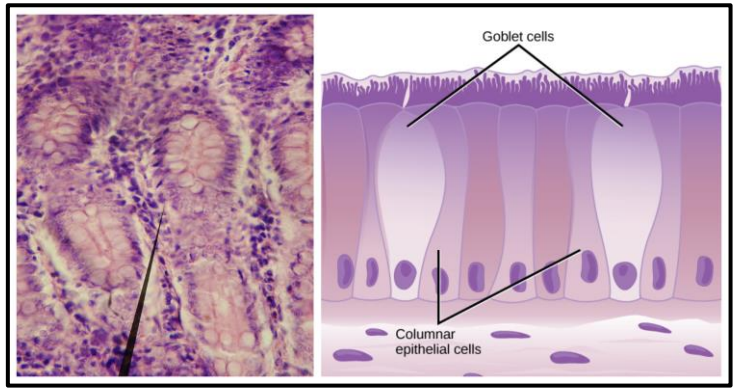
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CLASSIFICATION OF ANIMAL TISSUES



Epithelial Tissue





1.The covering epithelial tissue:

- ✓ **Based on the epithelial layers**

1. Simple - Single layer
2. Stratified - More than one layer
3. Ciliated - Cells with cilia

- ✓ **Based on the cell shapes**

1. Squamous - Flat
2. Cuboidal - Cube
3. Columnar – Rectangular

2.Glandular epithelial tissue:

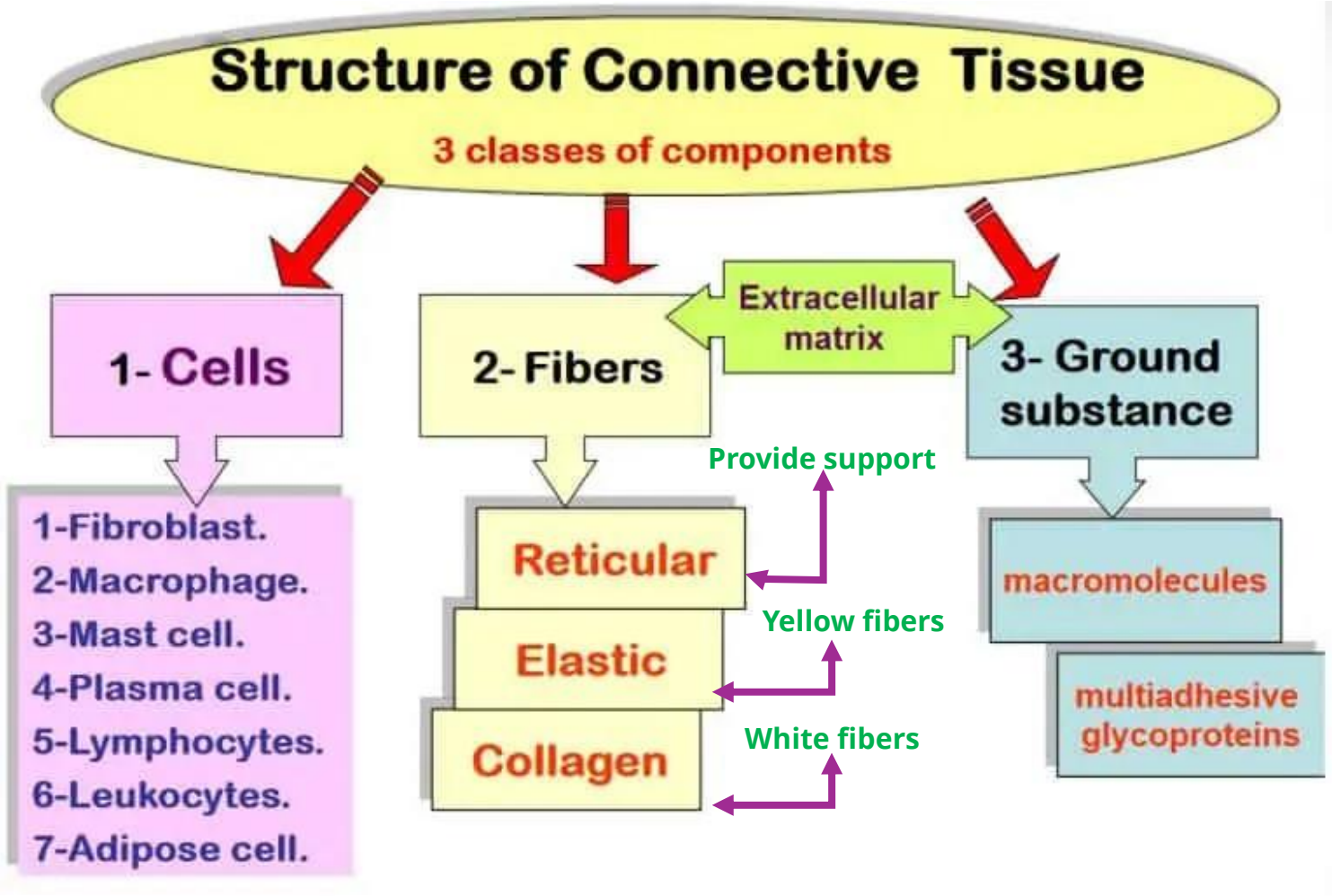
A portion of epithelial cells folds inward, which results in the formation of a multicellular gland.

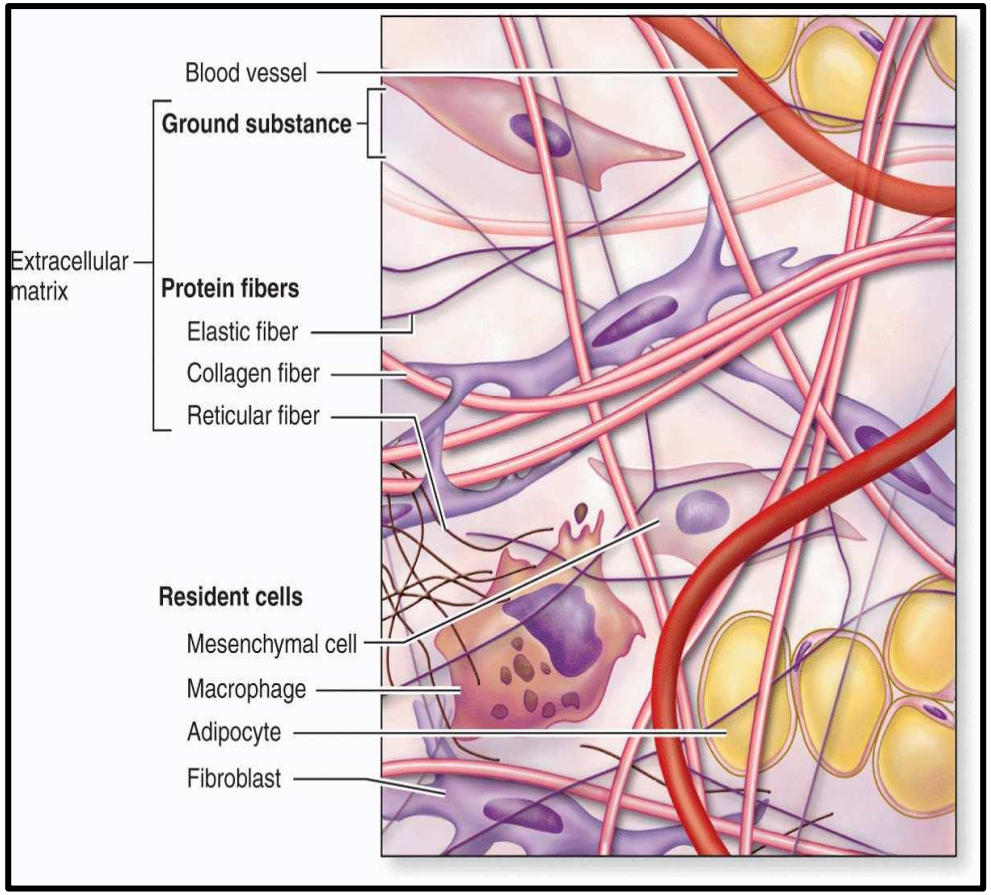
Location: It is found in the stomach, intestine and pancreas.

Function: It involves the synthesis and secretion of chemical substances at the epithelial surface.

Connective tissue

Origin: Connective tissue arises from the **mesoderm** of the embryo.
Location: These tissues are specialized to connect various body organs. It provides the **structural framework** and support different tissue to form organs.



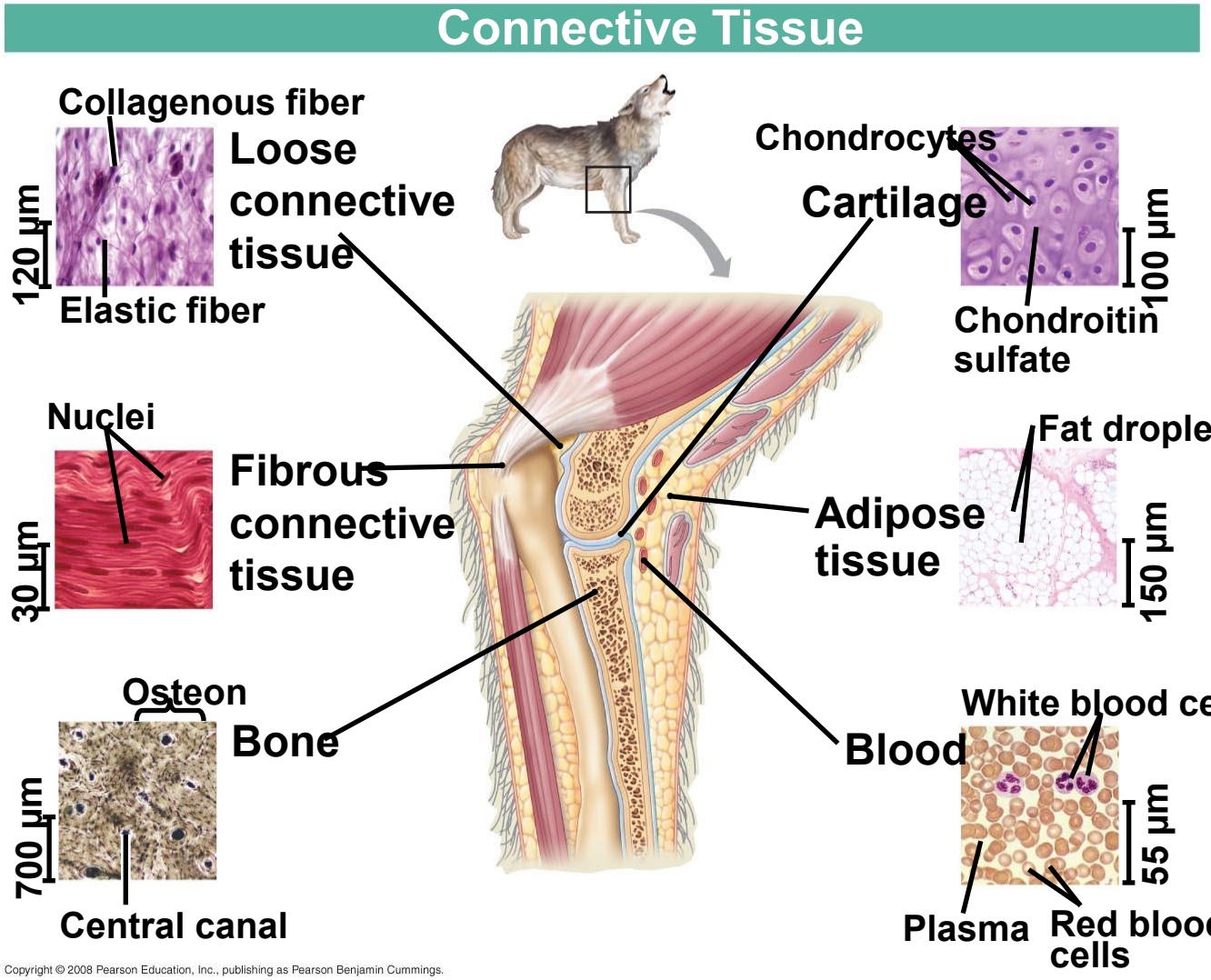


In vertebrates, the fibers and foundation combine to form *six major types of connective tissue*:

1- ***Loose connective tissue:*** binds epithelia to underlying tissues

2-(Dense)***Fibrous connective tissue*** is found in ***tendons***, which attach muscles to bones, and ***ligaments***, which connect bones at joints

3-(***Support connective tissue)*** ***Bone*** is mineralized and forms the skeleton.



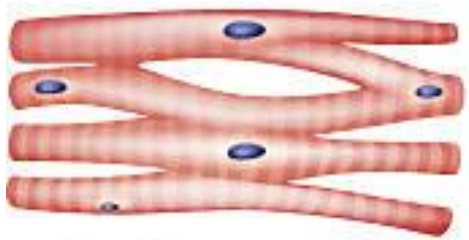
4- (***Support connective tissue) Cartilage*** is a strong and flexible support material.

5- ***Adipose tissue*** stores fat for insulation and fuel.

6- (Fluid connective tissue)***Blood*** is composed of blood cells and cell fragments in blood plasma.

Types of Muscle





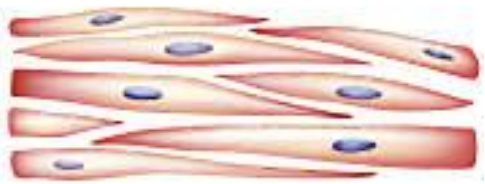
Cardiac muscle





Skeletal muscle

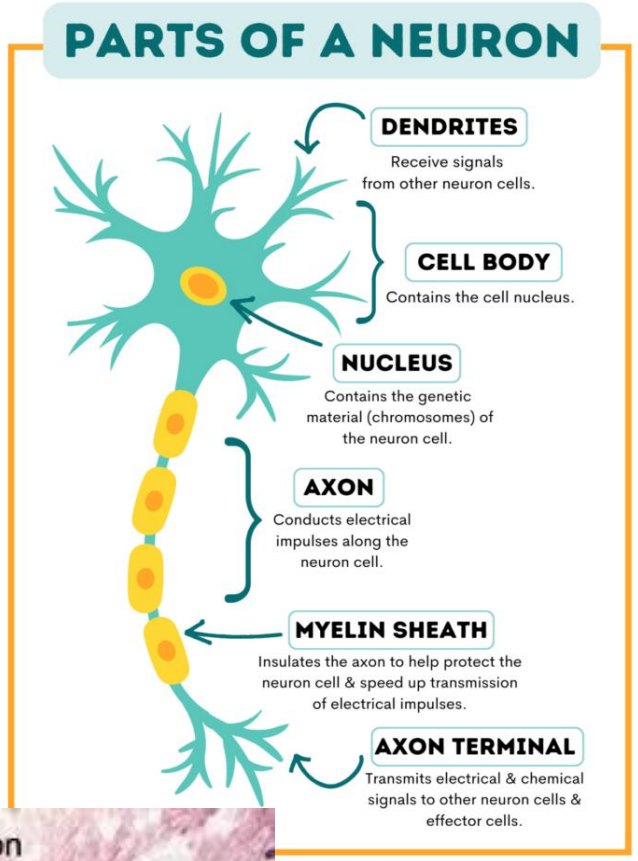




Smooth muscle

Nervous tissue

Nervous tissue senses stimuli and transmits signals throughout the animal. Also, it **abundantly occurs in the brain, spinal cord, and nerves.**



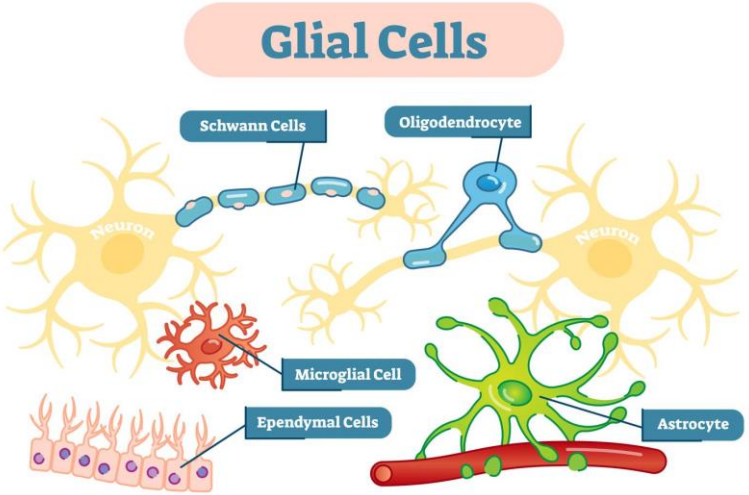
Nervous tissue contains:

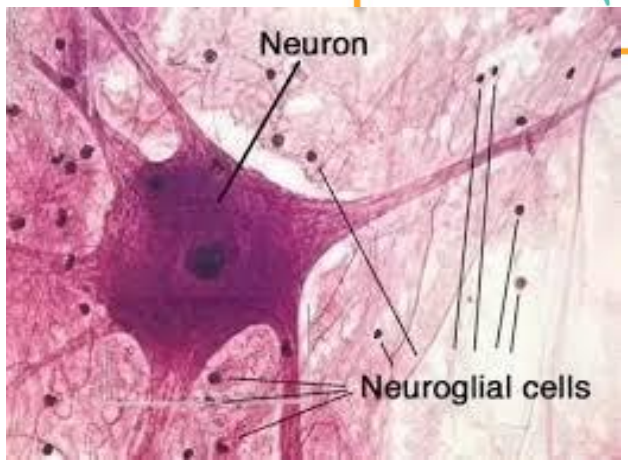
A-Neurons, or nerve cells, that transmit nerve impulses. A single neuron can be up to a meter long and is made up of three main components:

1.Cell body
2.Axon
3.Dendrites

B-Glial cells, or **glia**, are a group of supportive cells that help nourish, insulate, and replenish neurons.

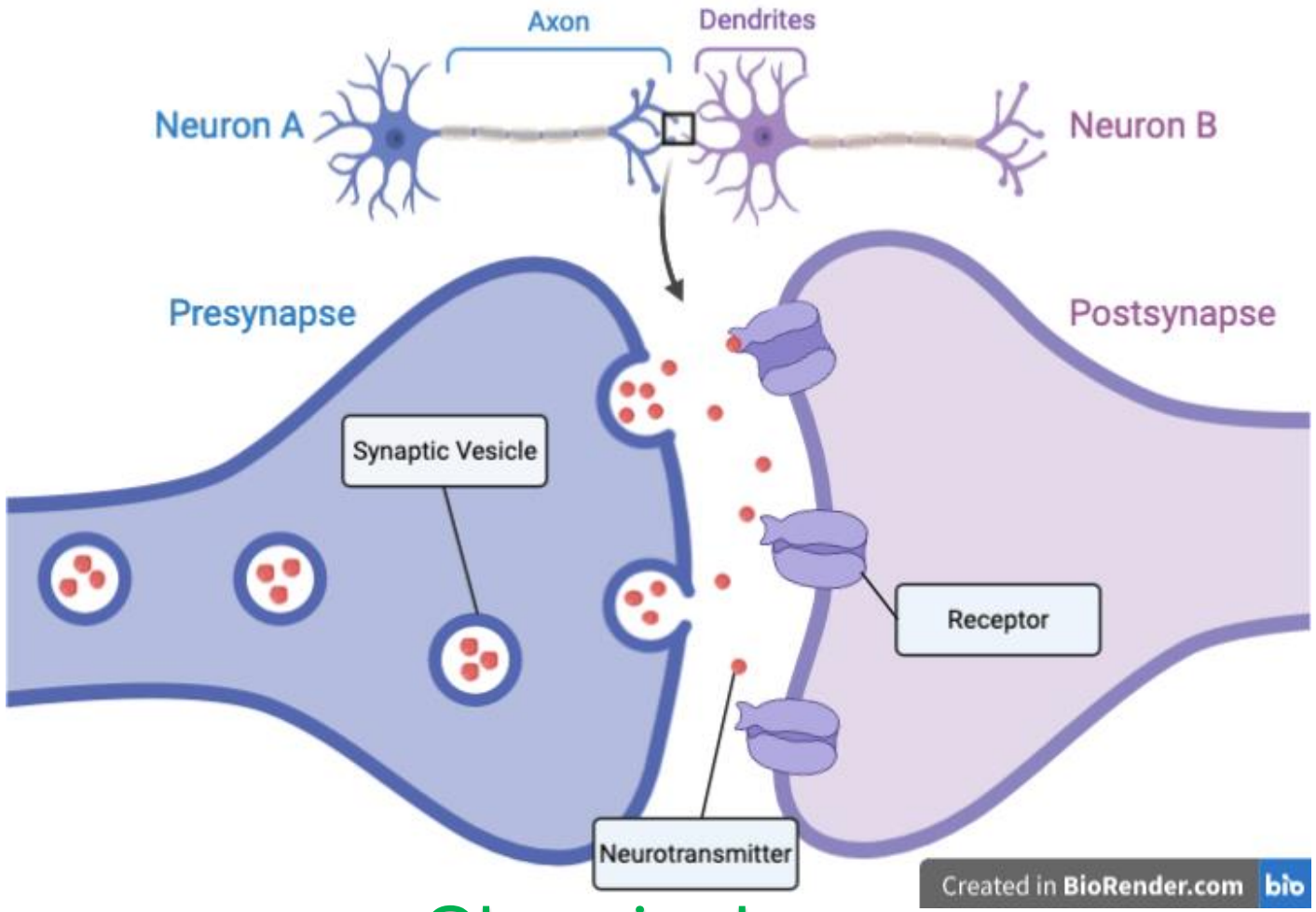
- They maintain the myelin sheath
- Provide nutrient support.
- They also retain homeostasis





Neurons communication (neuronal synapses): is a combination of electrical and chemical signals. A synapse is a small gap at the end of a neuron that allows a signal to pass from one neuron to the next.

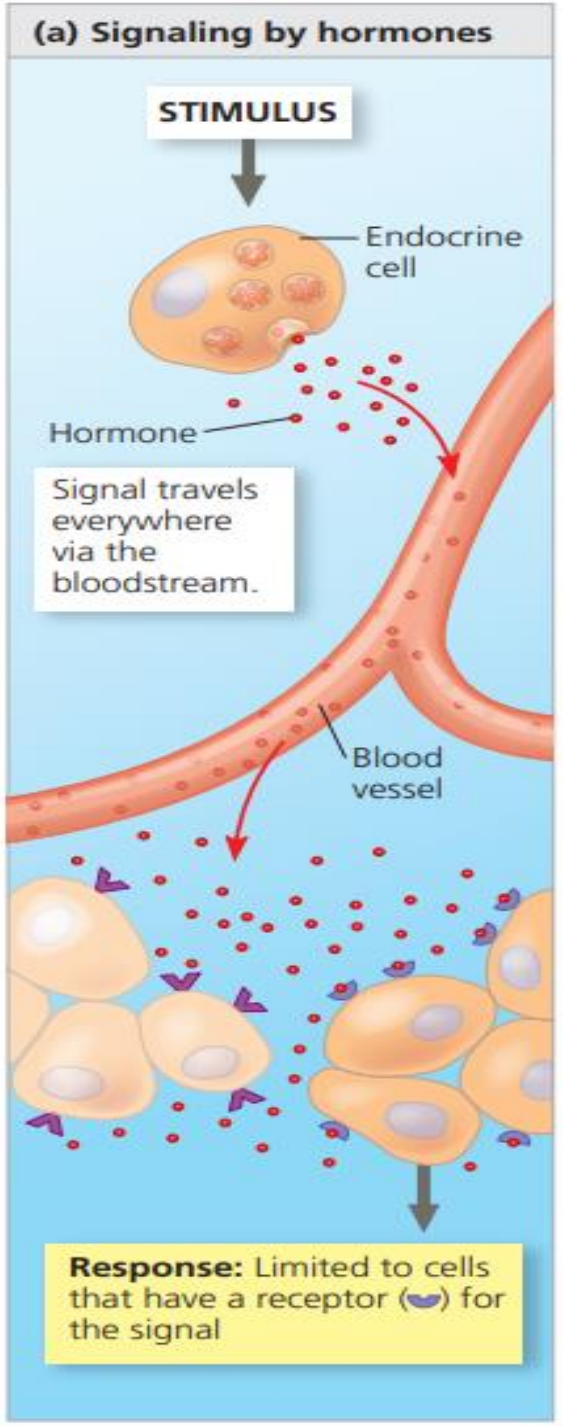
Neurons are cells that transmit information between your brain and other parts of the central nervous system.



Chemical synapse

Coordination and Control

- Control and coordination within a body depend on the *endocrine system* and the *nervous system*.
- The endocrine system transmits *chemical signals* called ***hormones*** to receptive cells throughout the body via blood.
- A hormone may affect one or more regions throughout the body.
- Hormones are relatively slow acting, but can have long-lasting effects. however, because hormones can remain in the bloodstream for minutes or even hours

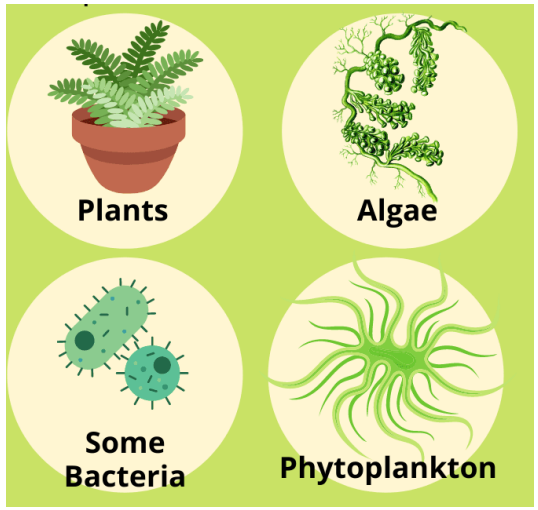


Animal Nutrition

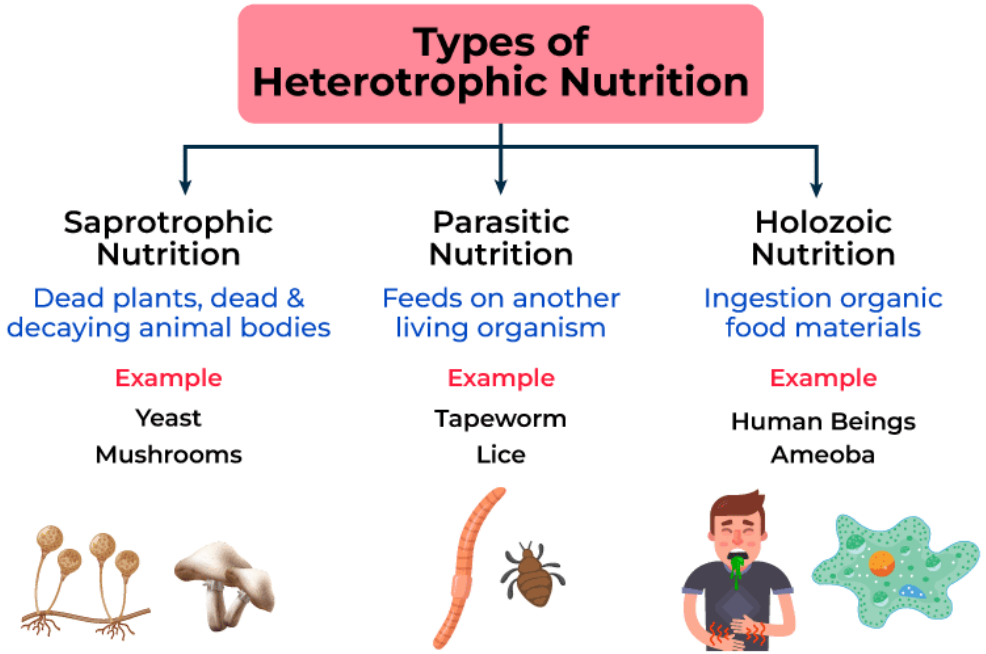
It is the process through which the animal feeds by ingesting complex organic food (either in the solid or liquid form), which is then digested and absorbed into their bodies.

Classifying Different Modes of Nutrition

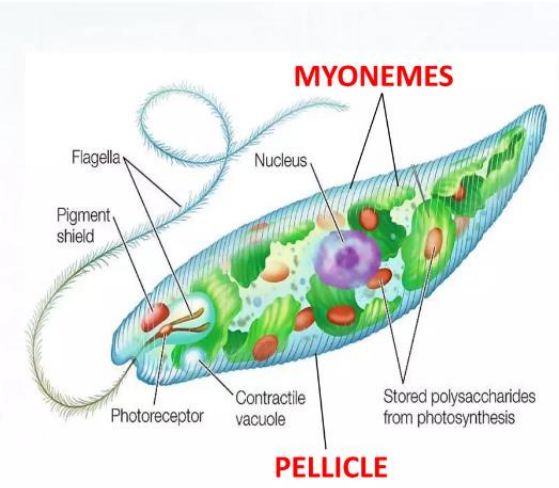
Autotrophs (producer):
It is an organism that produce its own food



Heterotrophs (consumers):
It is an organism that does not make its own food



Mixotrophic:
It is an organism that can be autotrophic and heterotrophic



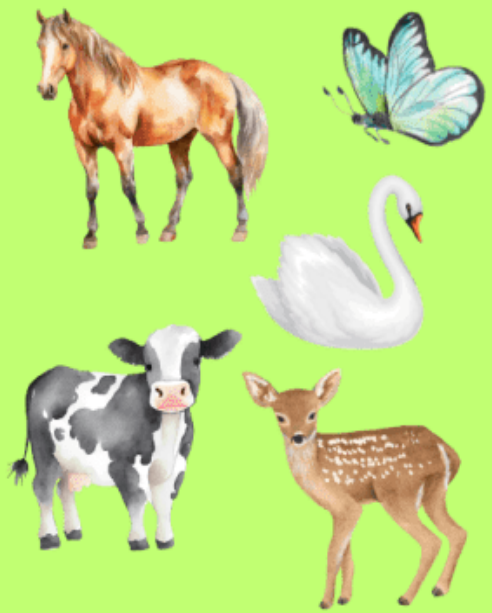
Euglena

Herbivores, Carnivores, and Omnivores

The three broad types of diets in the animal kingdom are herbivores, carnivores, and omnivores.

HERBIVORE

An herbivore eats plants.



CARNIVORE

A carnivore eats animals.



OMNIVORE

An omnivore eats both plants and animals.



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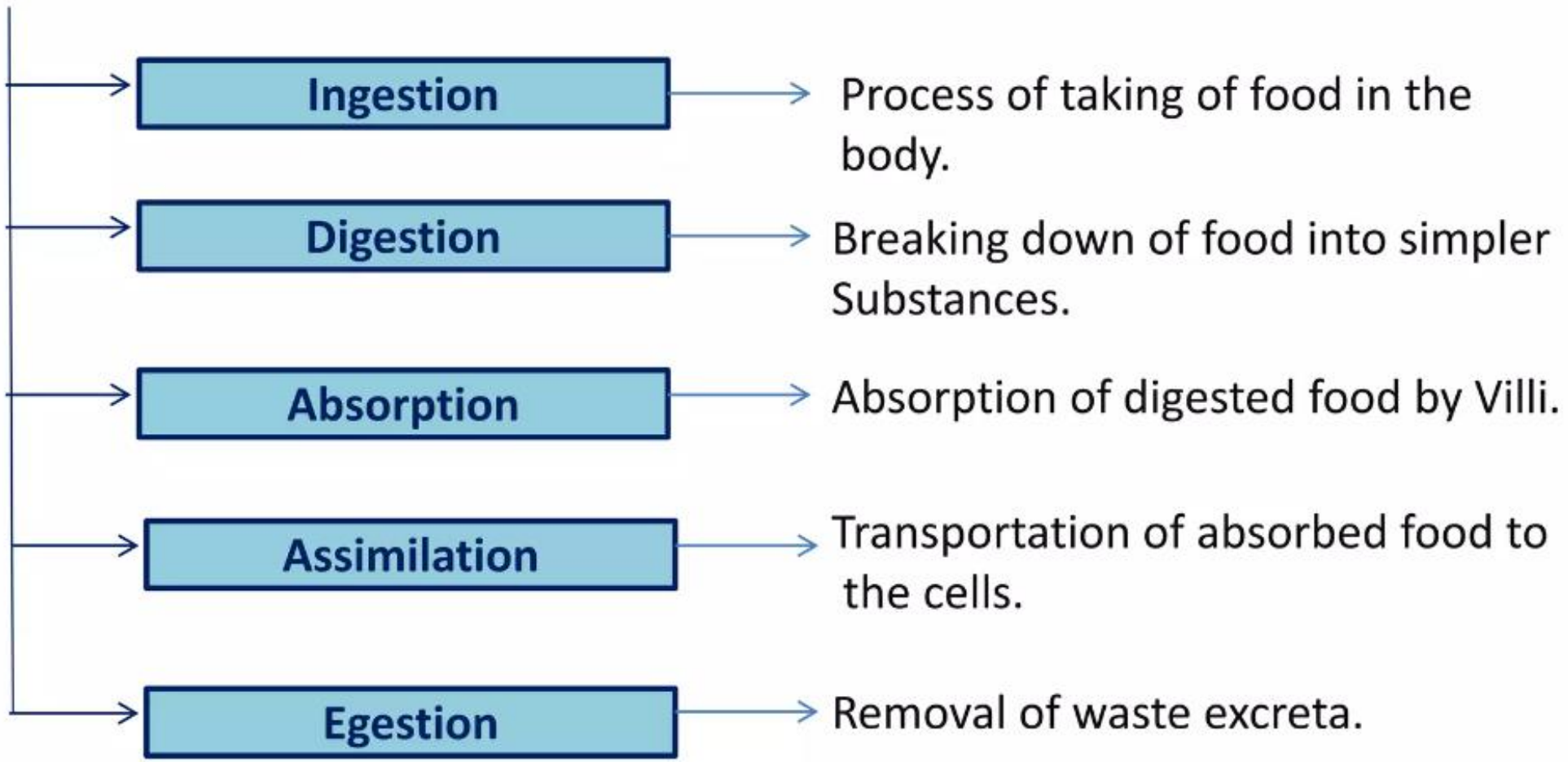
An animal's diet must supply chemical energy, organic molecules, and essential nutrients

- An animal's diet provides chemical energy, which is converted into **ATP** and powers processes in the body.
- Animals need a source of organic carbon and organic nitrogen in order to construct ***organic molecules***.
- **Essential nutrients** are required by cells and must be obtained from dietary sources.

There are six classes of essential nutrients:

1. **Water**: Dissolves and carries nutrients, regulate body function and body temperature.
2. **Carbohydrates**: Sugars-provides energy
3. **Protein:** Built and repairs tissues, enzymes and hormones.
4. **Fats and oils:** Store energy for long term in the body.
5. **Vitamins:** Promote normal growth. Provide proper metabolism and protect against diseases.
6. **Mineral:** support function of heart, metabolism, bones and teeth formation.

Five steps in the process of Nutrition in Animal:



Different ways of taking food(Ingestion)

Animal	Mode of ingestion
Amoeba	Engulfs food with the help of pseudopodia (false feet) and food vacuole digest it
Lice	Feeds by sucking blood from the skin
Honeybees and Hummingbirds	Collects nectar from flowers in plants
Dog	Chew and swallow their food using mouth
Frog	Long forked tongue to catch insects
Infants of mammalian	Feeds on mother's milk by using mouth
sponge	Filter tiny food particles



Sucking



Chewing



Long forked tongue

2.Digestion:-The process by which complex food substances are broken down into simpler substances is called digestion.



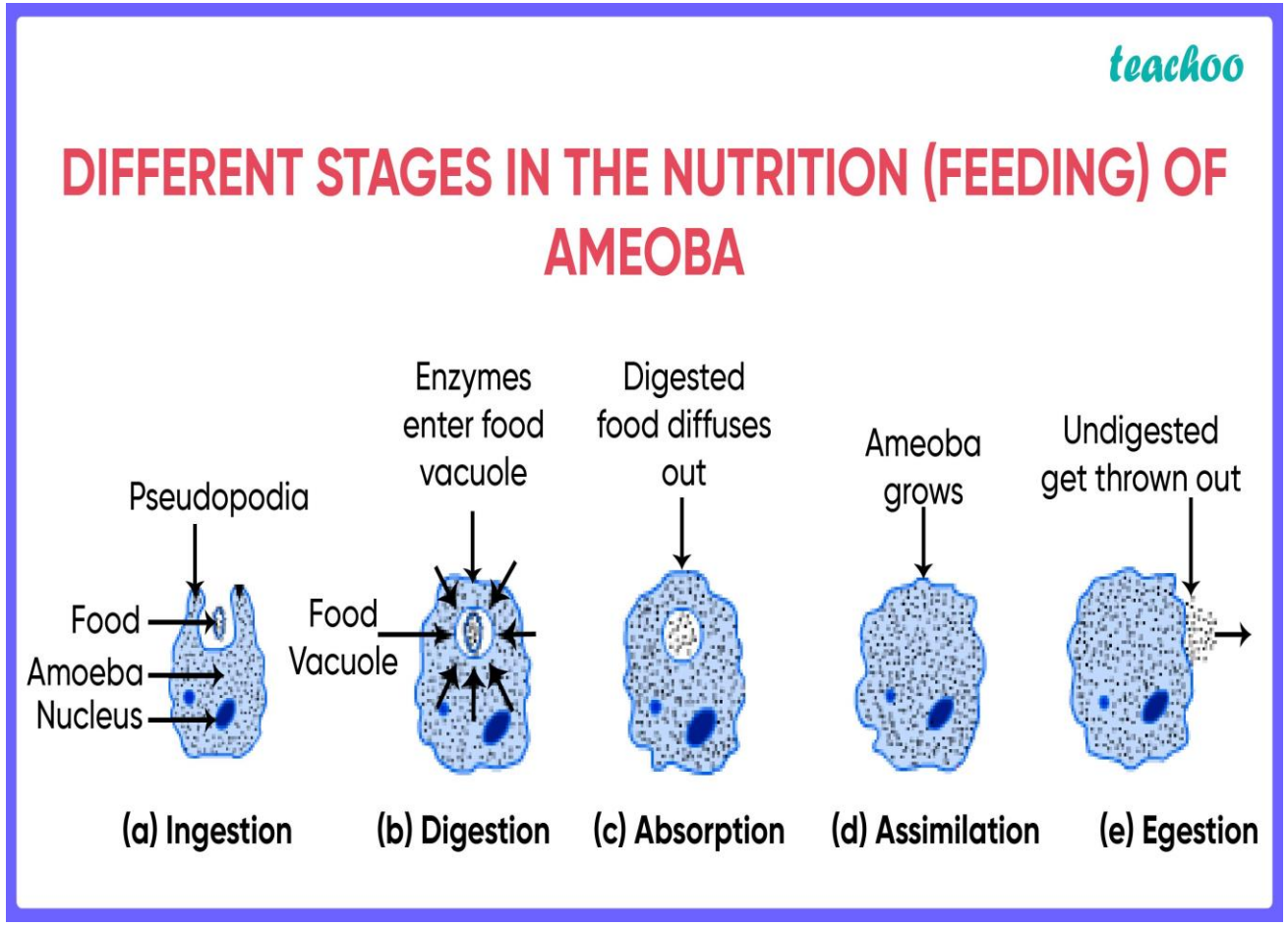
Complex Substances

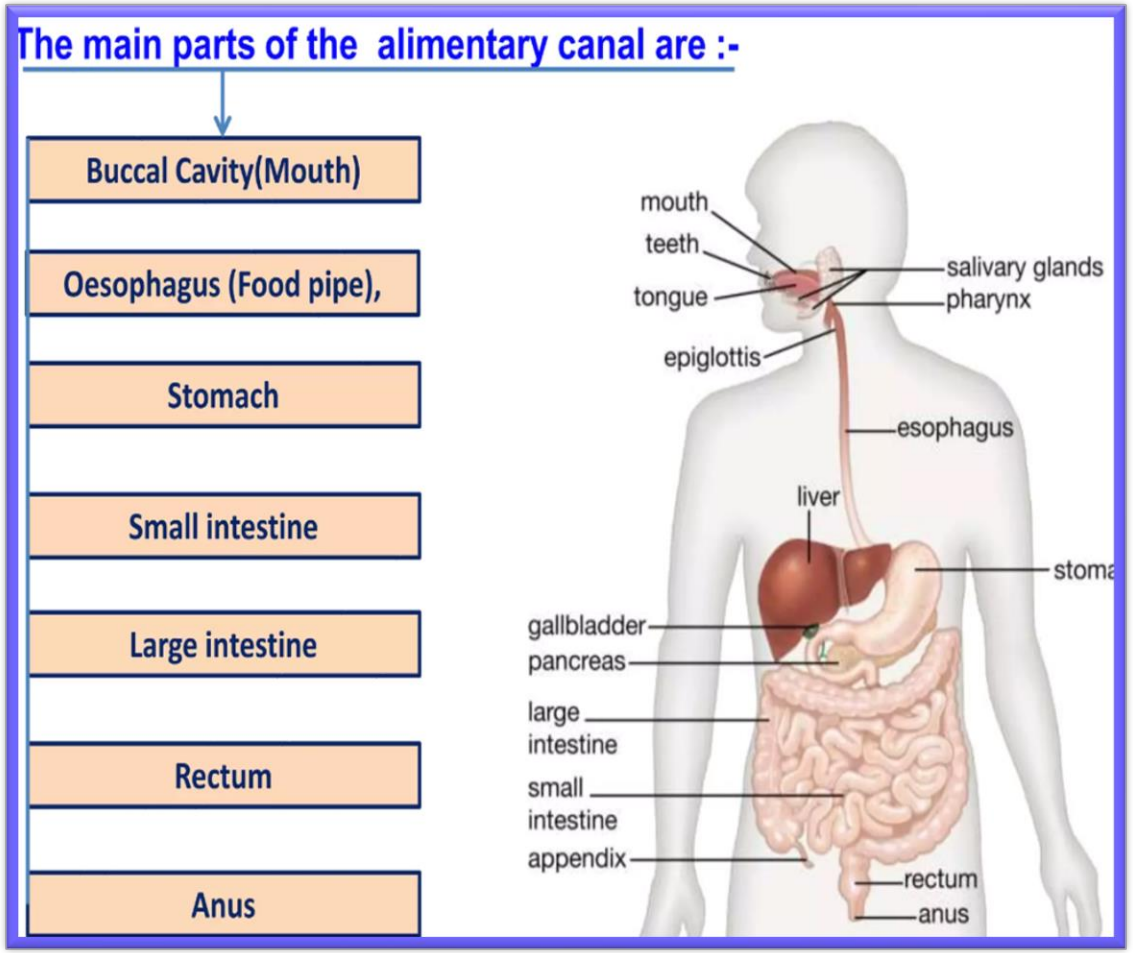
Simpler Substances

NUTRIENTS AND THEIR SIMPLER SUBSTANCES.

1.Carbohydrates	→	Glucose
2.Fats	→	Fatty Acids
3.Protiens	→	Amino Acids

Different stages in the Nutrition of Amoeba and Human

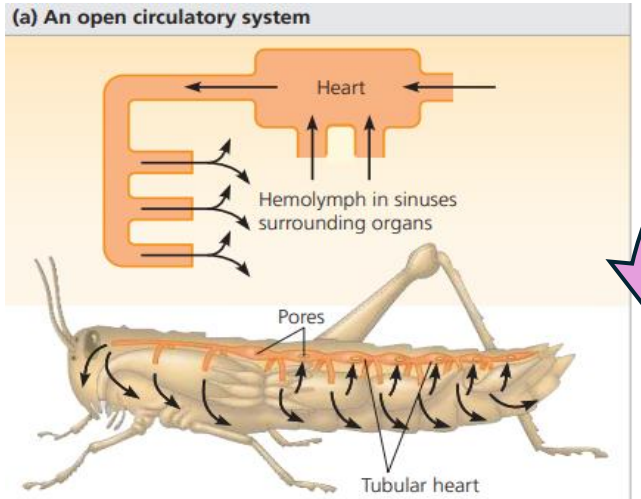


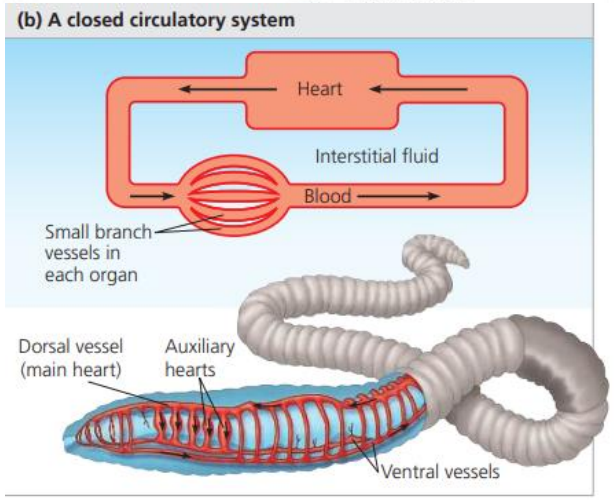


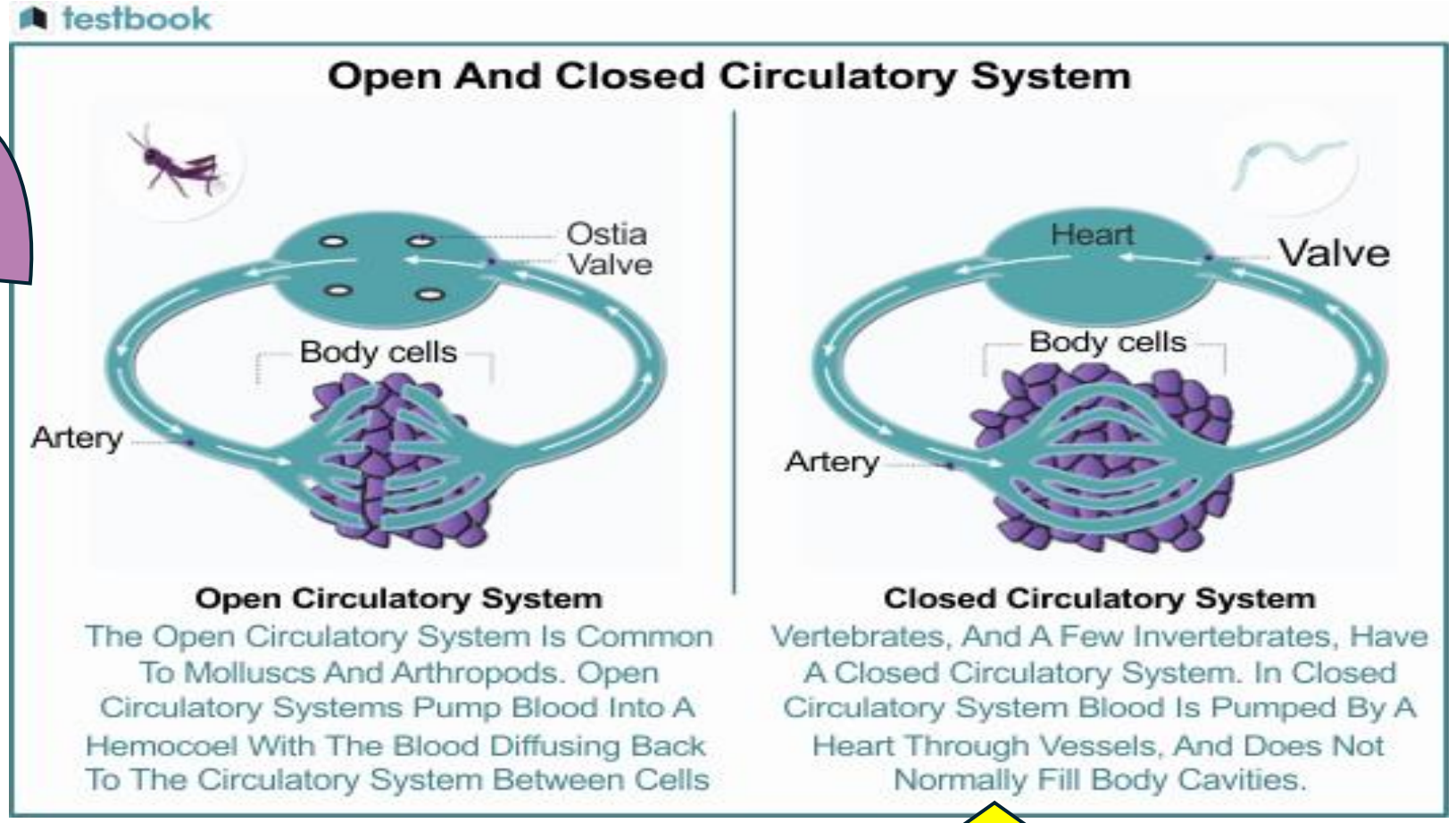
Circulation and Gas Exchange

The Circulatory System:

Large organisms require a transport system to distribute nutrients and oxygen and to remove wastes and CO_2 from cells distributed throughout the body.







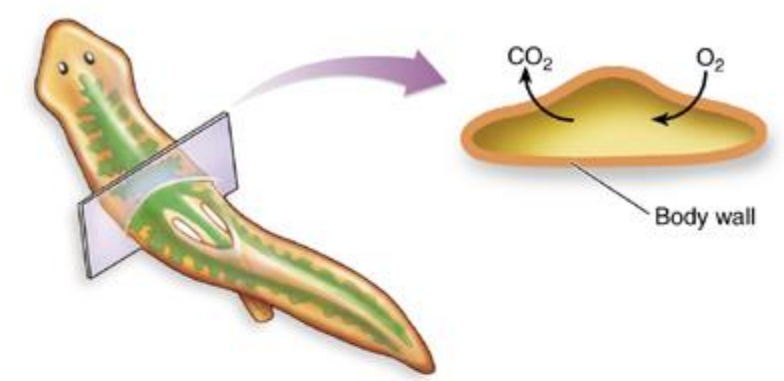
Gas exchange occurs across specialized respiratory surfaces

Gas exchange supplies oxygen for cellular respiration and disposes of carbon dioxide to stay a live.

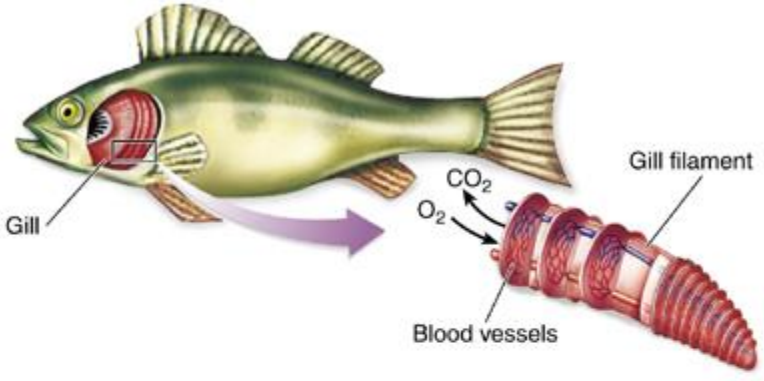
Major types of gas exchange system in animals:

1. Skin (body surface)
2. tracheae
3. gills
4. lungs

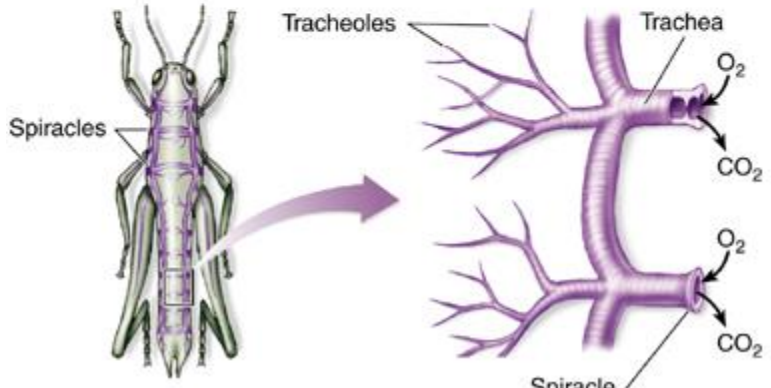
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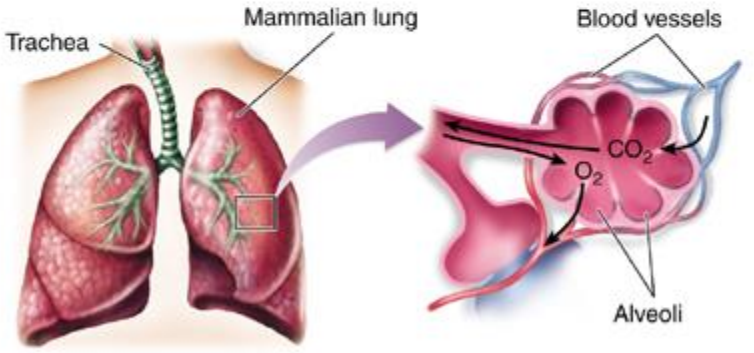
(a) Flatworm



(b) Fish



(c) Terrestrial arthropod



(d) Mammal

Animal reproduction

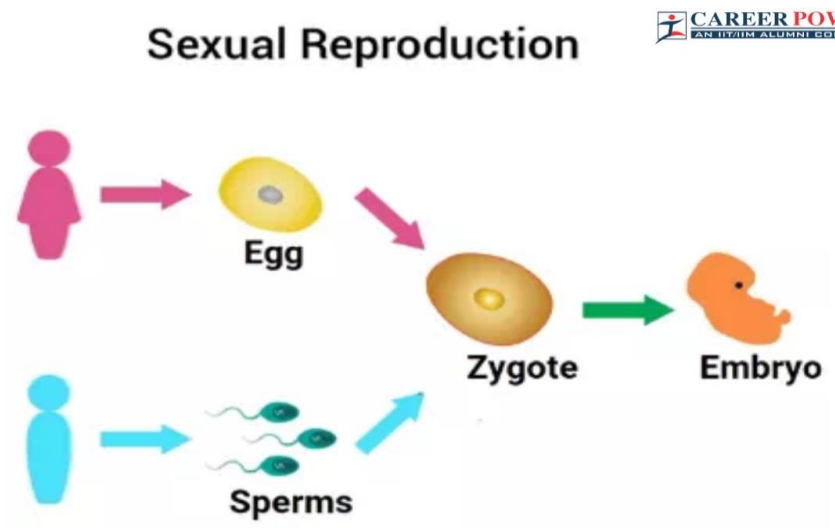
Reproduction is the biological process of producing the same kind of individuals. Most organisms reproduce by two types of animal reproduction include,

•Sexual Reproduction: is the creation of an offspring by fusion of a male gamete (*sperm*) and female gamete (*egg*) to form a *zygote*

•Asexual Reproduction: is creation of offspring without the fusion of egg and sperm . One parent *clones* offspring.

Type of Sexual reproduction in animals:

1- Internal fertilization occurs inside the female body when the male introduces the sperms into the female reproductive tract. The sperm fuses with the egg in the ampulla of the fallopian tube. This results in the formation of a zygote which undergoes mitosis to form an embryo.



2- External fertilization is a mode of reproduction in which a male organism's sperm fertilizes a female organism's egg outside of the female's body for example: fish and frog .



Type of Asexual reproduction in animals:

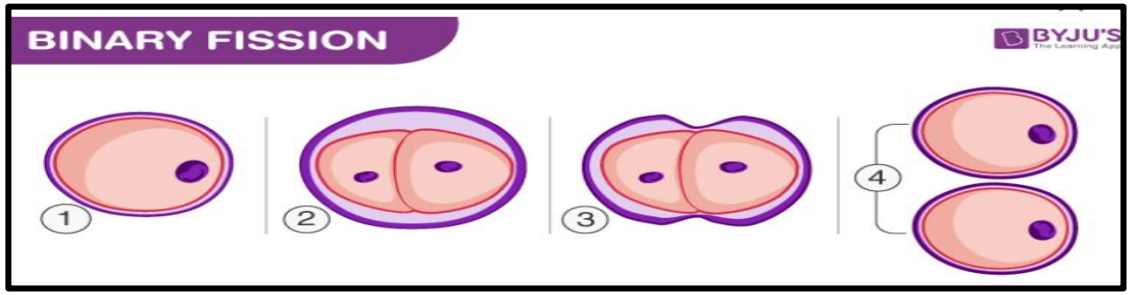
Binary Fission (separation of a parent into two or more individuals of about the same size ex: Amoeba

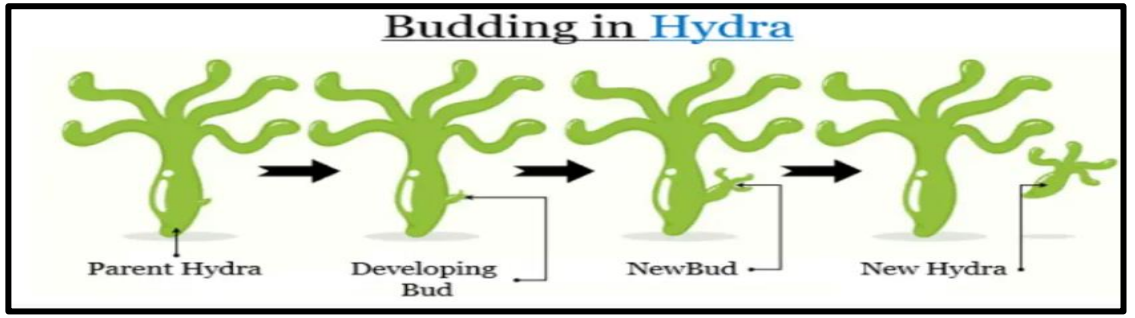
Budding : new individuals arise from outgrowths of existing ones. For example: Hydra.

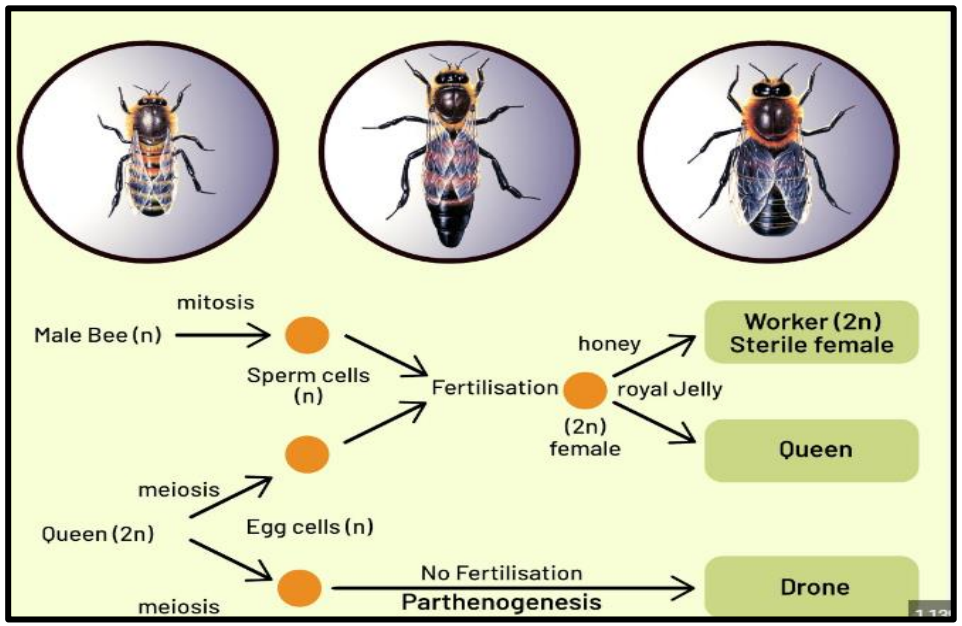
Fragmentation : breaking of the body into pieces, some or all of which develop into adults. *Fragmentation must be accompanied by regeneration* = regrowth of lost body parts. ex: starfish

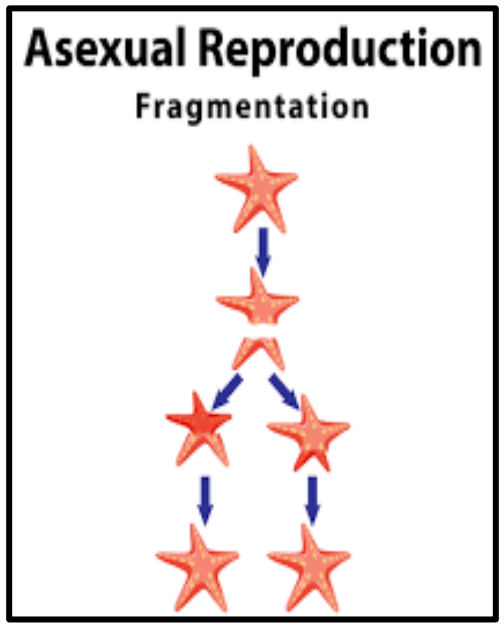
Parthenogenesis is the *development of a new individual from an unfertilized egg. Ex: Ant and honeybees*.

Gynogenesis, a form of parthenogenesis. The male donates his sperm, but this is only used as a stimulus for the development of the ovule. It does not actually provide its genetic material. *Ex.* rainbow trout and other species of fish.









Animal Development

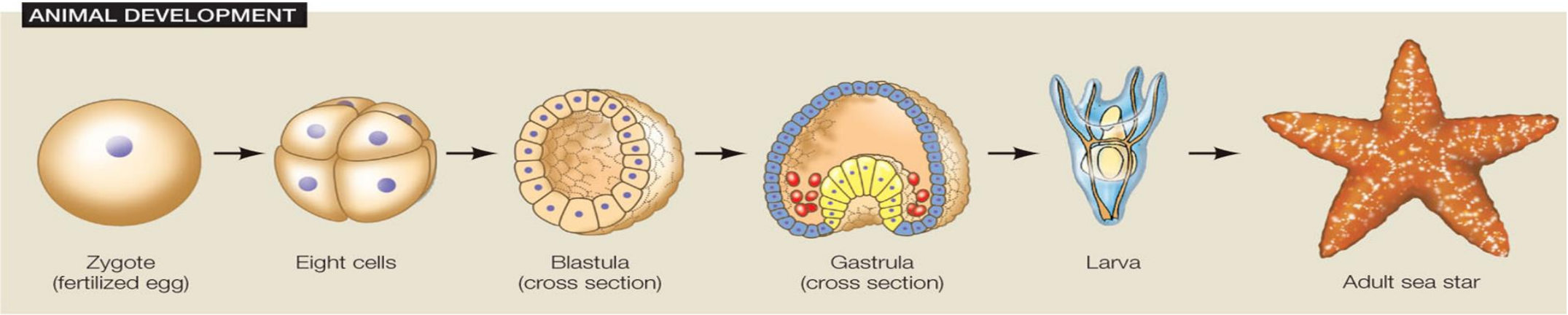
Animal development, the processes that lead eventually to the formation of a new animal starting from cells derived from one or more parent individuals

Development requires both **cell growth** and **cell differentiation** (different cells express different genes).

Some animals develop directly through transient stages into adults, but others have distinct larval stages.

- Larva is a sexually **immature stage** that is morphological distinct from the adult

- Larvae undergo **metamorphosis**, transforming the animal into an adult



Stages of Mammalian development

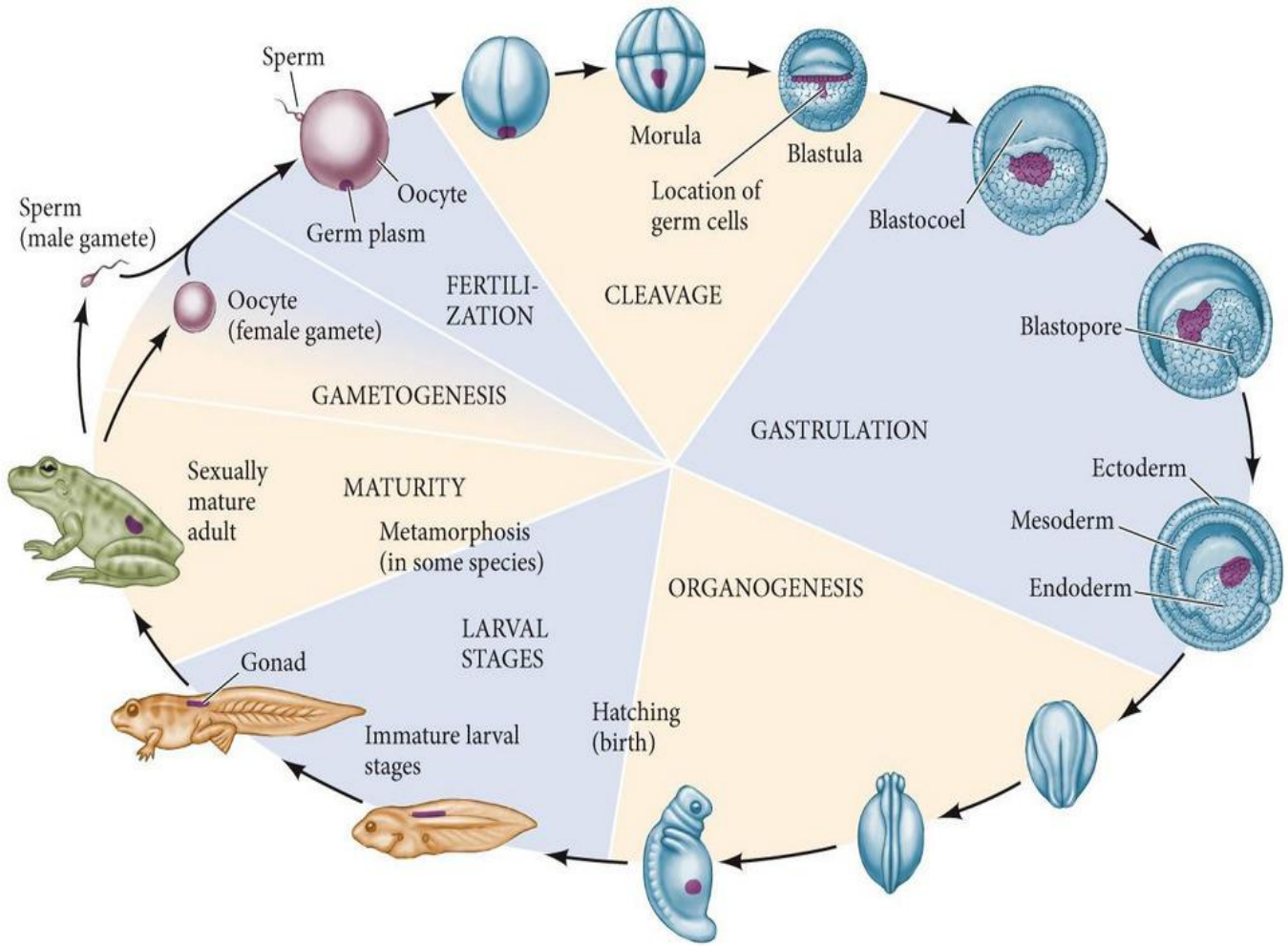
***1- Fertilization* and the zygote:** the process of union of two germ cells, **egg and sperm** to form zygot.

2-Cleavage: Mammals have a slow rate of division that is **between 12 and 24 hours**. These cellular divisions are asynchronous. Zygotic transcription starts at the two-, four-, or eight-cell stage.

3- Blastula to Morula: a hollow sphere of cells, or blastomeres, produced during the development of an embryo by **repeated cleavage** of a fertilized egg up 8–32 cells and it is called Morula.

3-Gastrulation: cells are **rearranged into a three-layered gastrula** that are ectoderm (Skin and Nerves system) , mesoderm (Muscles and spinal cord) and endoderm (elementary canal)

4- Organogenesis: the three germ layers interact and move to give rise to organs.



DEVELOPMENTAL BIOLOGY 11e, Figure 1.1
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The Immune System

A complex network of cells, tissues, organs, and the substances they make that helps the body fight infections and other diseases. The immune system includes white blood cells , organs, tissues of the lymph system, such as the thymus, spleen, and bone marrow.

Types of Immune system:

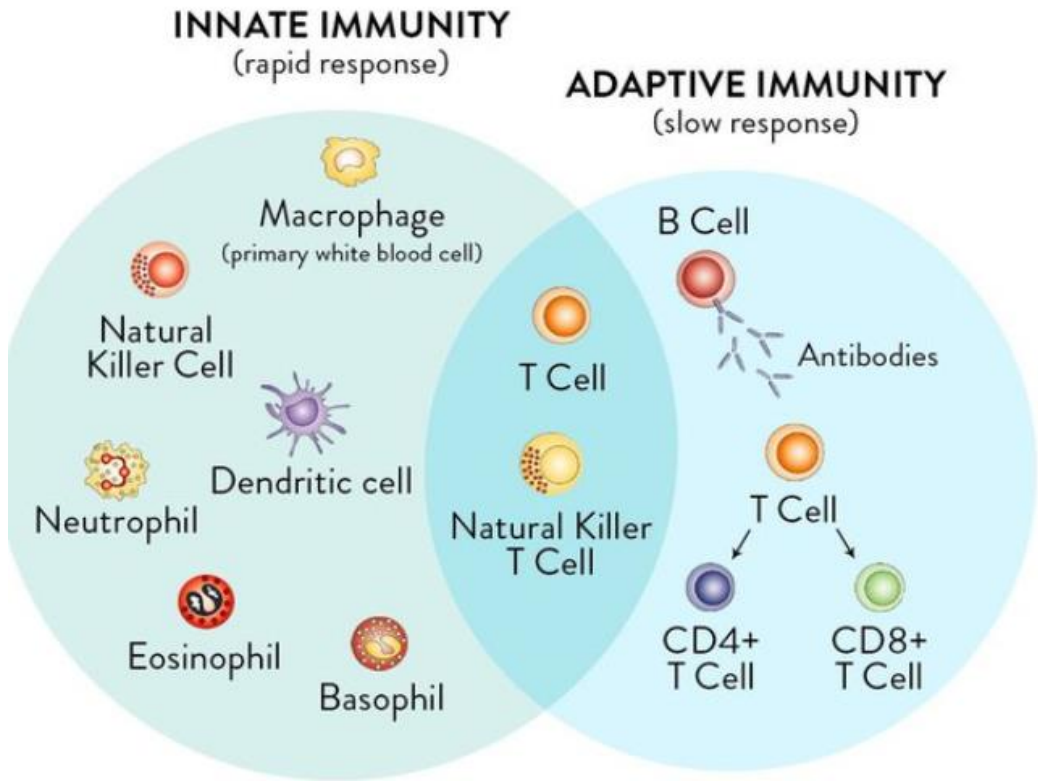
1-innate immunity **: is present before any exposure to pathogens and is effective from the time of birth (we are born with this). It has 3 components include:**

•Physical Barriers. such as skin, the gastrointestinal tract, the respiratory tract, the nasopharynx, cilia, eyelashes and other body hair.

•Defense Mechanisms. such as secretions, mucous, bile, gastric acid, saliva, tears, and sweat.

•General Immune Responses such as inflammation.

2-Adaptive immunity: **involves specialized immune cells and antibodies that attack and destroy foreign invaders and are able to prevent disease in the future by remembering what those substances look like and mounting a new immune response (You develop this when your body is exposed to microbes or chemicals released by microbes)**



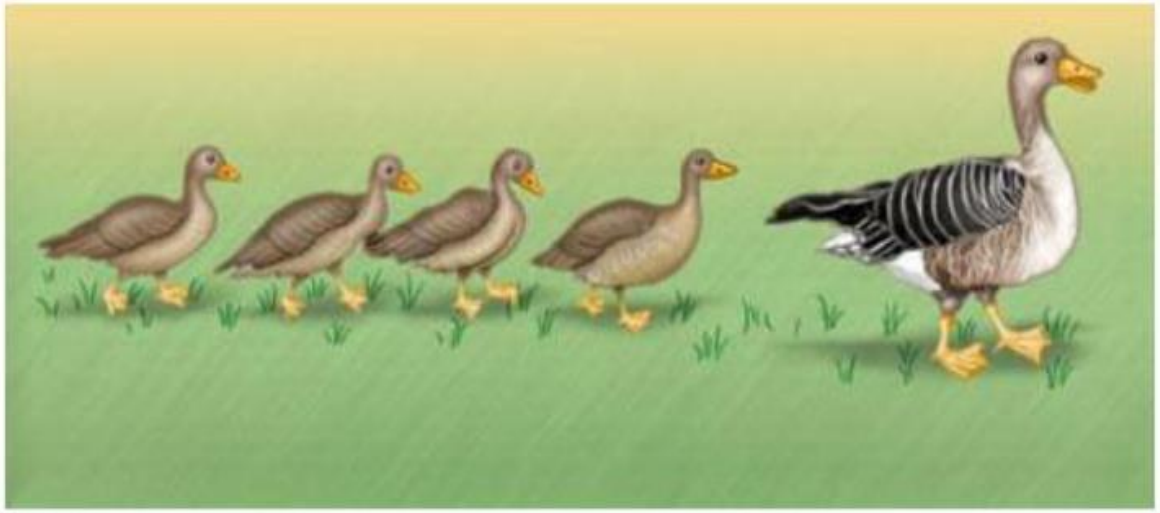
Animal behavior

- Animal behavior is based on physiological systems and processes.
- A **behavior** is the nervous system's response to a stimulus and is carried out by the muscular or the hormonal system.
- Behavior helps an animal:
  - Obtain food.
  - Find a partner for sexual reproduction.
  - Maintain homeostasis.
- An animal's behavior is its response to external and internal stimuli.

Animal Behavior is subject to Natural Selection.

- ***Ethology*** is the scientific *study of animal behavior*, particularly in **natural environments.**
- **Behavioral ecology** is the study of the ecological and evolutionary basis for animal behavior.
- It integrates proximate and ultimate explanations for animal behavior.
- **Proximate causation**, or "how" explanations, focus on
  - Environmental stimuli that trigger a behavior
  - Genetic, physiological, and anatomical mechanisms underlying a behavior.
- **Ultimate causation**, or "why" explanations, focus on
  - Evolutionary significance of a behavior.

BEHAVIOR: Young geese follow and imprint on their mother.



PROXIMATE CAUSE: During an early, critical developmental stage, the young geese observe their mother moving away from them and calling.

ULTIMATE CAUSE: On average, geese that follow and imprint on their mother receive more care and learn necessary skills, and thus have a greater chance of surviving than those that do not follow their mother.

References

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