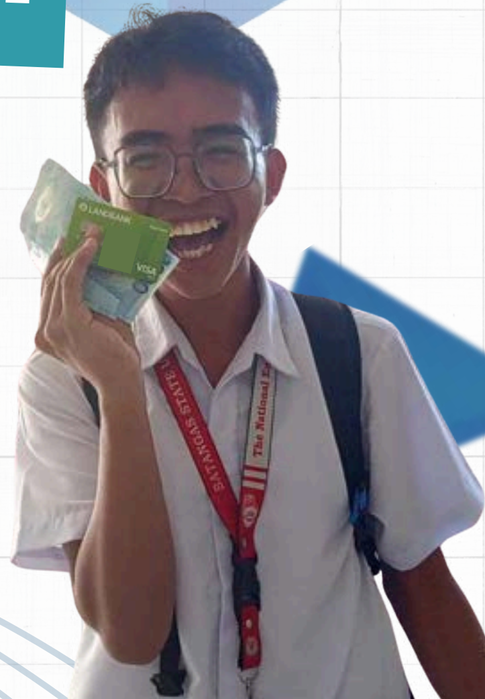
Project REACH CALABARZON

Kuya Emman

Speaker



Biology

Topic Outline

- **Introduction to Cells and Microscopy**

Definition and Characteristics of Cells, Cell Theory, Prokaryotic vs. Eukaryotic Cells, Organelles and its Functions, Microscopy

- **Basic Cellular Processes**

Biological Molecules, Cellular Metabolism, Cellular Transports

- **Cell Cycle and Genetics**

Cell Cycle, Cell Division: Mitosis & Meiosis, Genetics: Mendelian and Non-Mendelian Inheritance

- **Plant and Human Anatomy**

Plant Anatomy: Monocots vs. Eudicots, Plant Organs and Organ Systems, Plant Reproduction, Human Anatomy: Organ and Organ Systems, Homeostasis, Reproduction.

- **Evolution, Taxonomy, and Ecology**

Evolution: Definition and Concepts, Major Theories in Evolution, Taxonomy, Levels of Biological Organization, Ecology, Ecological Interactions, Conservation and Sustainability


Biology


Adventitious root system
SKELETAL SYSTEM
CHICKEN

What is Biology?

Biology is the scientific study of life. It's a vast and diverse field that explores all aspects of living organisms, from their tiniest components to their complex interactions within ecosystems.

- The structure, function, growth, origin, evolution, and distribution of living organisms.
- How living things interact with each other and their environment.
- The processes that make life possible, from the molecular level to the ecosystem level.

Introduction to Cells and Microscopy

Cell Biology

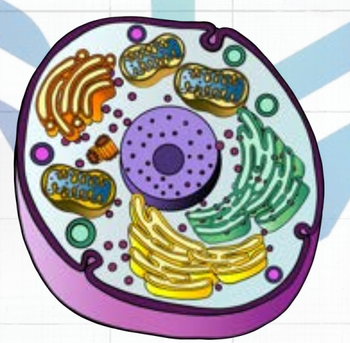
- study of cell structure and function,
- revolves around the concept that the cell is the fundamental unit of life.

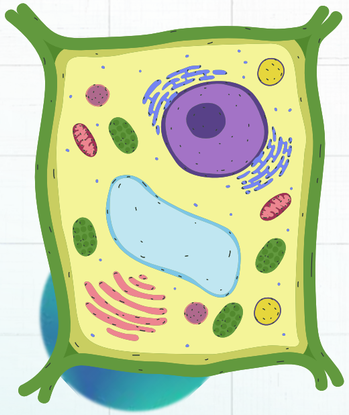
Cell

- described by **Robert Hooke** in **1665**
- **basic fundamental unit of life**.
- simplest collection of matter that can live.
- tiny, measuring on average about 0.002 cm (20 um) across

Prokaryotic Cell

Eukaryotic Cell





Cell Theory

First proposed by German scientists **Theodor Schwann** and **Matthias Jakob Schleiden** in **1838**, the theory that all plants and animals are made up of cells

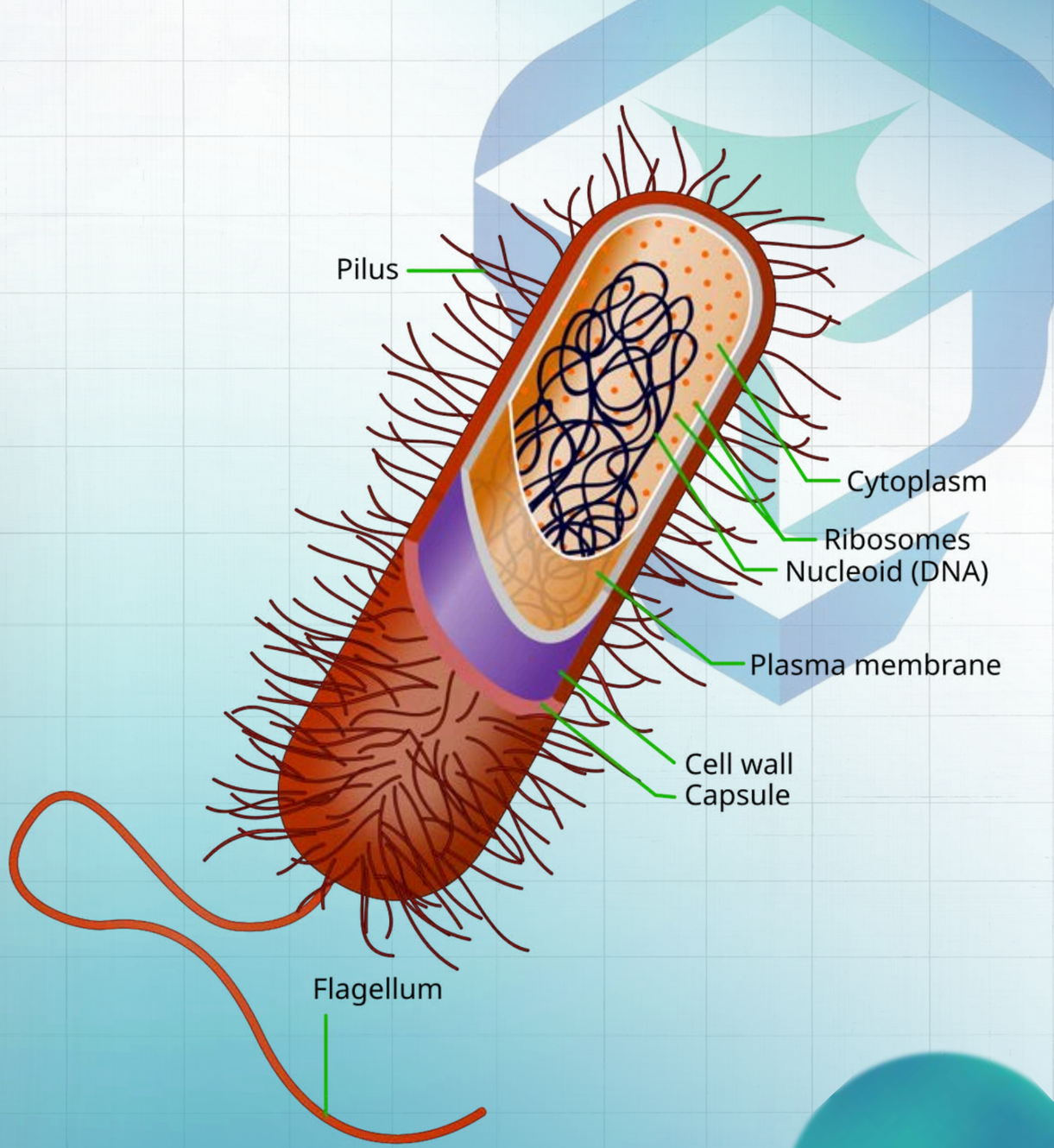
All living things are composed of one (**unicellular**) or more cells **(multicellular)**.

The cell is the basic unit of life.

New cells arise from pre-existing cells.

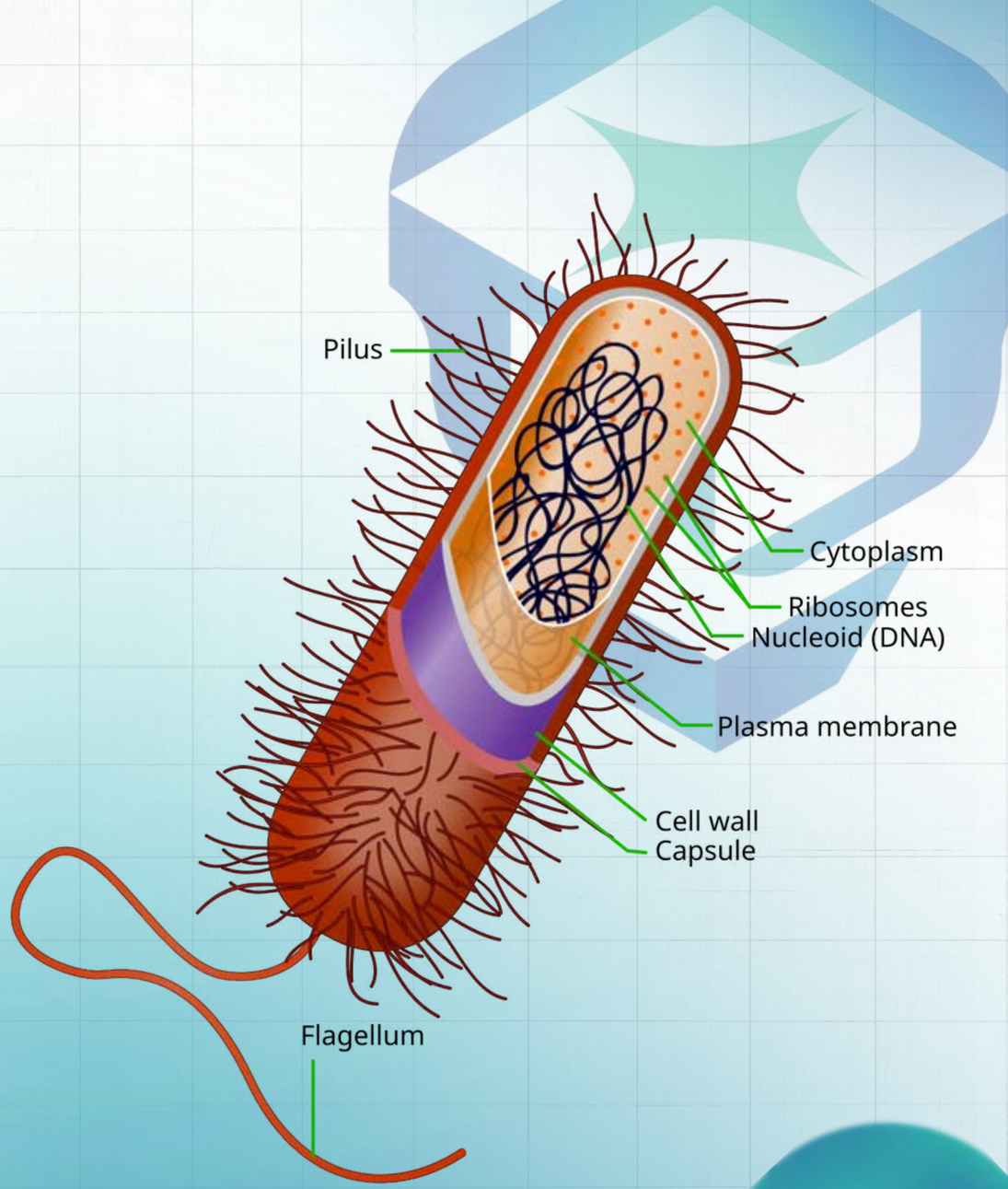
Prokaryotic Cell

- *"pro"* before, *"karyon"* kernel
- Domain Eubacteria and Archaebacteria
- Unicellular organisms
- Lacks membrane-bound organelles
- Circular DNA found on the nucleoid region
- Smaller in structure
- Complex cell wall for protection



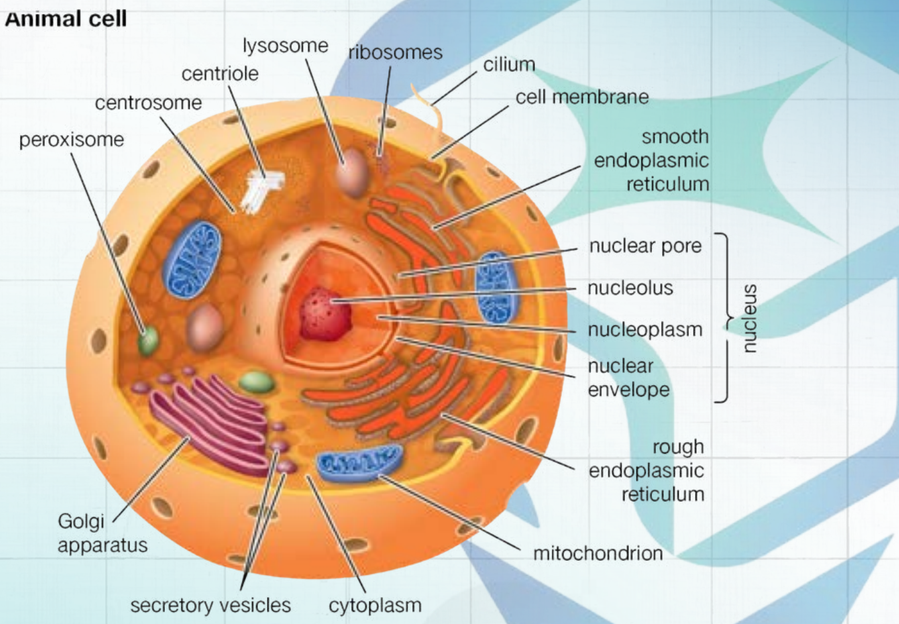
Prokaryotic Cell

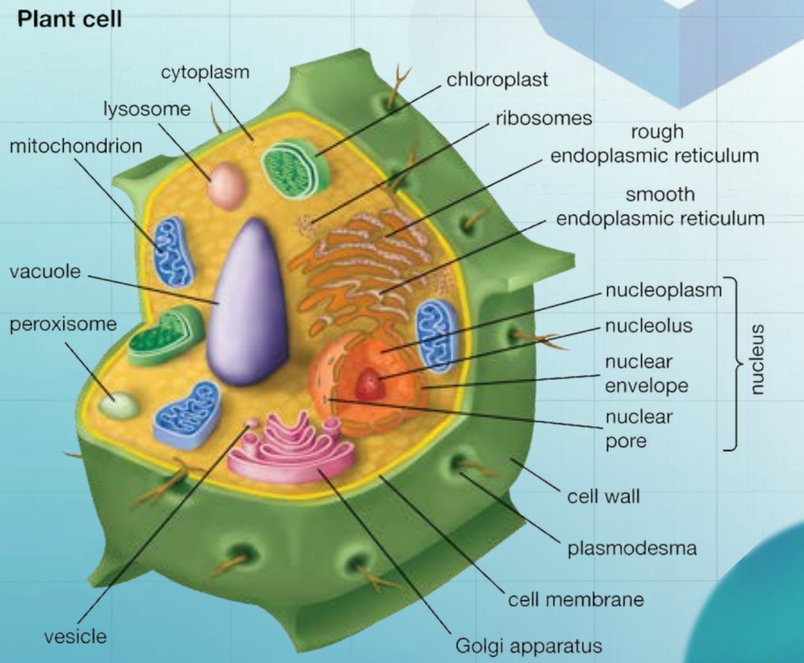
Structure	information
Capsule	Glycogalyx – firm or disorganised Adherence and protection
Nucleoid	Region containing bacterial chromosome
Pili (fimbriae)	Anchoring functions
Flagella	Motility; 3 parts – basal body, hook and filament
Cell Wall	Growth and division Peptidoglycan
Plasma membrane	Phospholipids
Cell structures	Cytosol – fluid filled portion Ribosomes – "free" or inner surface PM
Spores and cysts	Survive unfavourable environmental conditions (metabolically inactive)



Eukaryotic Cell

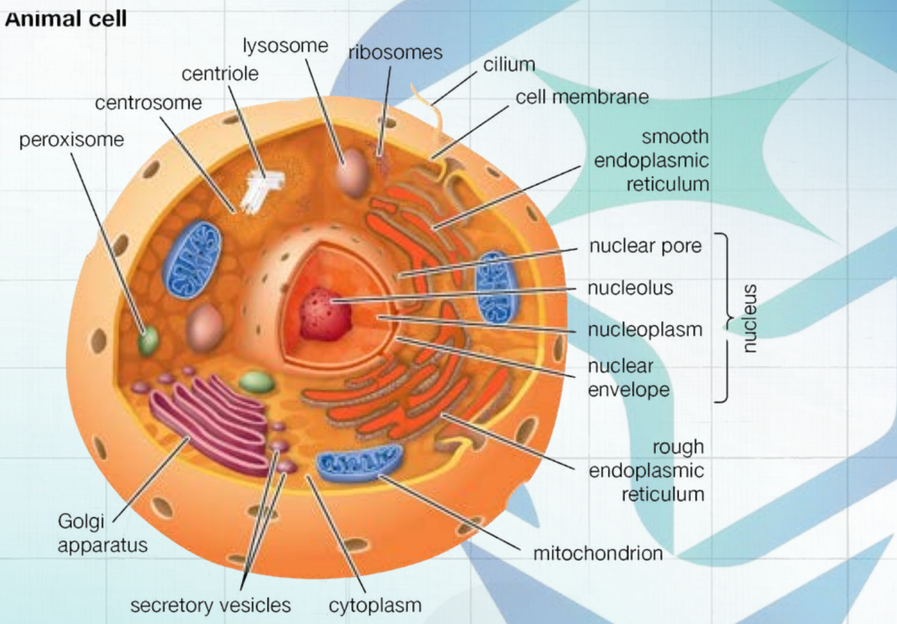
- *"eu"* true, *"karyon"* kernel
- Kingdom Protista, Fungi, Plantae, and Animalia
- Can exist as unicellular or multicellular
- Presence of Membrane-bound organelles (e.g., mitochondria)
- Linear DNA is stored in the nucleus
- Complex in structure
- Simpler to absent cell wall

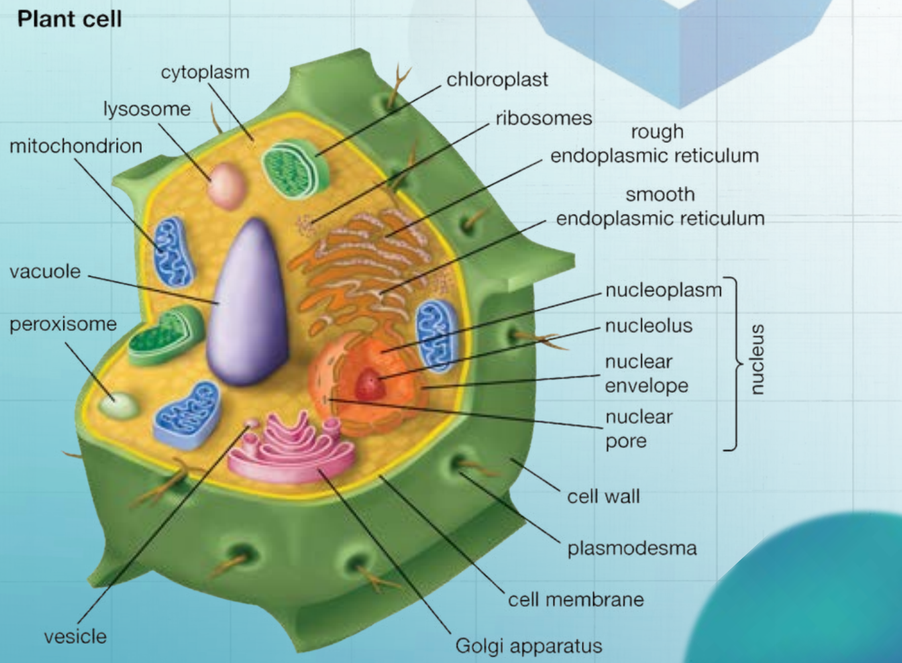




Eukaryotic Cell

Eukaryotic organelles	Functions
Plasma membrane	Mechanical cell boundary, selectively permeable barrier with transport systems, mediates cell to cell interactions and adhesion to surfaces, secretion
Cytoplasmic matrix	Environment for other organelles, location of many metabolic processes
Microfilaments, intermediate filaments, and Microtubules.	Cell structure and movements from the cytoskeleton
Endoplasmic reticulum	Transport of materials, protein and lipid synthesis
Ribosome	Proteins synthesis
Golgi apparatus	Packaging and secretion of materials for various purposes, lysosome formation
Lysosomes	Intracelluar digestion
Mitochondria	Energy production through use of the tricarboxylic acid cycle, electron transport, oxidative hosphorylation, and other path ways
Chloroplasts	Photosynthesis, trapping light energy and formation of carbohydrate from CO_2 and water
Nucleus	Repository for genetic information, control center for cell
Cell wall and pellicle	Strengthen and give shape to the cell
Cilia and flagella	Cell attachment and Cell movement
Vacuole	Temporary storage and transport, digestion (food vacuoles), water balance(contractile vacuole)





Microscopy

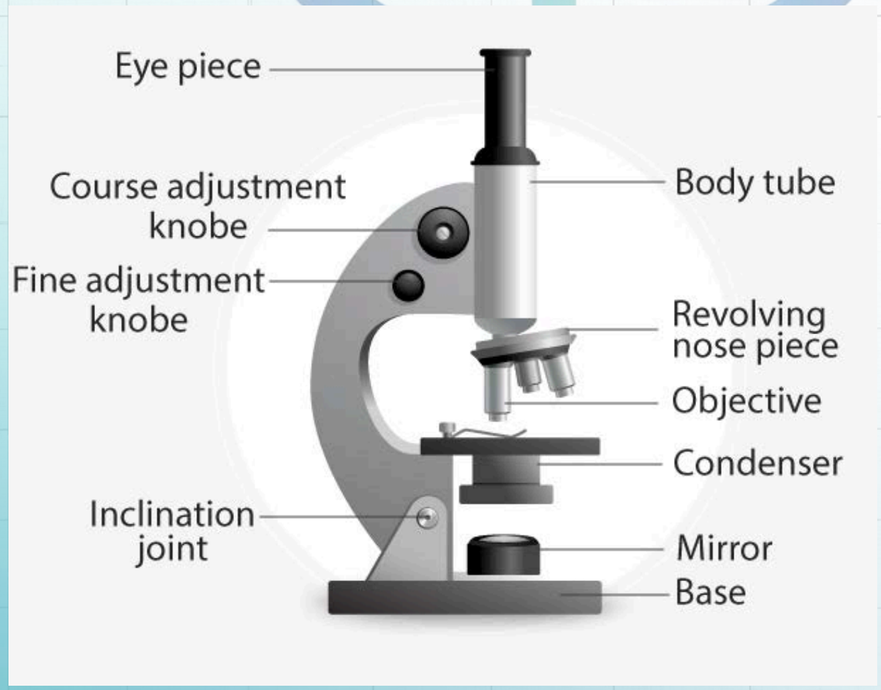
- the use of microscopes to view objects too small to be seen with the naked eye.

Basic Principles of Microscopy

- **Magnification**: Increasing the apparent size of an object.
- **Resolution**: The ability to distinguish between two closely spaced points. A key factor in image clarity.
- **Contrast**: The difference in brightness or color between different parts of the specimen.
- **Illumination**: Providing light to view the specimen.

Microscopy

Part	Function	Description
Ocular Lens (Eyepiece)	Magnifies the image formed by the objective lens.	The lens you look through, usually providing 10x magnification.
Objective Lenses	Primary lenses that magnify the specimen.	Lenses closest to the specimen, typically providing different levels of magnification (e.g., 4x, 10x, 40x, 100x).
Nosepiece	Holds the objective lenses and rotates to change magnification.	A revolving turret that allows you to switch between objective lenses.
Stage	Supports the microscope slide.	A flat platform where the specimen is placed for observation.
Stage Clips	Hold the slide in place on the stage.	Small clips that secure the slide to prevent it from moving.
Condenser	Focuses the light from the light source onto the specimen.	A lens system below the stage that concentrates the light.
Diaphragm (Aperture Diaphragm)	Controls the amount of light entering the condenser.	A lever or iris that adjusts the diameter of the light beam.
Light Source	Provides illumination for viewing the specimen.	Can be a built-in LED or a halogen lamp.
Coarse Adjustment Knob	Used for large adjustments in focus, primarily with lower magnification objectives.	The larger knob used for initial focusing.
Fine Adjustment Knob	Used for small, precise adjustments in focus, especially with higher magnification objectives.	The smaller knob used for final sharpening of the image.
Condenser Adjustment Knob	Raises or lowers the condenser to focus the light.	Adjusts the vertical position of the condenser.
Focusing Knob for Condenser	Focuses the light from the condenser.	Adjusts the focus of the condenser.
Carrying Handle	Used for safely transporting the microscope.	A handle on the arm of the microscope.
Arm	Connects the head of the microscope to the base.	The part of the microscope you grip when carrying it.
Base	Provides a stable foundation for the microscope.	The bottom part of the microscope.



Short Quiz

Fill-in the blanks

1. All __ are composed of one (unicellular) or more cells (multicellular).
2. The __ is the basic unit of life.
3. New cells arise from __ cells.

Enumeration

- Name the (4) two types of cells, and name (5) one distinct organelles from each.

Short Quiz

Answers

1. All **living things** are composed of one (unicellular) or more cells (multicellular).
2. The **cell** is the basic unit of life.
3. New cells arise from **pre-existing** cells.
4. **Prokaryotic Cells** & **Eukaryotic Cells**
5. **Prokaryotic Cells** (nucleoid, pili/pilus, capsule, plasmid); **Eukaryotic Cells** (all organelles *except nucleoid, pili/pilus, capsule, plasmid)*

Basic Cellular Processes

Biological Molecules

Micromolecules

- monomers
- smaller *("micro")* molecules
- **Amino acids:** building blocks of proteins
- **Monosaccharides:** simple sugars (e.g., glucose, fructose).
- **Nucleotides:** components of DNA and RNA (e.g., adenine, guanine, cytosine, thymine, uracil).
- **Fatty acids:** Components of lipids.

Biological Molecules

Macromolecules

- polymers
- larger *("macro")* molecules
- **Proteins:** enzymes, structural components, hormones, etc
- **Carbohydrates:** provide energy and structural support (e.g., starch, glycogen, cellulose)
- **Nucleic acids:** They store and transmit genetic information (DNA and RNA).
- **Lipids:** store energy, form cell membranes, act as insulators (e.g., fats, oils, phospholipids).

Cellular Metabolism

- chemical reactions within a cell
- providing the building blocks and energy needed for cell division and synthesis
- repairs and replaces cellular components
- adapt its metabolic pathways to changing conditions
- metabolic disorders occur when specific metabolic pathways are disrupted.

Cellular Metabolism

- **Metabolic pathways:** organized sequences of chemical reactions
- **Enzymes:** proteins that catalyze (speed up) specific chemical reactions in metabolic pathways
- **Energy:** meabolism involves the transfer and transformation of energy. Some reactions release energy (exergonic), while others require energy input (endergonic).

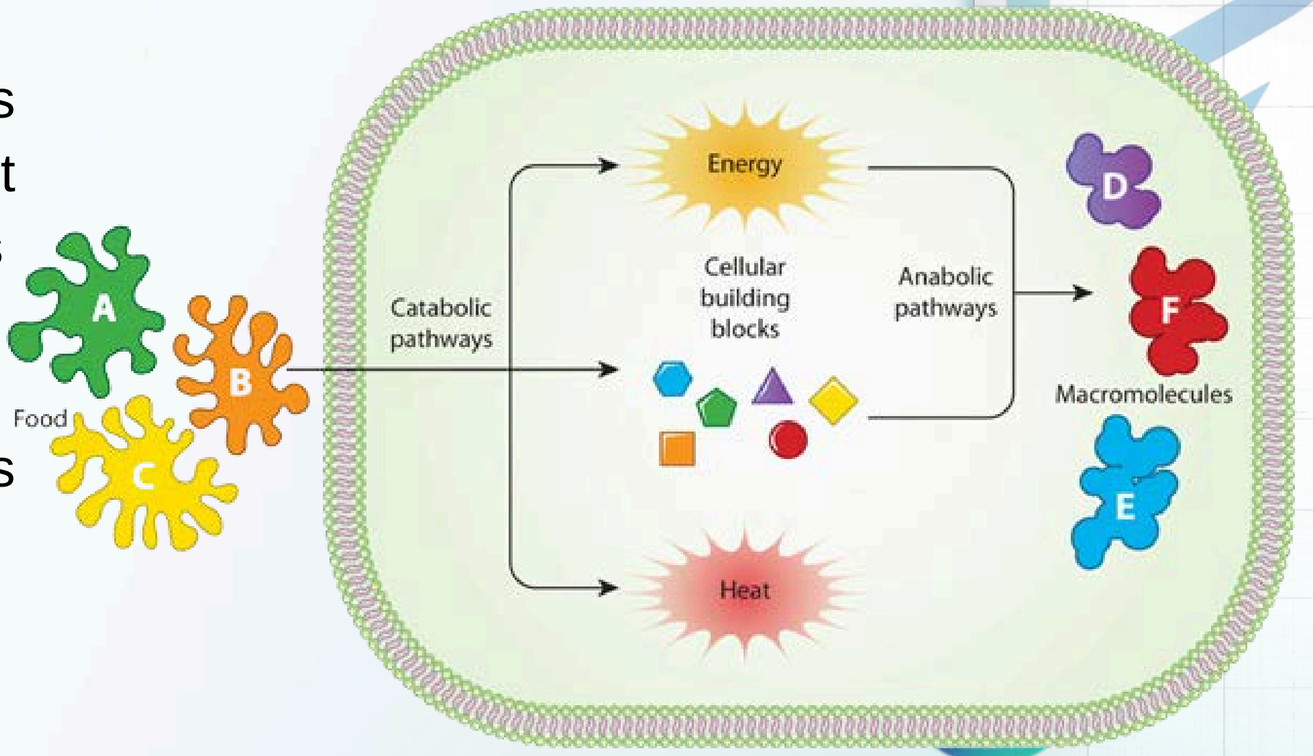
Cellular Metabolism

Anabolism

- simple to complex molecules
- usually requires energy input
- example is protein synthesis

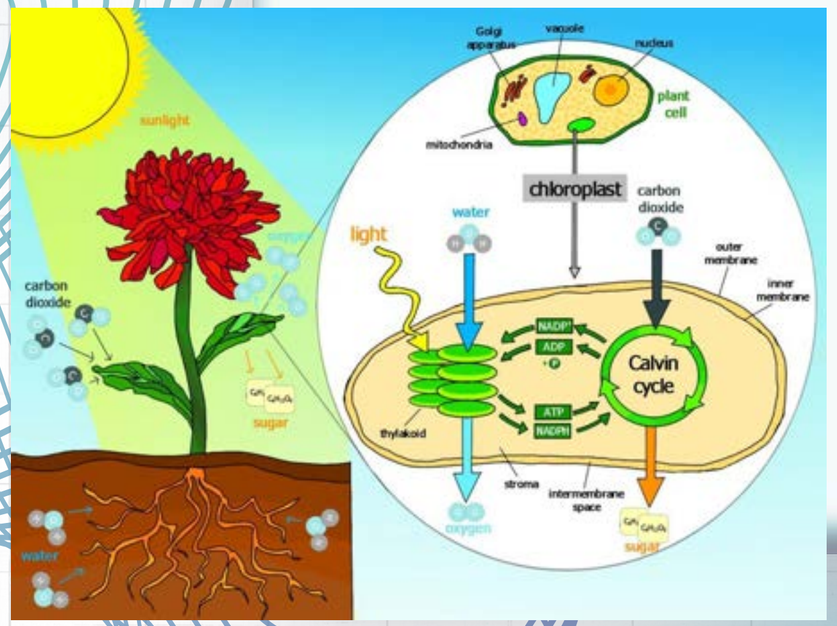
Catabolism

- complex to simple molecules
- often releasing energy
- example is glucose breakdown

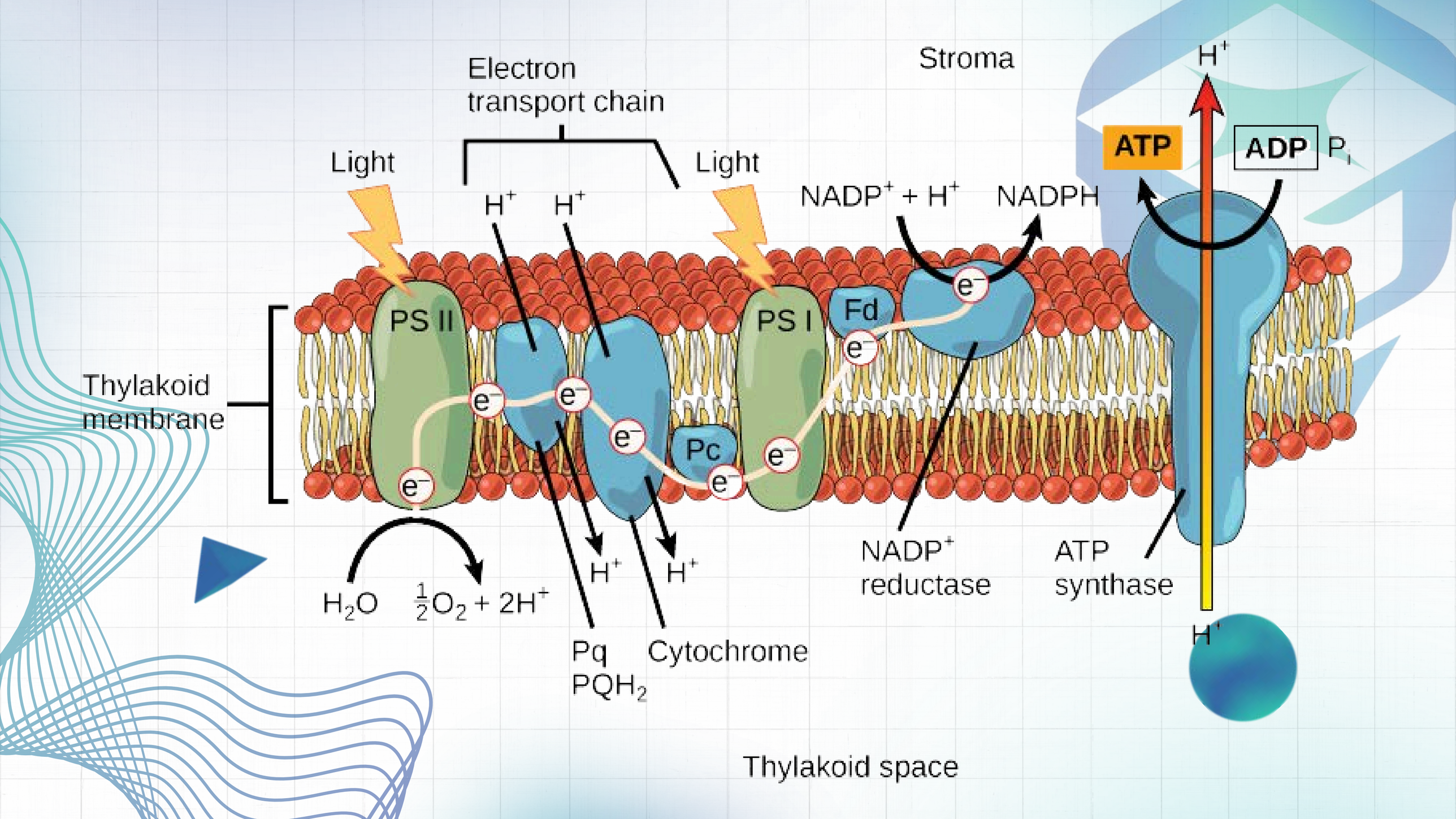


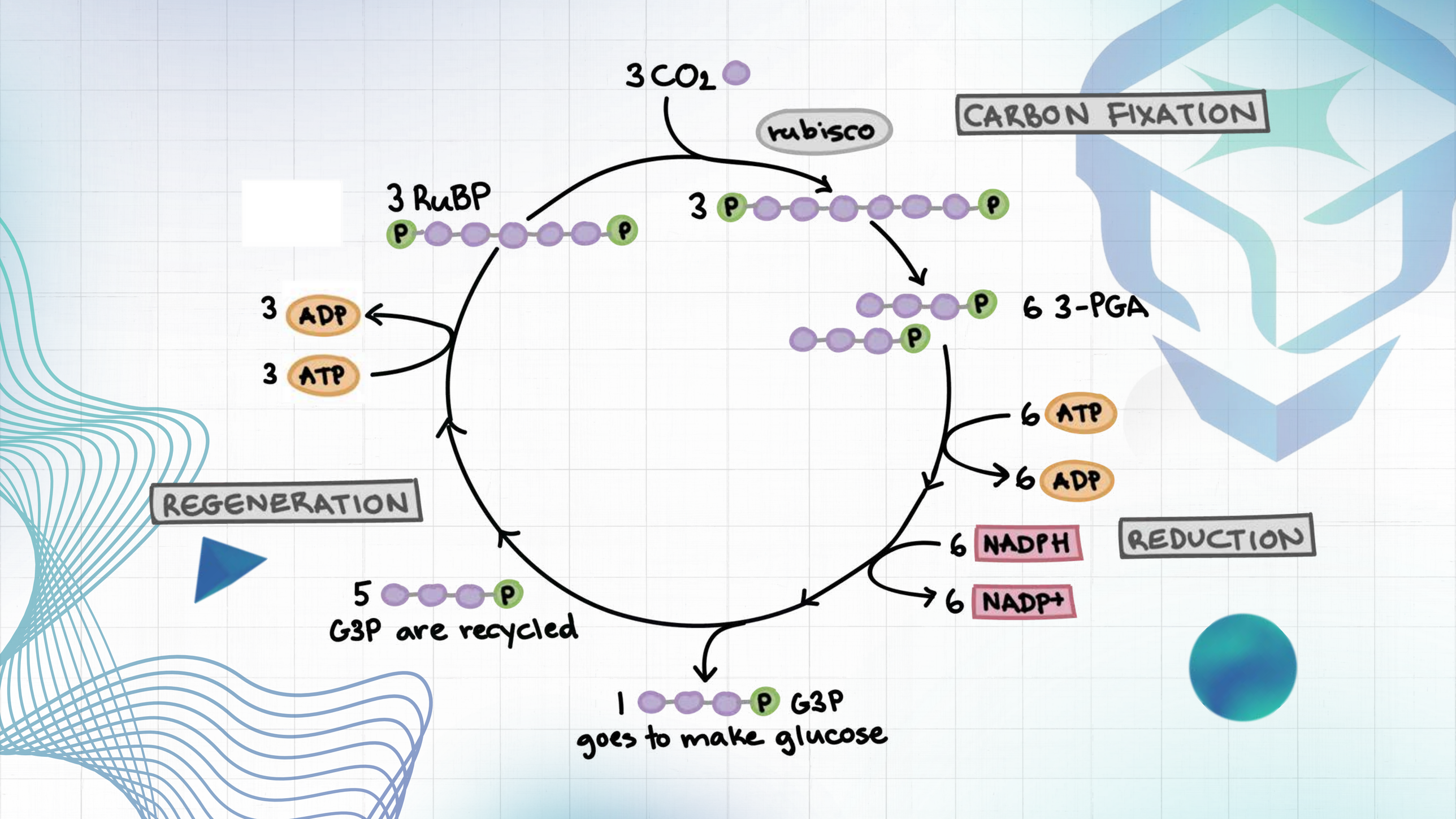
Photosynthesis

- **plants, algae, and some bacteria**
- **light energy to chemical energy** (sugars)
- **6CO2 + 6H2O + light energy -> C6H12O2 + 6O2**
- **leaves > chloroplasts > chlorophyll** (green pigment)



Feature	**Light-Dependent Reactions**	**Light-Independent Reactions (Calvin Cycle)**
Location	Thylakoid membranes	Stroma
Energy source	Light energy	ATP and NADPH
Reactants	Water, light energy	Carbon dioxide, ATP, NADPH
Products	ATP, NADPH, oxygen	Glucose

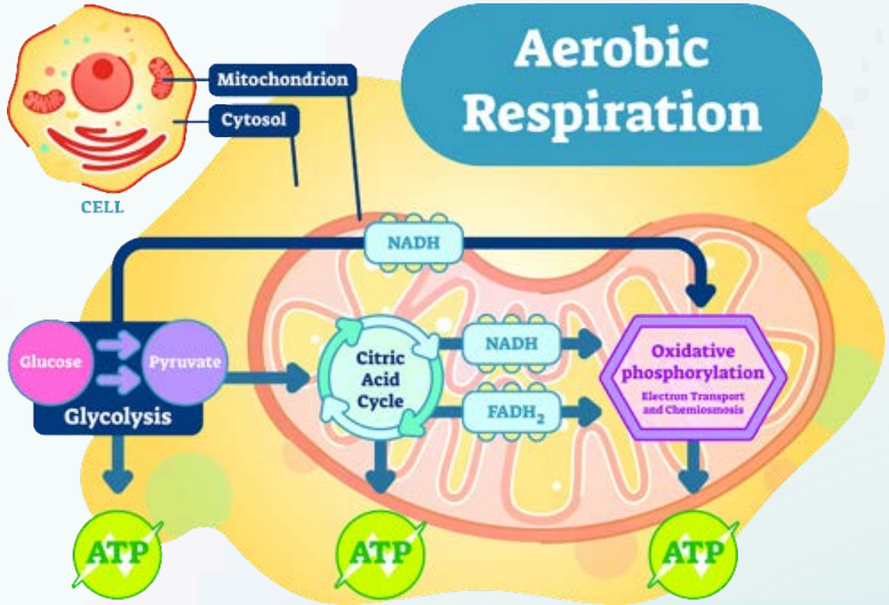

Stroma
Electron transport chain
Light
Light
H+
H+
NADP+ + H+
NADPH
H+
ATP
ADP
Pi
PS II
PS I
Fd
e−
Thylakoid membrane
Pc
H2O
½O2 + 2H+
H+
H+
NADP+ reductase
ATP synthase
Pq
PQH2
Cytochrome
H+
Thylakoid space


3 CO_2
rubisco
CARBON FIXATION
3 RuBP
3 P P
6 3-PGA
3 ADP
3 ATP
6 ATP
6 ADP
REGENERATION
6 NADPH
REDUCTION
6 NADP+
5 P
G3P are recycled
1 P G3P
goes to make glucose

Cellular Respiration

Aerobic Respiration

- $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ + Energy (ATP)
- glucose to ATP (adenosine triphosphate).
- uses oxygen
- mitochondria
- 32 ATP

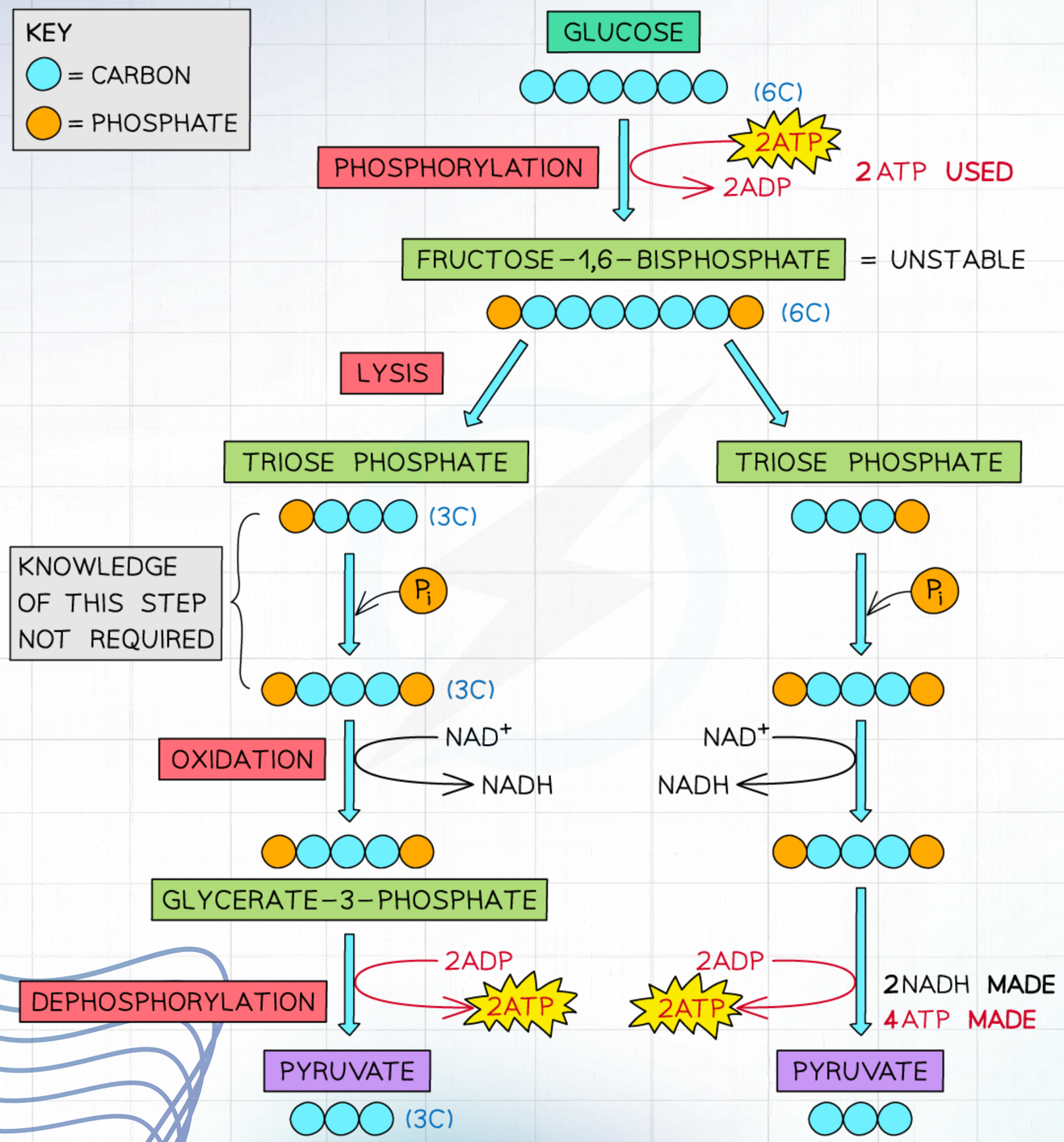


Cellular Respiration

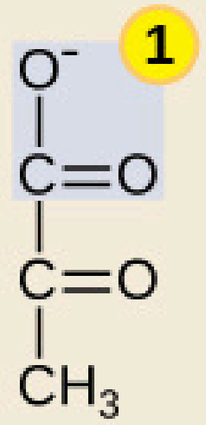
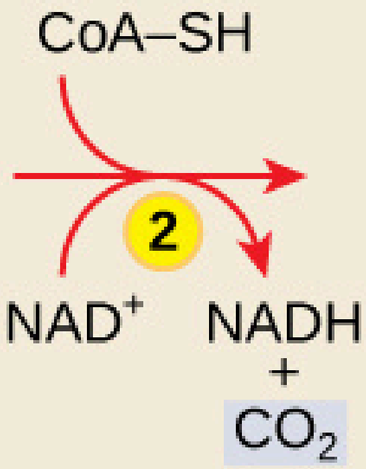
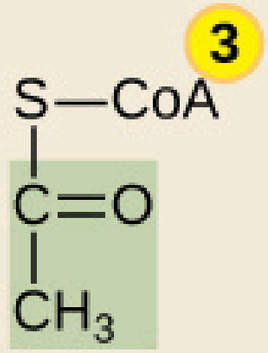
Aerobic Respiration

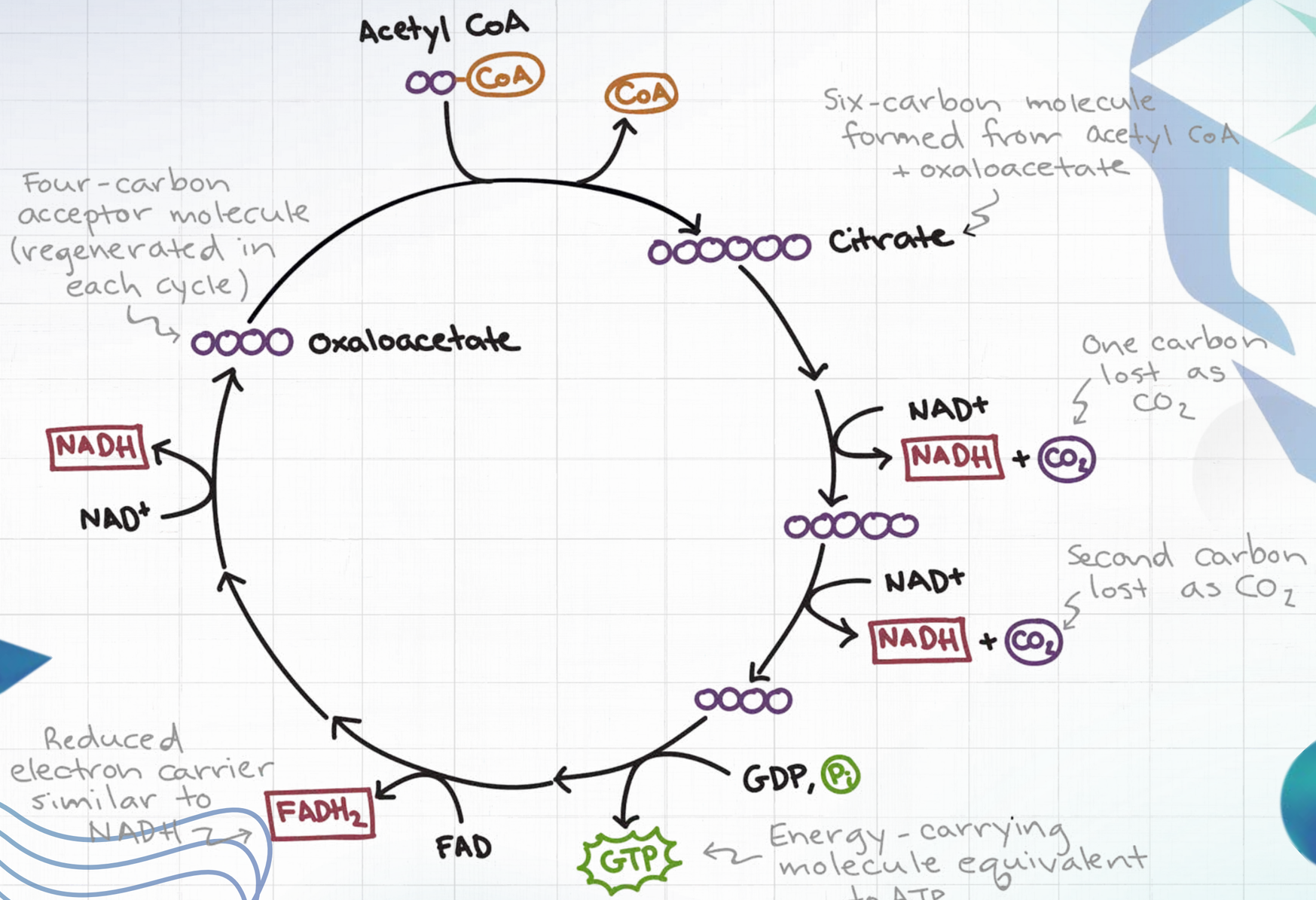
The Stages:

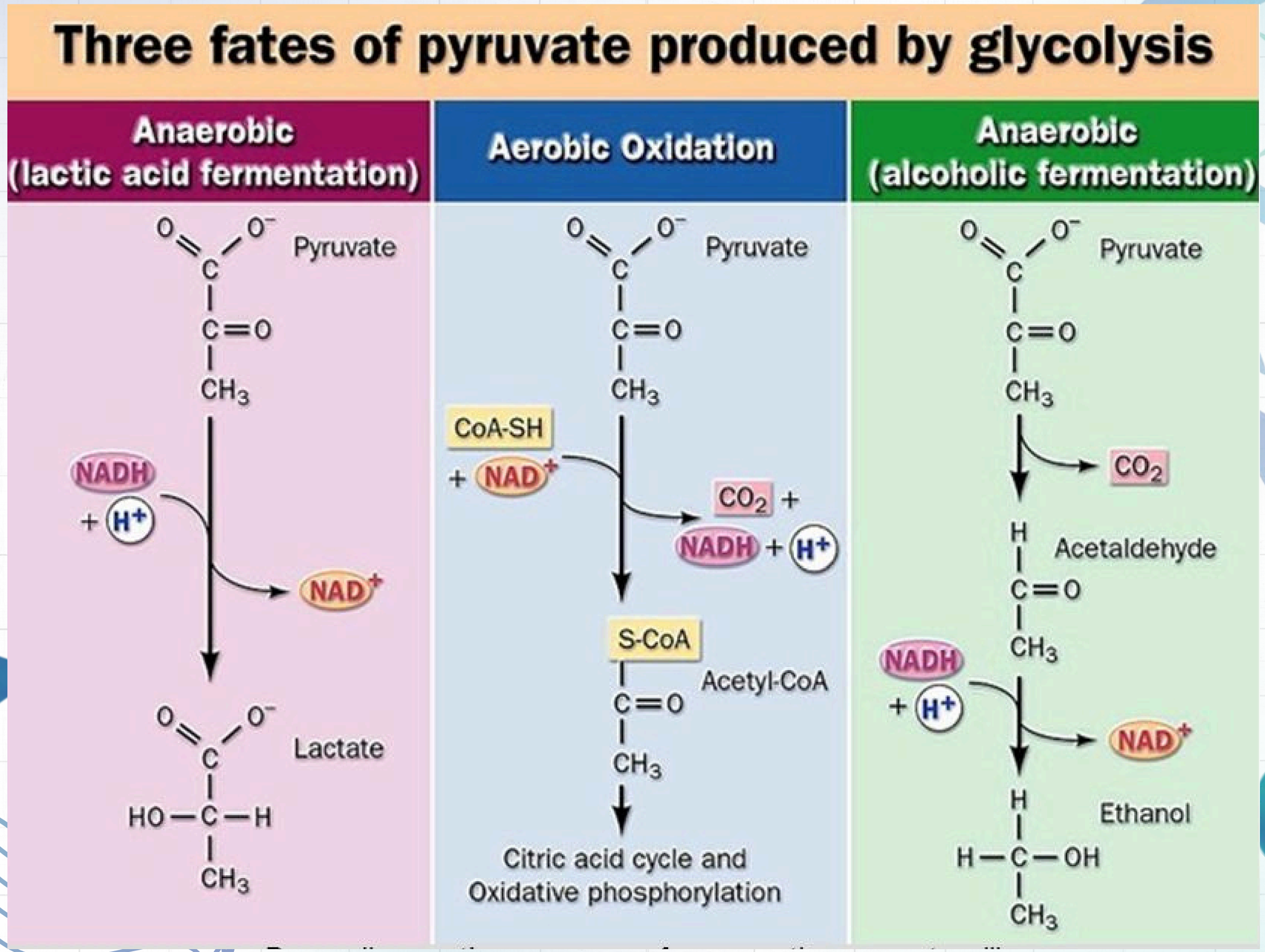
- **Glycolysis:** Glucose = 2 pyruvate, 2 ATP, 2 NADH
- **Pyruvate Oxidation**: Pyruvate = 2 acetyl coenzyme A (acetyl CoA), 2 NADH
- **Krebs Cycle (Citric Acid Cycle):** Acetyl CoA = 2 ATP, 4 FADH, 6 NADH
- **Electron Transport Chain (ETC) and Oxidative Phosphorylation**

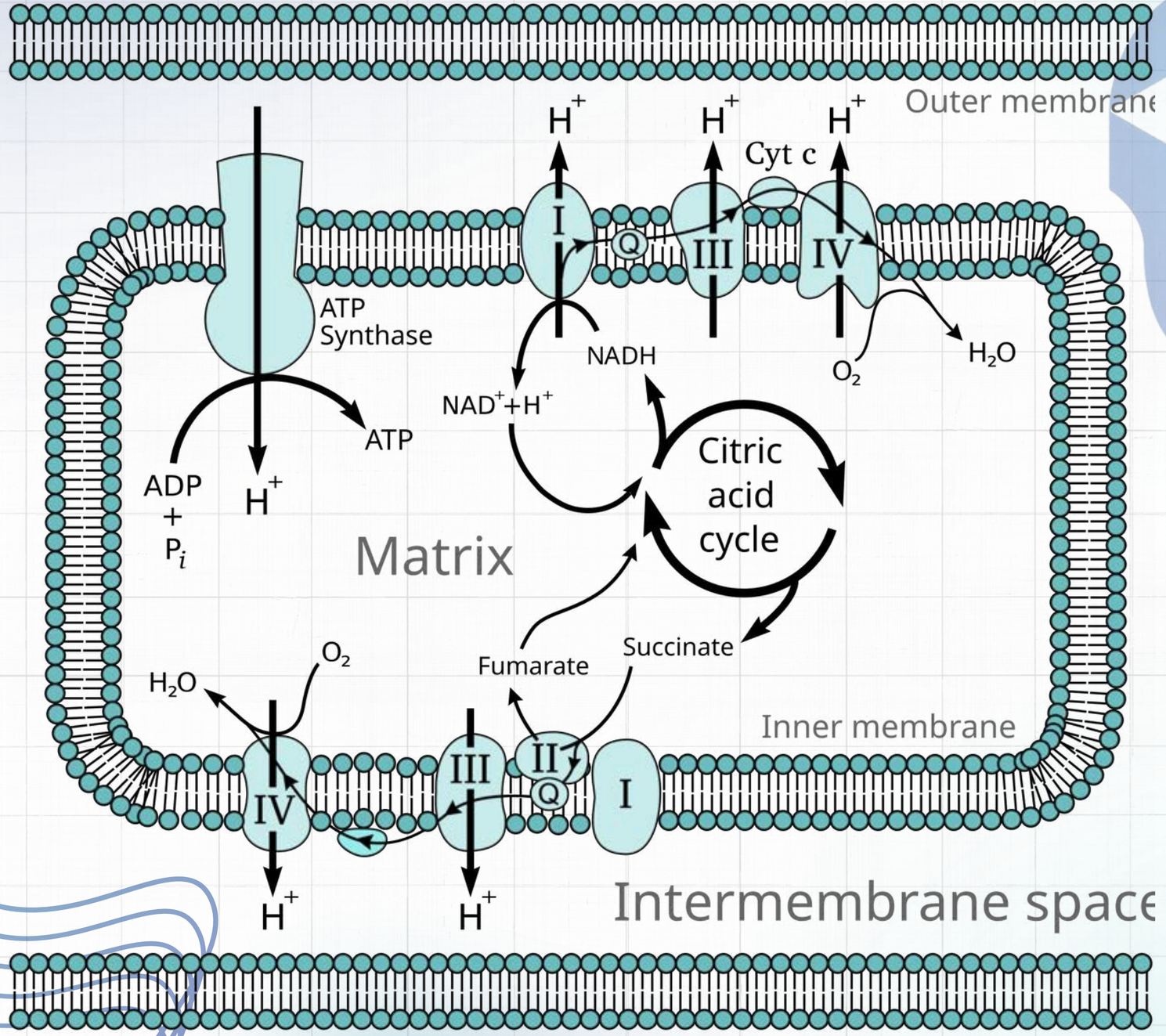


Oxidation of Pyruvate

 Pyruvate	 Oxidation reaction	 Acetyl CoA
1 A carboxyl group is removed from pyruvate, releasing carbon dioxide.	2 NAD^+ is reduced to NADH.	3 An acetyl group is transferred to coenzyme A, resulting in acetyl CoA.


Acetyl CoA
CoA
CoA
Six-carbon molecule formed from acetyl CoA + oxaloacetate
Citrate
Four-carbon acceptor molecule (regenerated in each cycle)
Oxaloacetate
One carbon lost as CO_2
NAD+
NADH + CO_2
Second carbon lost as CO_2
NAD+
NADH + CO_2
GDP, P_i
GTP
Energy-carrying molecule equivalent to ATP
FAD
$FADH_2$
Reduced electron carrier similar to NADH
NAD+
NADH


Three fates of pyruvate produced by glycolysis
Anaerobic (lactic acid fermentation)
Aerobic Oxidation
Anaerobic (alcoholic fermentation)
Pyruvate
NADH
+ H+
NAD+
Lactate
CoA-SH
+ NAD+
CO2 +
NADH + H+
S-CoA
Acetyl-CoA
Citric acid cycle and
Oxidative phosphorylation
CO2
Acetaldehyde
NADH
+ H+
NAD+
Ethanol


Outer membrane
H+
H+
H+
Cyt c
I
Q
III
IV
ATP
Synthase
NADH
NAD+ + H+
O2
H2O
ATP
ADP
+
Pi
H+
Citric
acid
cycle
Matrix
Fumarate
Succinate
O2
H2O
Inner membrane
IV
III
II
Q
I
H+
H+
Intermembrane space

Cellular Respiration

Anaerobic Respiration

- produce energy (ATP) without using oxygen
- not as efficient as aerobic respiration
- starts with glycolysis
- follows a different path
- **fermentation** (pyruvate into other molecules to regenerate NAD+)

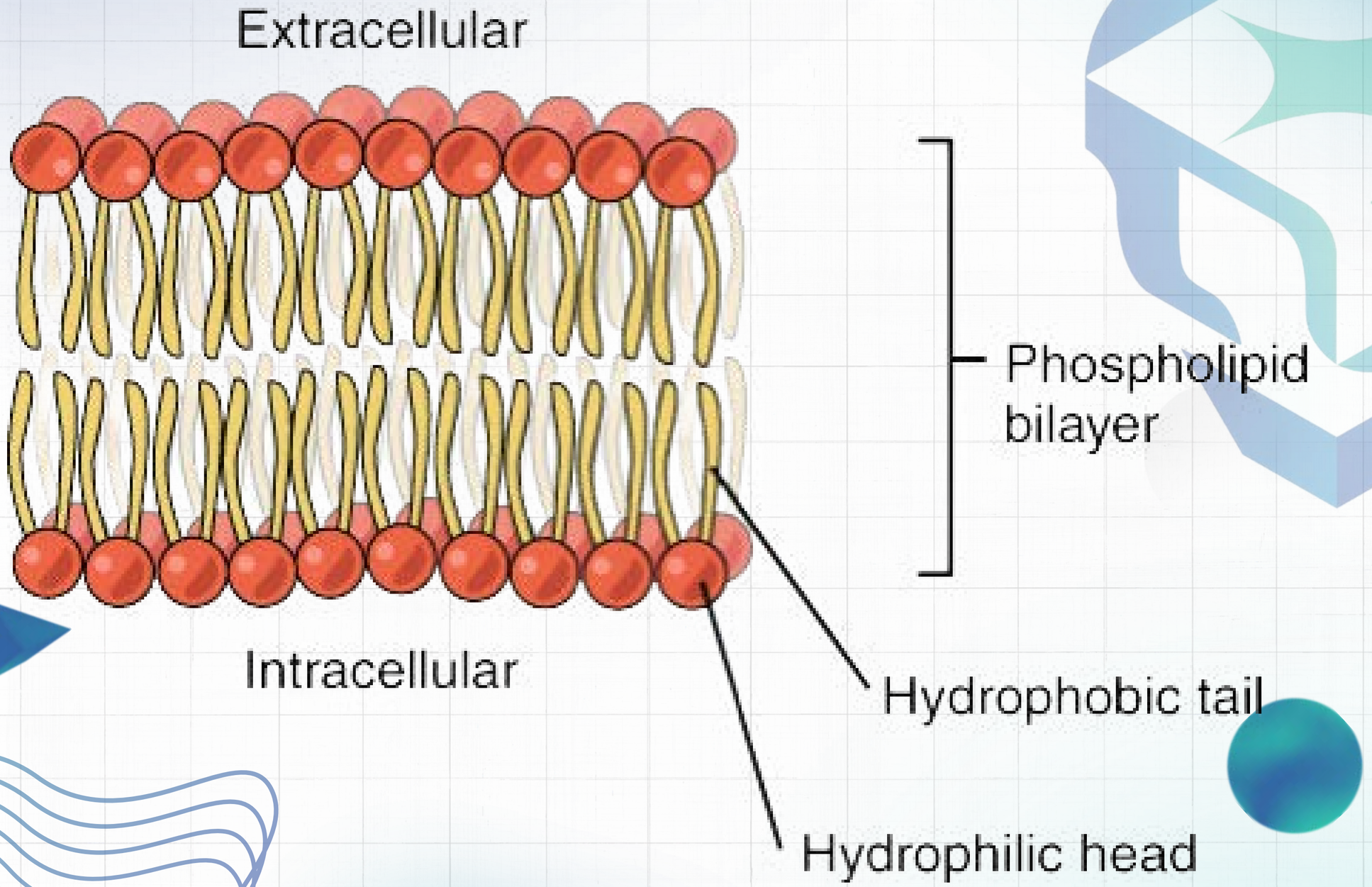
Lactic Acid Fermentation: Pyruvate is converted into lactic acid.
Alcoholic Fermentation: Pyruvate is converted into ethanol (alcohol) and carbon dioxide.

- **Other Anaerobic Pathways** (different substances as the final electron acceptor in their electron transport chain, e.g. NO3^1, SO4^2, or CO2)

Cell Transport

Passive Transport

- does not require the cell to expend energy
- follows the **concentration gradient** (from an area of high concentration to an area of low concentration).
- nutrient uptake
- waste removal
- gas exchange
- maintaining proper cell balance


Extracellular
Phospholipid bilayer
Intracellular
Hydrophobic tail
Hydrophilic head

Cell Transport

Passive Transport

Types of Passive Transport:

Simple Diffusion

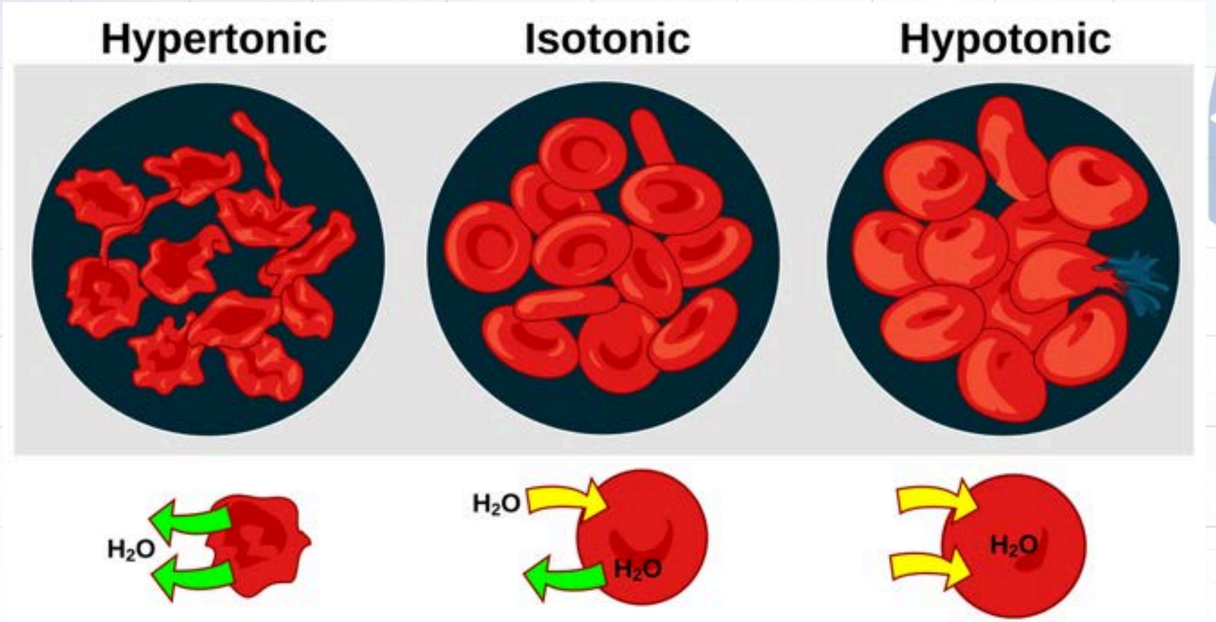
- nonpolar molecules (e.g oxygen)
- down their concentration gradient

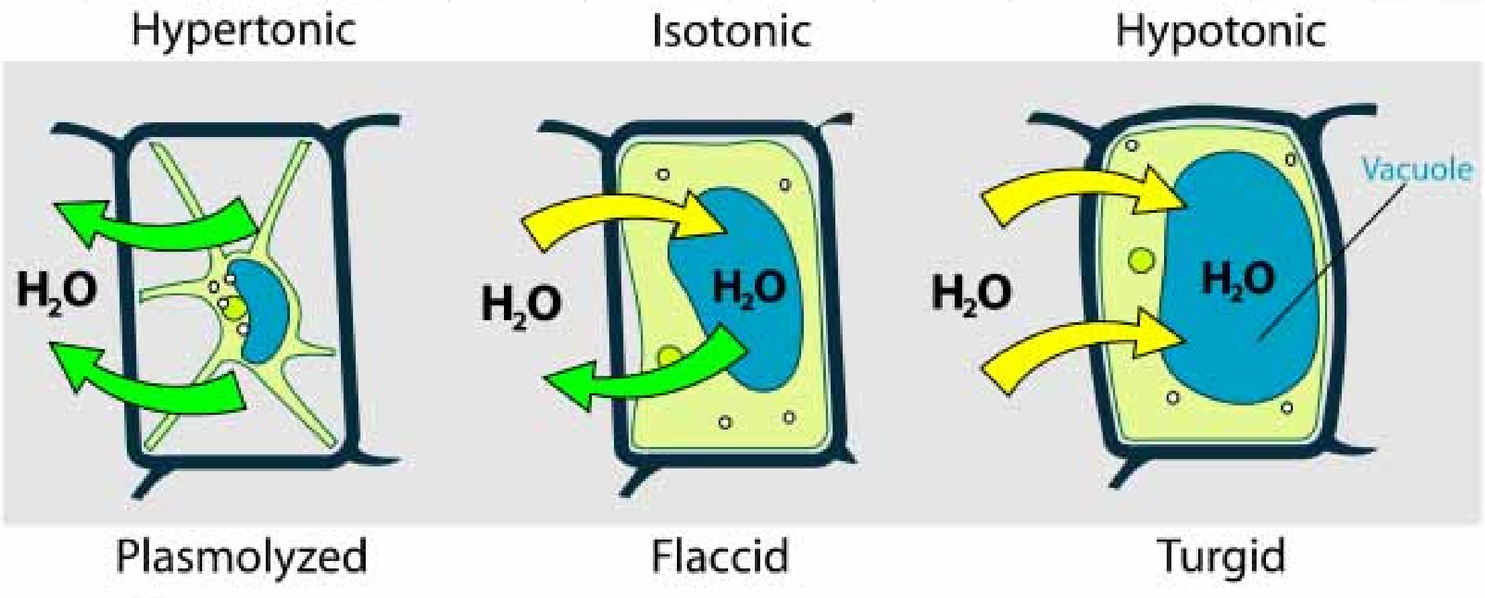
Facilitated Diffusion

- larger or polar molecules (e.g. glucose)
- use transport proteins (channel or carrier proteins)

Osmosis

- movement of water
- area of low solute concentration to an area of high solute concentration


Hypertonic
Isotonic
Hypotonic
H2O
H2O
H2O
H2O
H2O


Hypertonic
Isotonic
Hypotonic
H2O
H2O
H2O
H2O
H2O
Vacuole
Plasmolyzed
Flaccid
Turgid

Cell Transport

Active Transport

- requires the cell to expend energy
- against their concentration gradient
- involves transport proteins
- vital for taking in essential nutrients
- getting rid of waste products
- maintaining proper ion balance

Cell Transport

Active Transport

Types of Active Transport

Primary Active Transport

- directly uses energy
- e.g. sodium-potassium pump

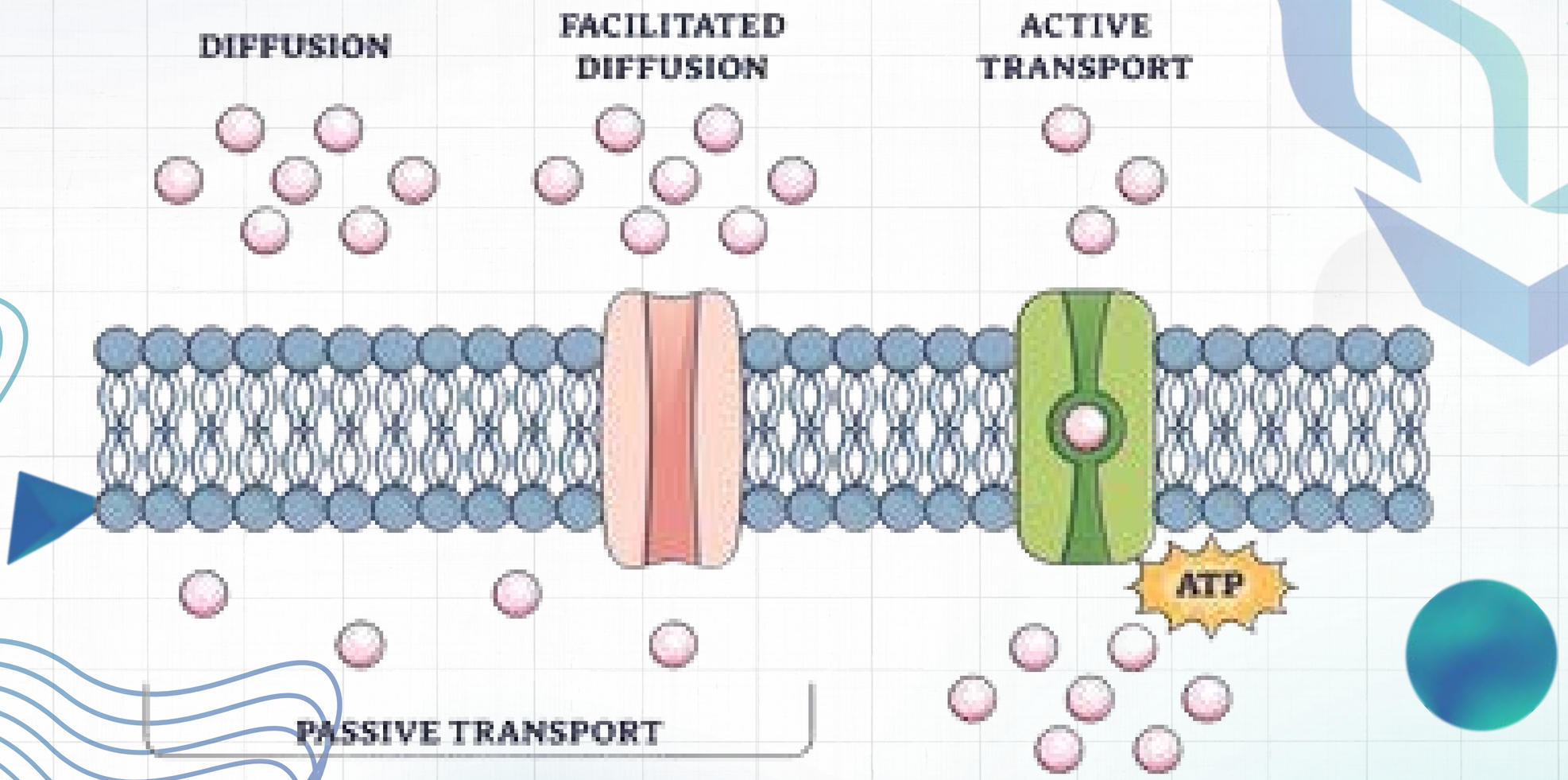
Secondary Active Transport

- uses energy stored in an **electrochemical gradient** (often created by primary active transport)

Bulk Transport

- used for moving large substances

ACTIVE AND PASSIVE TRANSPORT



Cell Transport

Bulk Transport

- requires the cell to use energy
- vesicles
- moves large substances

Types of Bulk Transport:

Endocytosis: take in large substances

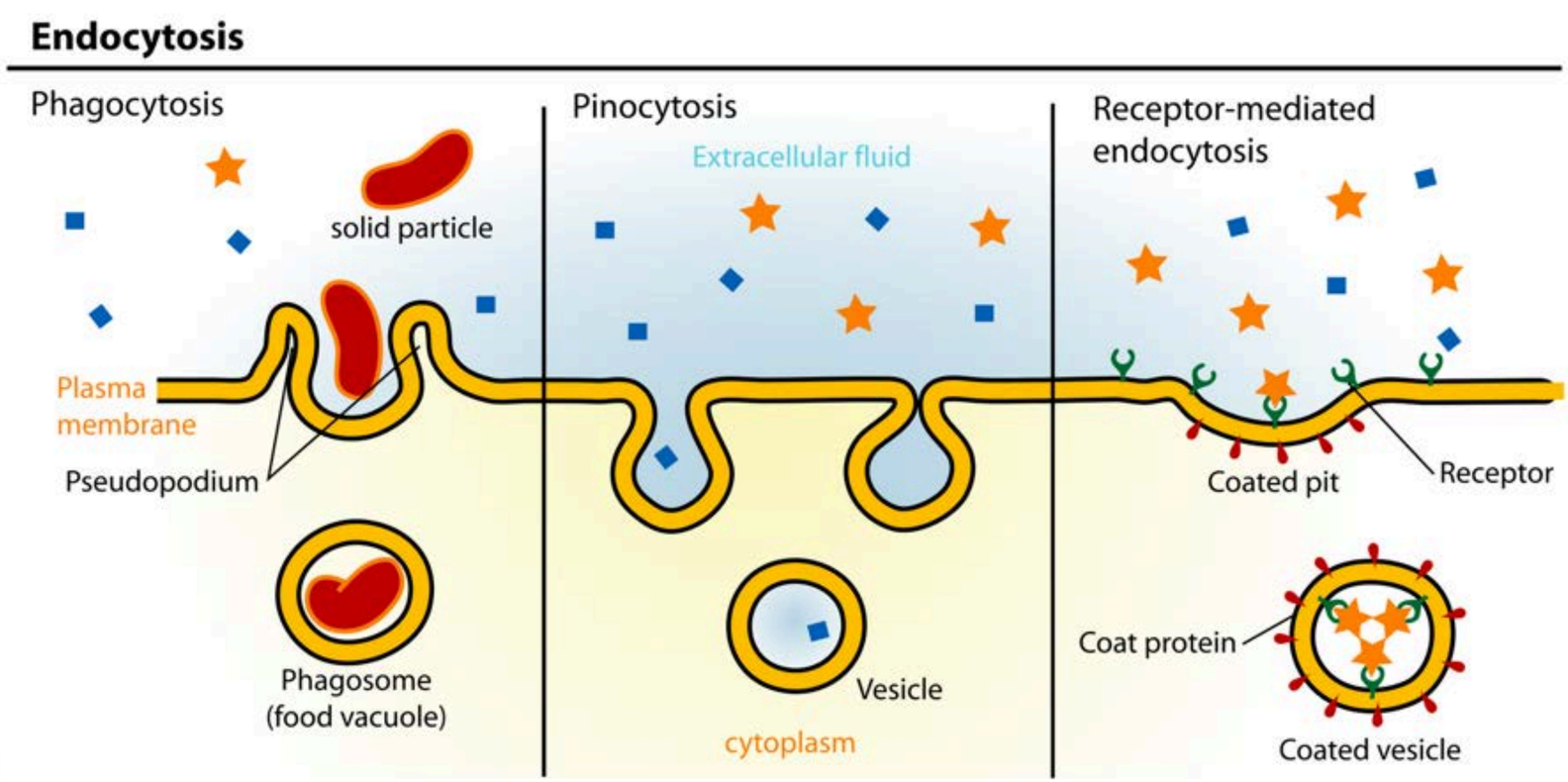
Phagocytosis: "Cell eating" - engulfing large particles or even other cells.

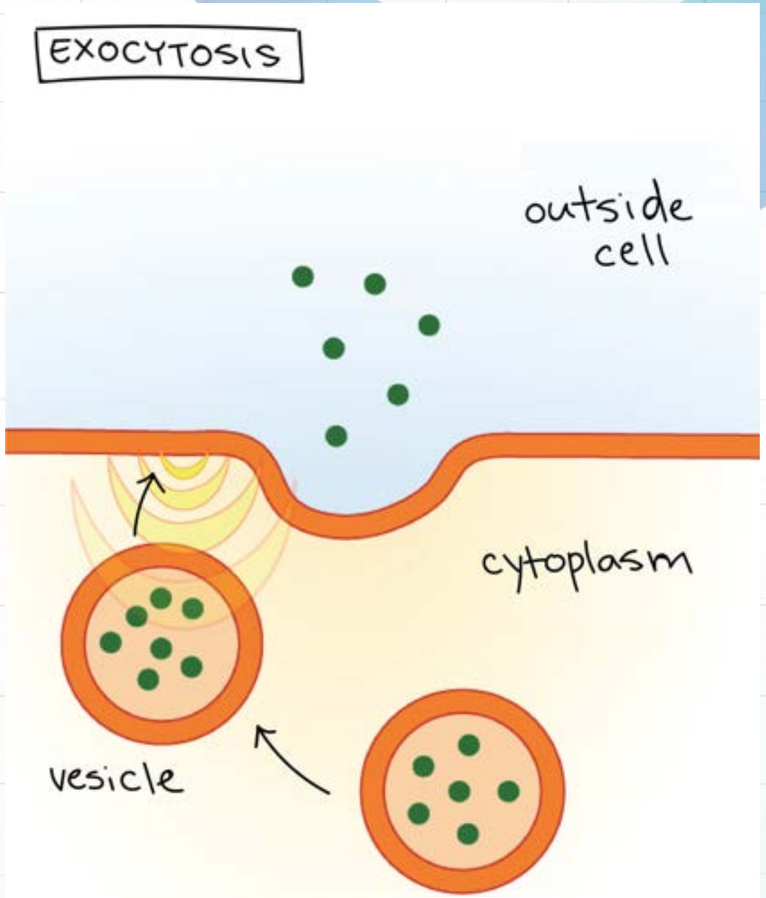
Pinocytosis: "Cell drinking" - taking in fluids and small dissolved substances.

Receptor-mediated endocytosis: Highly specific uptake of molecules using receptors on the cell surface.

Exocytosis: release large substances.

Bulk Transport





Short Quiz

Short Quiz

Identification

1. amino acids, monosaccharides, nucleotides, fatty acids
2. protein, carbohydrates, DNA/RNA, lipids

Enumeration

3. Two (2) types of modes of cellular metabolism
4. Chemical formula of photosynthesis
5. Two (2) types of cellular transport

Short Quiz

Answers

1. **micromolecules**
2. **macromolecules**
3. **anabolism**, **catabolism**
4. **6CO2 + 6H2O + light energy -> C6H12O2 + 6O2**
5. **passive transport**, **active transport**

Cell Cycle and Genetics

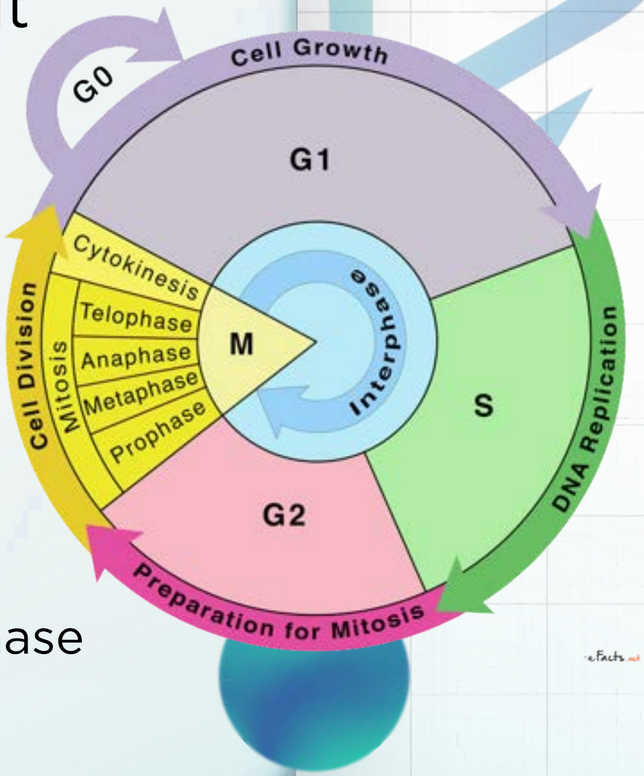
Cell Cycle

- series of events that takes place in a cell as it grows and divides.

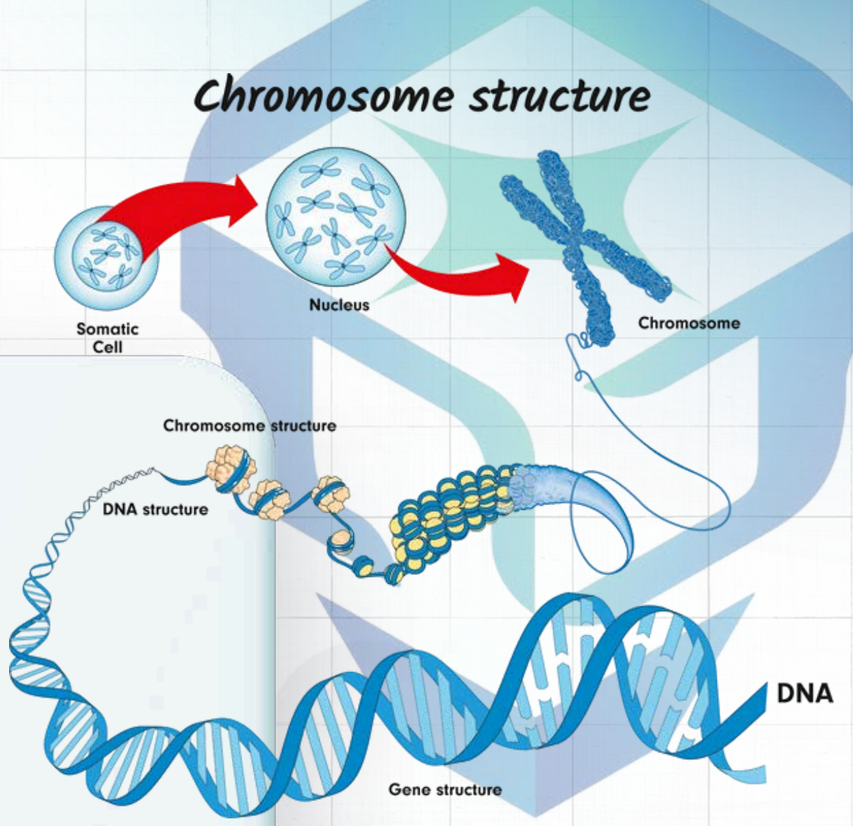
Interphase

- cell is not actively dividing
- longest phase during cell cycle
- mRNA replication
  - **G0 Phase -** resting phase
  - **G1 Phase -** cell growth, protein synthesis
  - **S Phase -** DNA replication, DNA repair
  - **G2 Phase -** organelle duplication, preparation for M-phase

M Phase - cell division occurs



Chromatin? Chromosome? Chromatids?



Chromatin

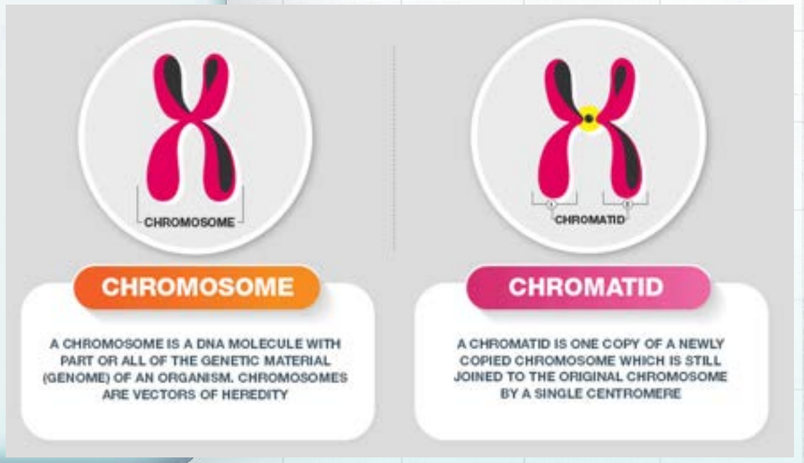
- The general term for the DNA and protein complex that makes up chromosomes.

Chromosomes

- The organized structures of DNA that form during cell division.

Chromatids

- The two identical halves of a replicated chromosome.
- They are joined together at the centromere.



Cell Division

Mitosis

- Equational Division (2n → 2n)
- One cell produces two identical daughter cells.
- Used for growth and repair of cells
- Occurs in somatic cells (each with 23 pairs of chromosomes)

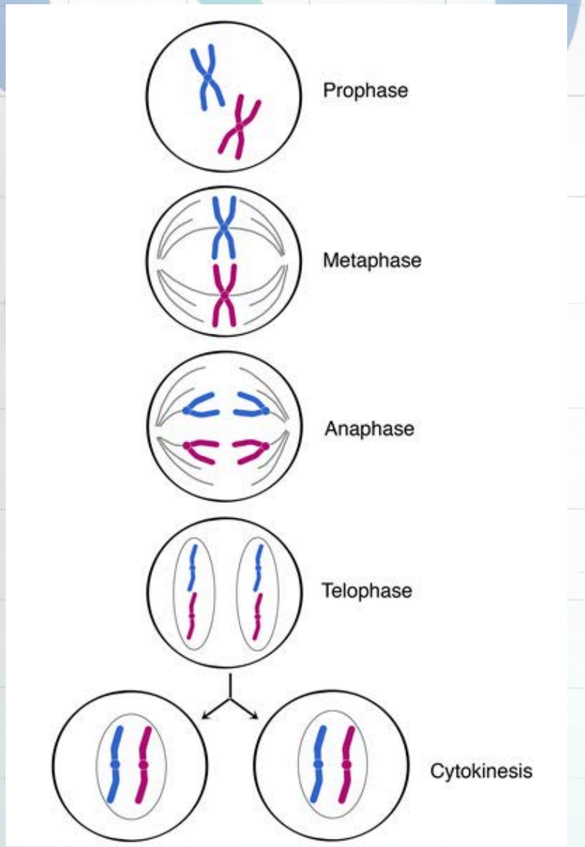
Prophase - chromosomes condense, nuclear envelope breaks down, mitotic spindle begins to form

Metaphase - chromosomes align along the metaphase plate

Anaphase - sister chromatids separate and move to opposite poles of the cell

Telophase - chromosomes decondense, nuclear envelope reforms, cytoplasm becomes divided by cell plate

Cytokinesis - cytoplasm completely divides, resulting in two distinct daughter cells



Cell Division

Meiosis

- Reductional Division (2n → n)
- One cell produces four daughter cells
- Present in gametes (sperm cell, egg cell)

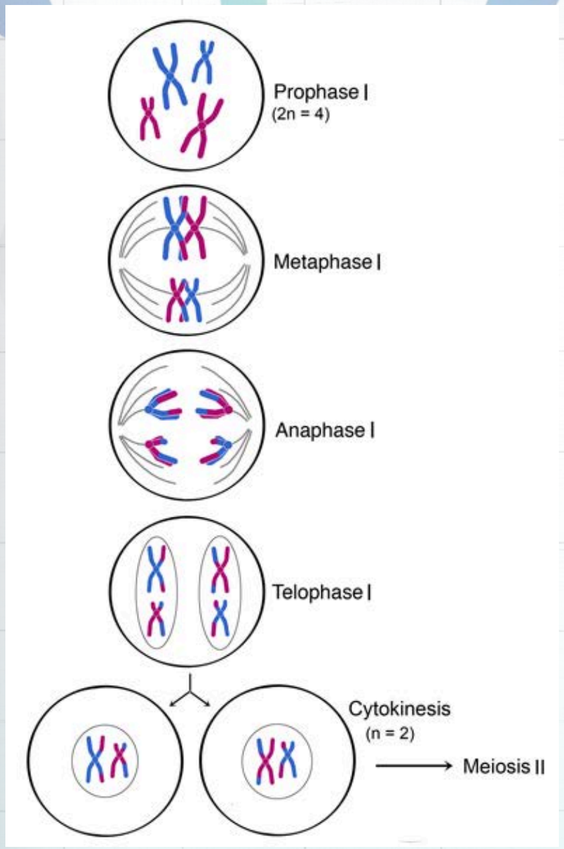
MIEOSIS I

Prophase I - chromosomes condense, nuclear envelope breaks down, mitotic spindle begins to form

Metaphase I - homologous chromosome pairs; synapsis, meiotic recombination, genetic shuffle

Anaphase I - homologous chromosome pairs move along the spindle fibers to opposite poles

Telophase I - cell pinches and divides



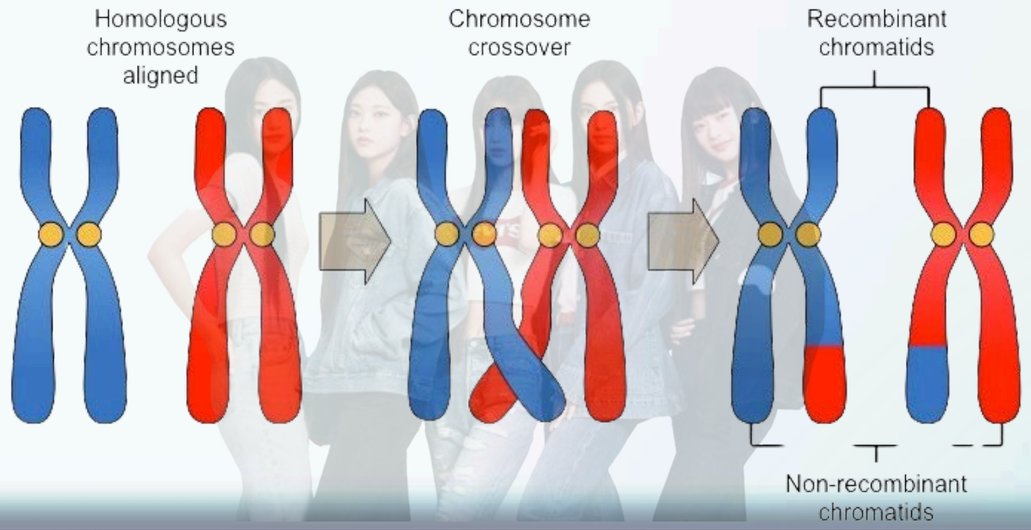
Cell Division

Meiosis

Recombinant chromosomes

- chromosomes with new combination of genes
- happens due to crossing over during meiosis

1. **Homologous Chromosomes Pair Up**
2. **Crossing Over Occurs**
3. **Swapping of segments results in recombinant chromosomes**



Cell Division

Meiosis

MIEOSIS II

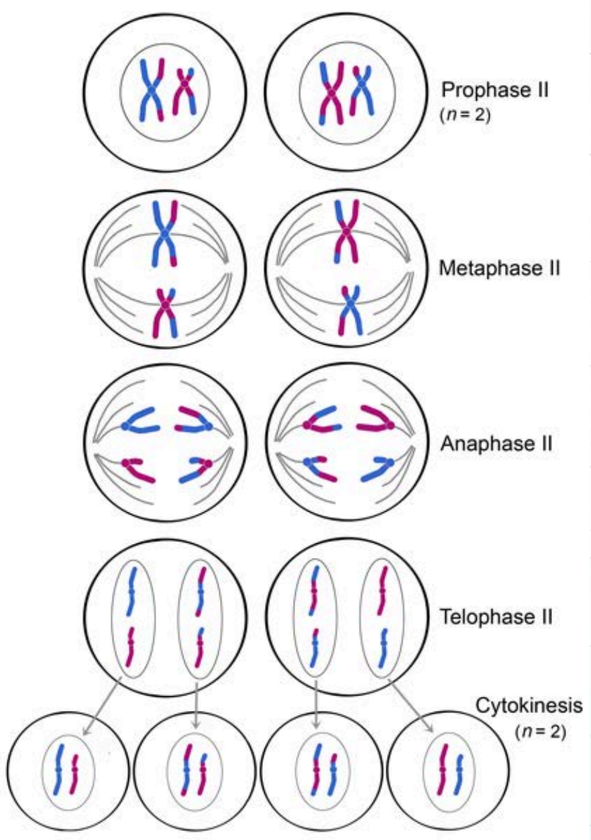
Prophase II - nuclear envelope breaks down, mitotic spindle begins to form

Metaphase II - paired chromosomes line up

Anaphase II - chromatids split at the centromere and migrate along the spindle fibers to opposite poles

Telophase II - cells pinch in the center and divide

Final outcome: 4 haploid daughter cells

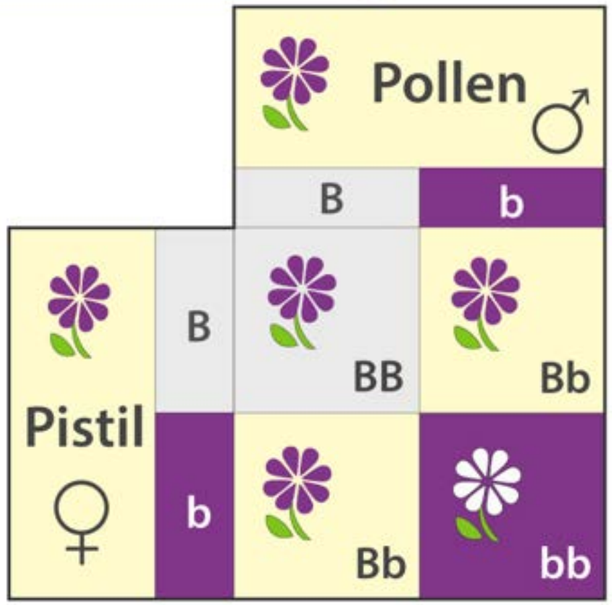


Genetics

Mendelian Inheritance

Gregor Mendel's Law

1. **Law of Segregation** Each individual has two alleles for each gene, and these alleles separate during gamete formation (sperm or egg production).
2. **Law of Independent Assortment:** Alleles for different genes assort independently of each other during gamete formation (this applies when genes are on different chromosomes).



Dominant Trait: B ; purple flower
Recessive Trait: b ; white flower
Phenotypic Ratio: 3 purple flower : 1 white flower
Genotypic Ratio: 1 BB : 2 Bb : 1 bb

Genetics

Mendelian Inheritance

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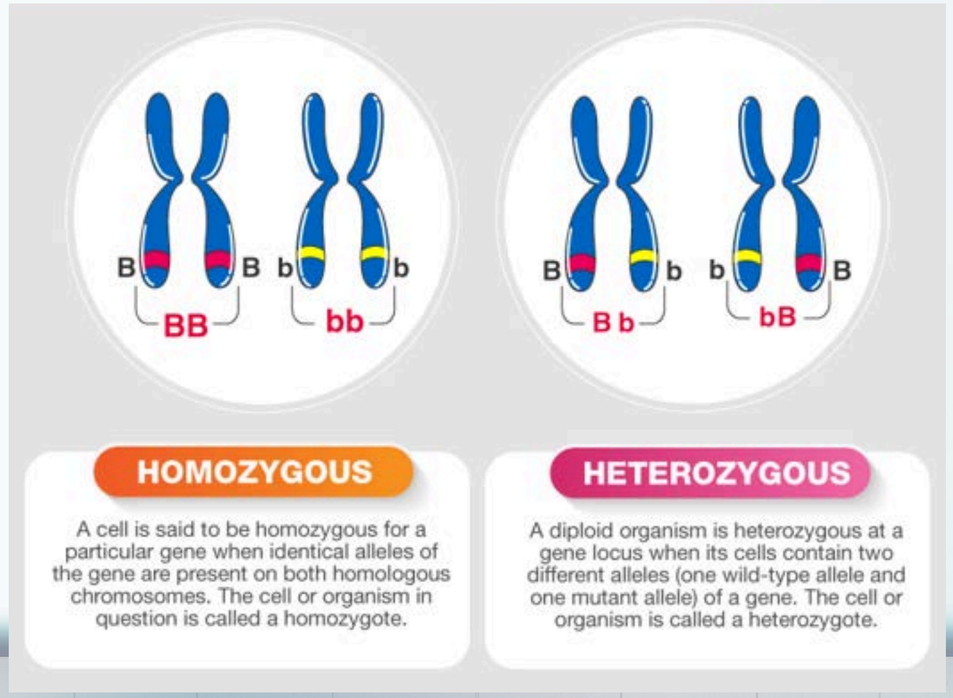
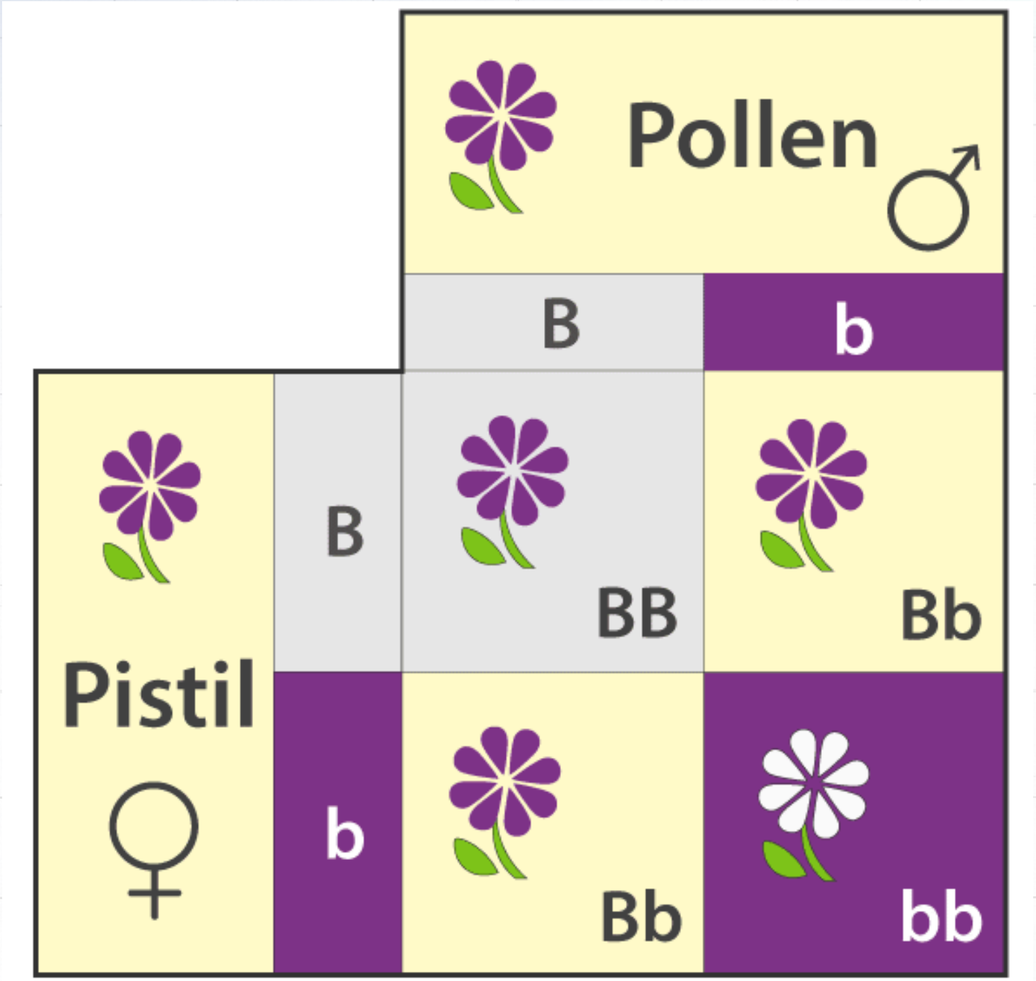


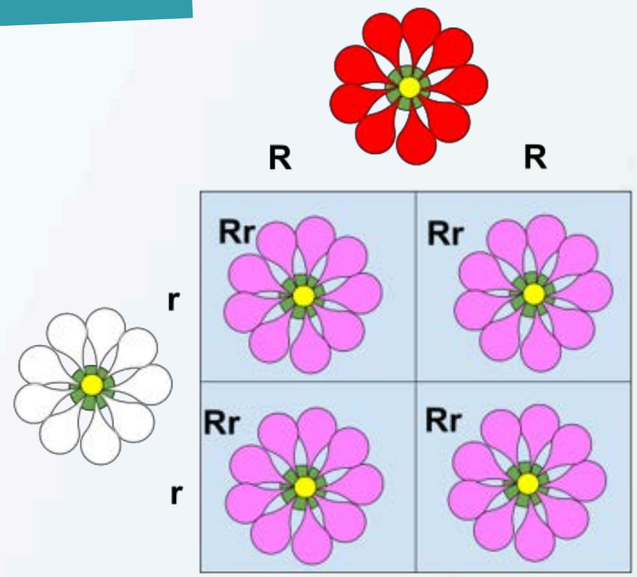


Parents: two Heterozygous purple flower
Dominant Trait: B ; purple flower
Recessive Trait: b ; white flower
Phenotypic Ratio: 3 purple flower : 1 white flower
Genotypic Ratio: 1 BB : 2 Bb : 1 bb

Genetics

Non- Mendelian Inheritance

- **Multiple Alleles:** More than two alleles exist for a gene (e.g., human blood types have A, B, and O alleles).
- **Incomplete Dominance:** Neither allele is completely dominant, resulting in a blended phenotype (e.g., red and white flowers might produce pink flowers).
- **Codominance:** Both alleles are expressed equally (e.g., a flower might have both red and white patches).
- **Sex-linked Genes:** Genes located on sex chromosomes (X or Y) show unique inheritance patterns.
- **Epistasis:** One gene masks the expression of another gene.
- **Polygenic Inheritance:** Traits controlled by multiple genes (e.g., height, skin color).
- **Mitochondrial Inheritance:** Genes located in mitochondria (organelles inherited from the mother) have a unique pattern of inheritance.



Parent: Homozygous Dominant red flower, Homozygous Recessive white flower
Dominant Trait: R ; red flower
Recessive Trait: r ; white flower
Phenotypic Ratio: 4 pink flower
Genotypic Ratio: 4 Bb
Type: Incomplete Dominance

Short Quiz

Short Quiz

Application

Create a funny, relatable (in Gen Z context) mnemonic for Cell Cycle, Mitosis, Meiosis, or Genetics. (choose one sub-topic only)

Plant and Human Anatomy

Plant Anatomy

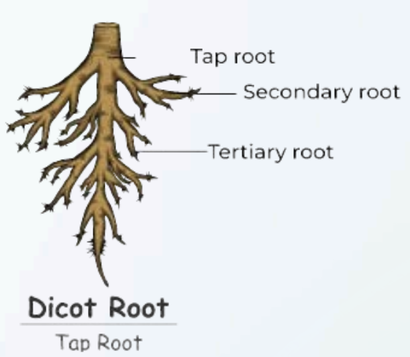
Organs and Organ systems

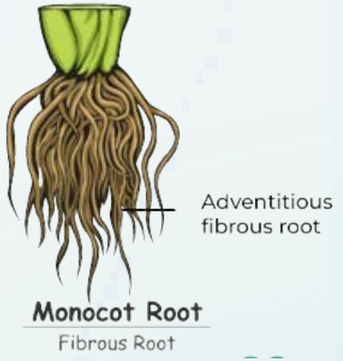
Root System

Components: Roots (taproot, fibrous roots), root hairs

Functions:

- Anchoring the plant in the soil
- Absorbing water and minerals from the soil
- Storing food (in some plants)





Plant Anatomy

Organs and Organ systems

Shoot System

Components: Stems, leaves, flowers, fruits

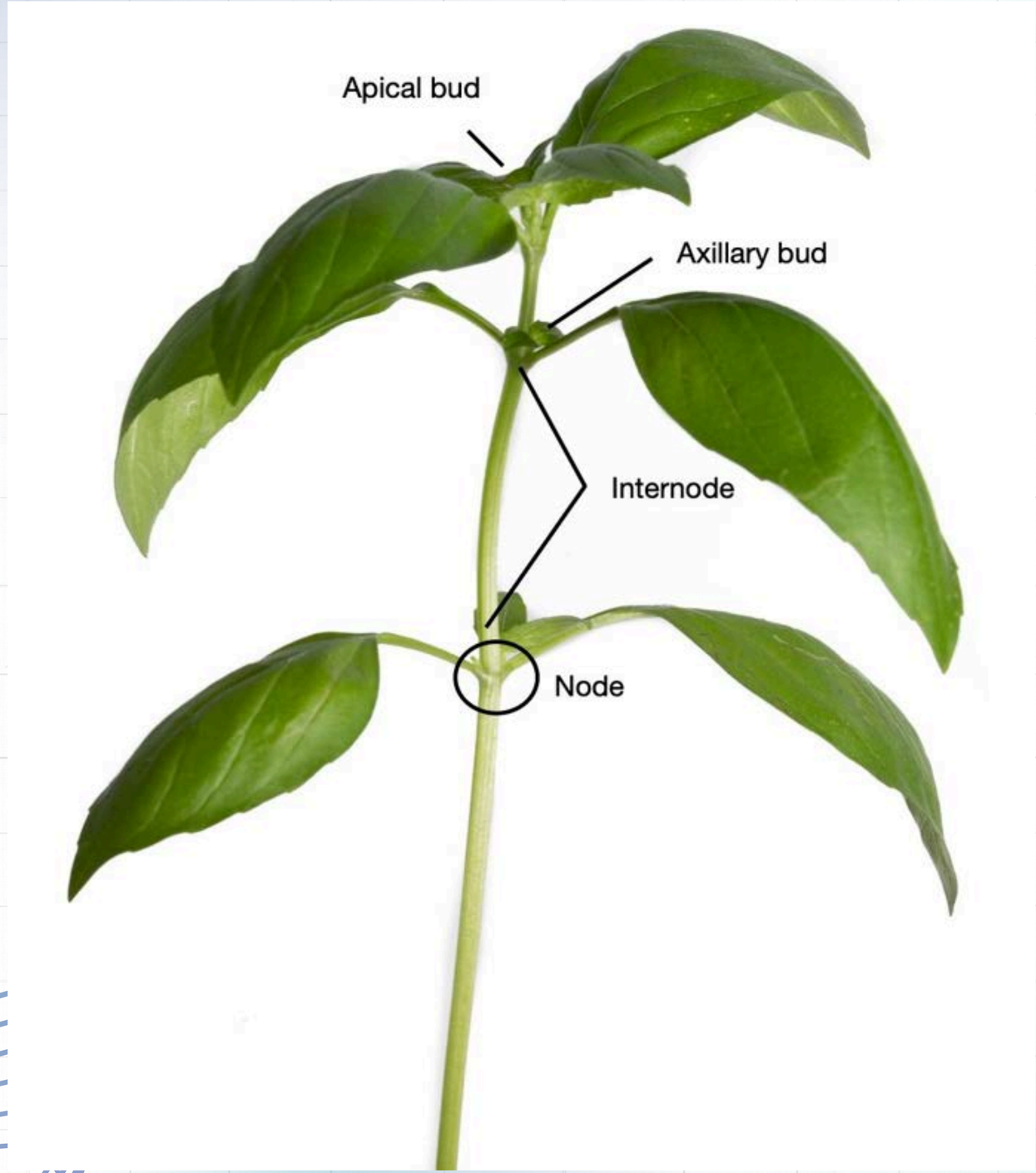
Functions:

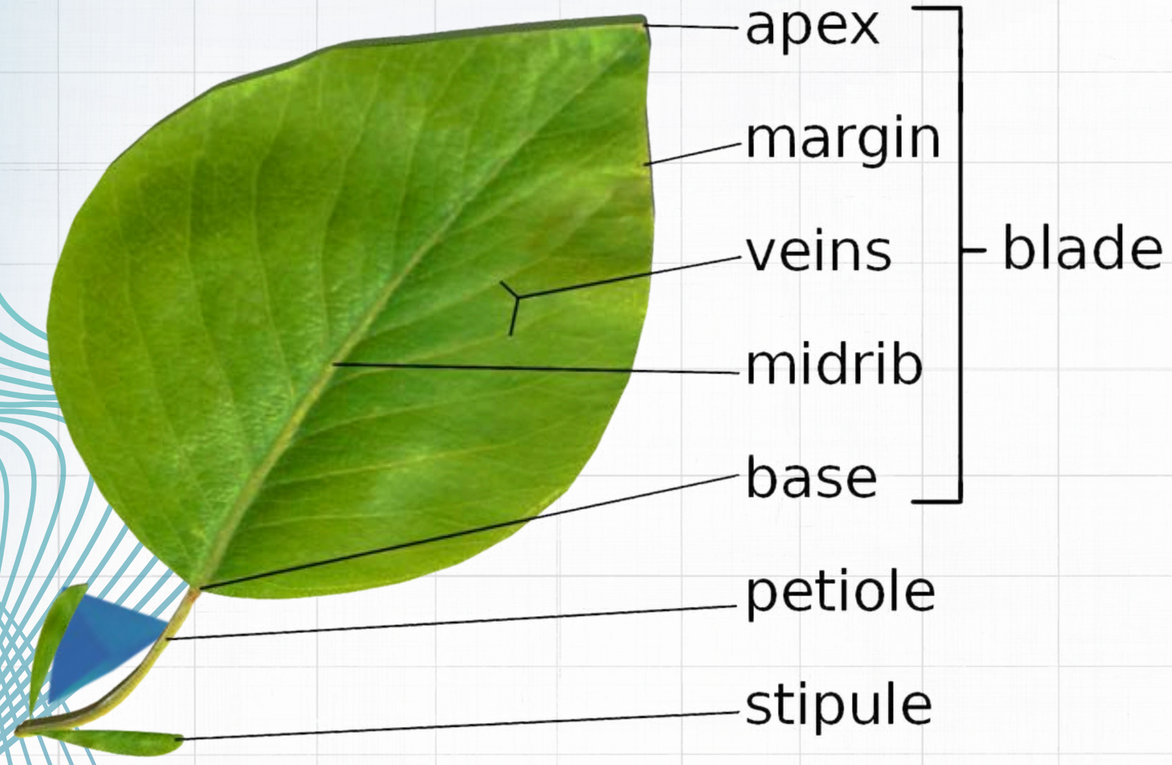
Stems: Support leaves, flowers, and fruits. Transport water and nutrients between roots and leaves

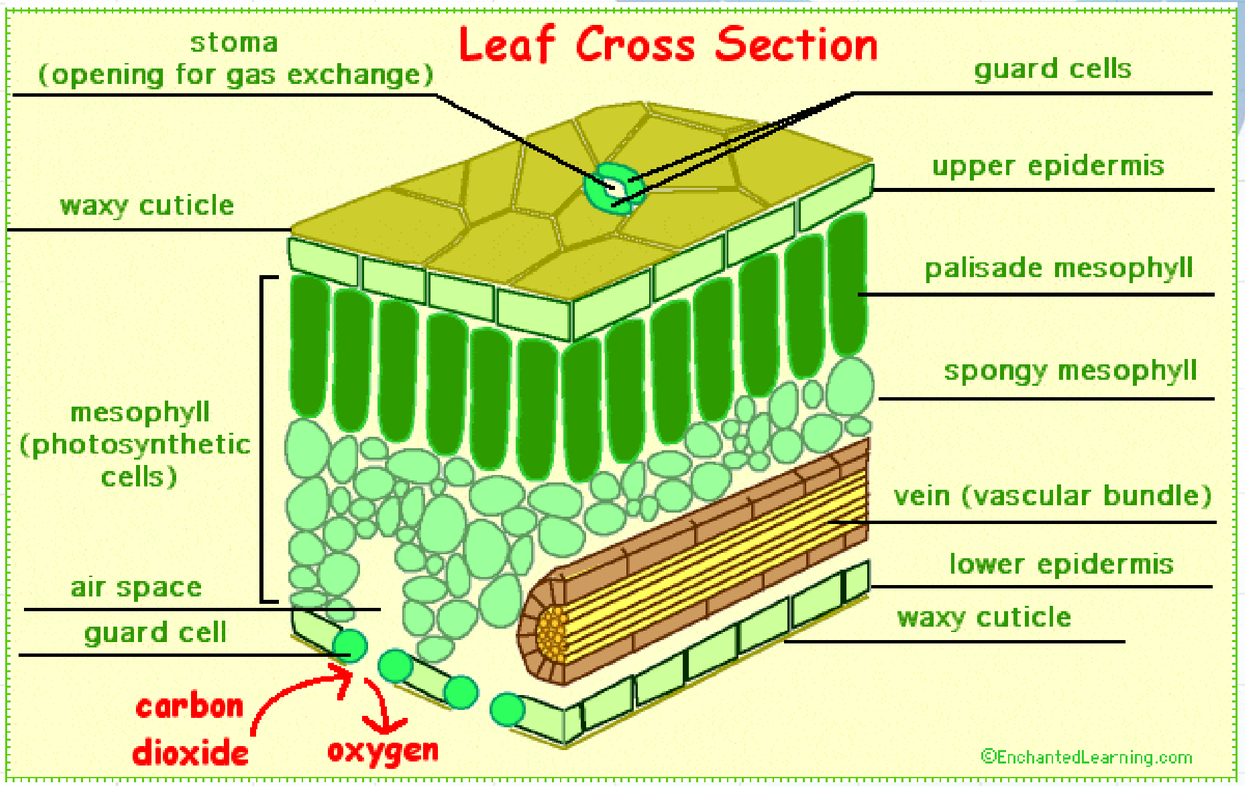
Leaves: Main site of photosynthesis (making food) an gas exchange (CO2 in, O2 out)

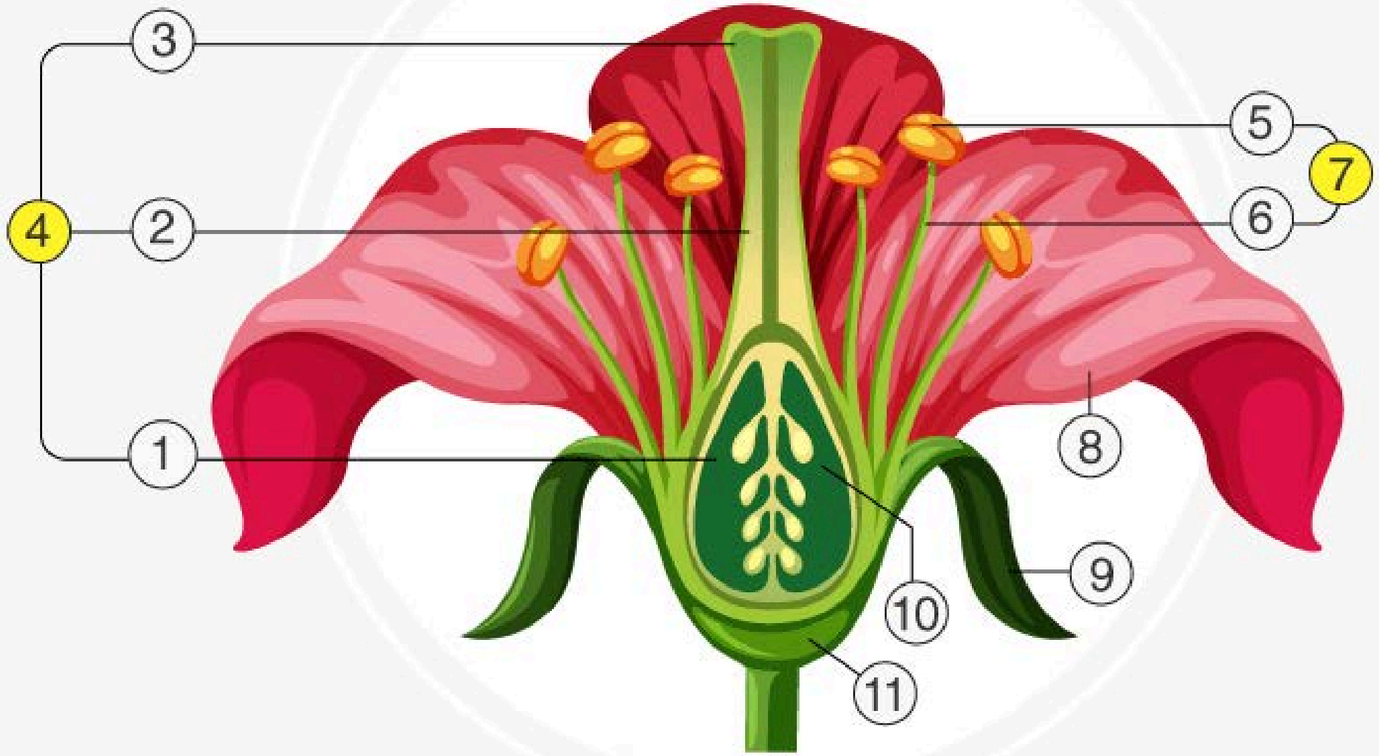
Flowers: Reproduction (attracting pollinators, producing seeds)

Fruits: Protect seeds, Aid in seed dispersal


Apical bud
Axillary bud
Internode
Node


apex
margin
veins
midrib
base
blade
petiole
stipule

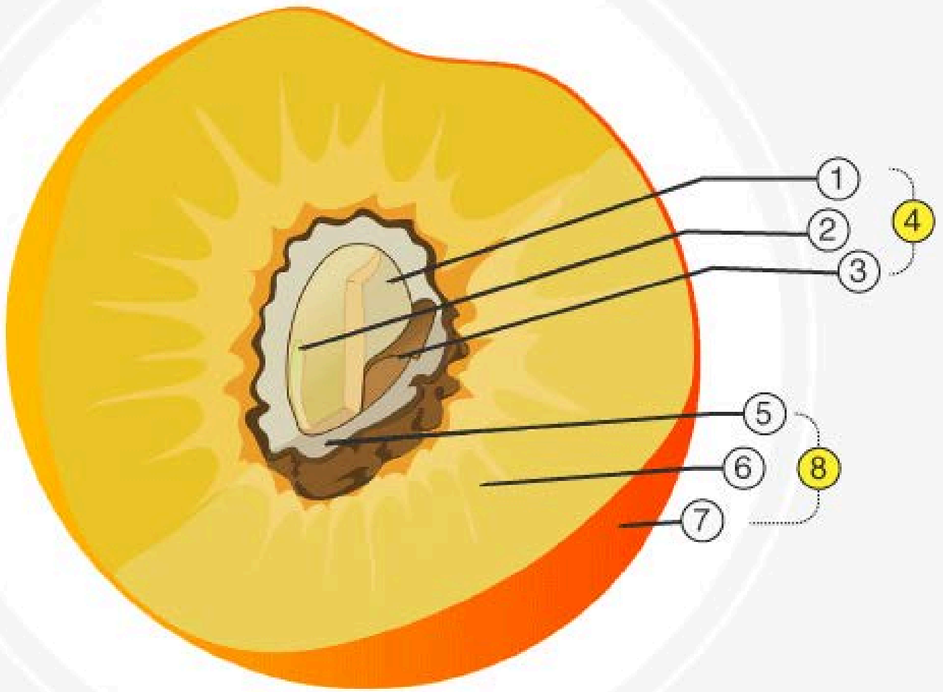

Leaf Cross Section
stoma
(opening for gas exchange)
guard cells
upper epidermis
waxy cuticle
palisade mesophyll
spongy mesophyll
mesophyll
(photosynthetic
cells)
vein (vascular bundle)
lower epidermis
air space
waxy cuticle
guard cell
carbon
dioxide
oxygen
©EnchantedLearning.com



1 Ovary | 2 Style | 3 Stigma | 4 Pistil

5 Anther | 6 Filament | 7 Stamen | 8 Petal

9 Sepal | 10 Ovule | 11 Receptacle



1 Endosperm | 2 Embryo | 3 Seed Coat | 4 Seed

5 Endocarp | 6 Mesocarp | 7 Exocarp | 8 Pericarp

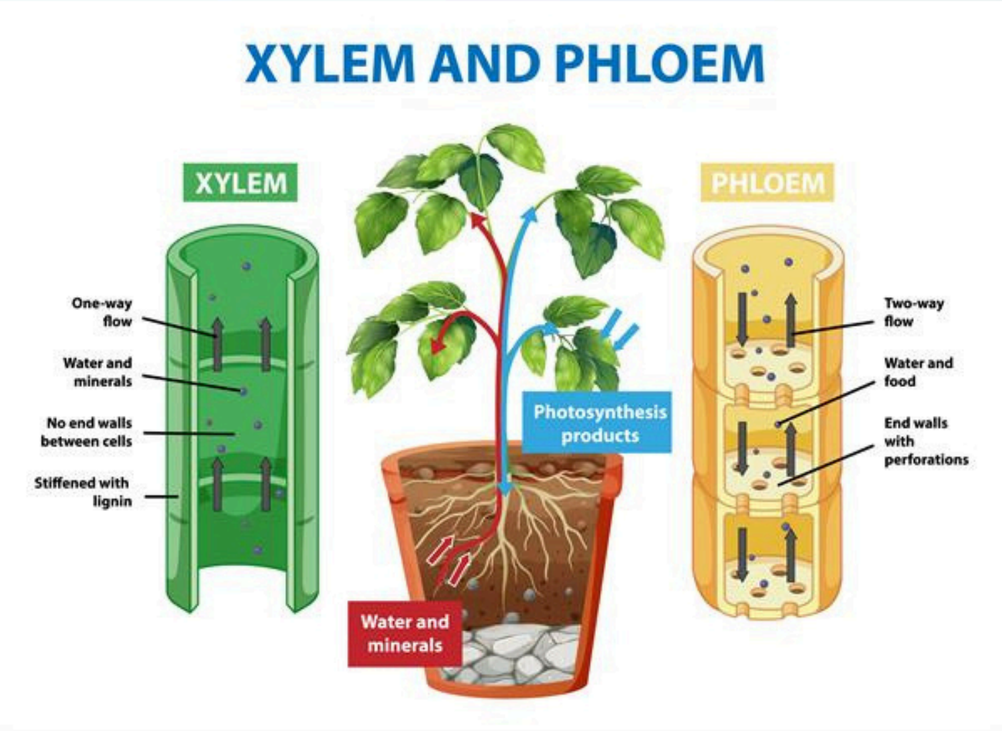
Plant Anatomy

Organs and Organ systems

Transport System:

Xylem: Transports water and minerals upwards from roots to leaves.

Phloem: Transports sugars (made in leaves) to other parts of the plant.



Plant Anatomy

Monocotyledonous vs. Dicotyledonous Plants

Feature	Monocots	Dicots
Cotyledons (Seed Leaves)	One cotyledon (single seed leaf)	Two cotyledons (two seed leaves)
Root System	Fibrous root system (many thin roots)	Taproot system (one main root with smaller branches)
Stem Vascular Bundles	Scattered vascular bundles	Vascular bundles arranged in a ring
Leaf Venation	Parallel veins	Netted or branched veins
Flower Parts	Flower parts in multiples of three	Flower parts in multiples of four or five
Pollen	Pollen grains usually with one pore or slit	Pollen grains usually with three pores or slits
Stem	Lack a vascular cambium, so they don't typically have secondary growth (increase in thickness)	Have a vascular cambium, allowing for secondary growth

Plant Anatomy

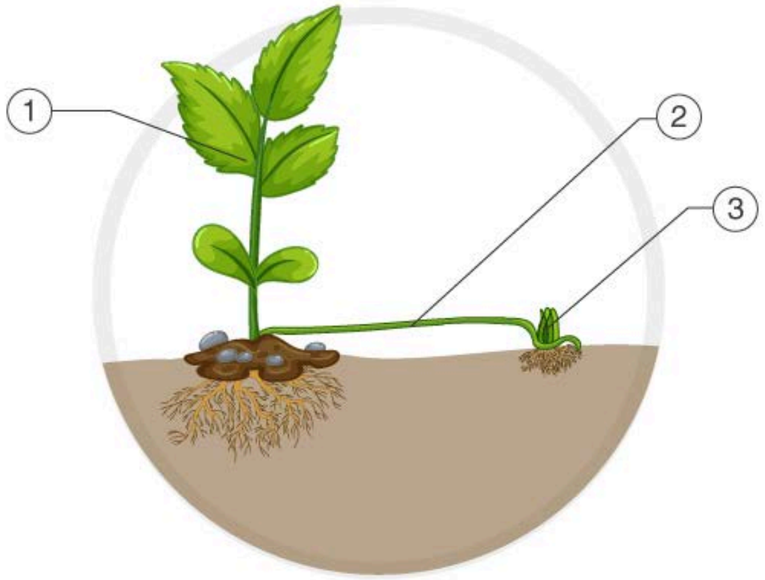
Reproduction

	Asexual Reproduction	Sexual Reproduction
Genetic Makeup of Offspring	Genetically identical to the parent (clones)	Genetically different from the parents and each other
Parent(s) Involved	One parent	Two parents (male and female)
Methods/ Examples	Vegetative propagation (runners, rhizomes, tubers, bulbs, cuttings, grafting), apomixis (seeds without fertilization)	Flowers (pollination, fertilization, seed development), spores (in some plants like ferns)
Structures Involved	Stems, roots, leaves (vegetative parts), sometimes specialized structures like bulbs or tubers	Flowers (stamens, pistils, petals, sepals), fruits, seeds, spores (in some plants)
Process	Mitosis (cell division for growth)	Meiosis (cell division for gamete production), fertilization (fusion of gametes)
Advantages	Rapid reproduction, especially in favorable environments; no need for pollinators; offspring well-suited to parent's environment	Increased genetic diversity, which can lead to better adaptation to changing environments
Disadvantages	Lack of genetic diversity, making populations vulnerable to disease; limited dispersal ability (in some methods)	Requires more energy and resources; relies on pollinators or other means of pollen transfer (in many cases)
Speed of Reproduction	Generally faster	Generally slower
Environmental Dependence	Less dependent on specific environmental conditions for successful reproduction (vegetative propagation)	More dependent on environmental conditions for pollination, seed dispersal, etc.
Evolutionary Adaptability	Lower due to lack of genetic variation	Higher due to increased genetic variation

Plant Anatomy

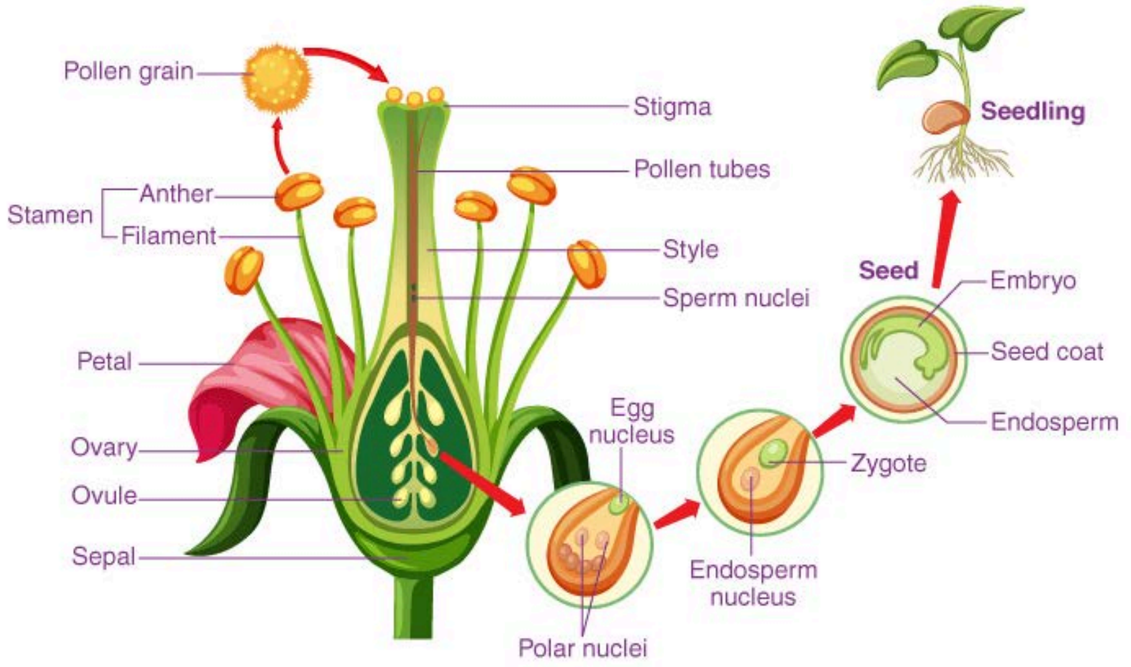
Reproduction

ASEXUAL REPRODUCTION IN PLANTS



1 Main plant | 2 Stolon (Runner) | 3 Bud

SEXUAL REPRODUCTION IN PLANTS



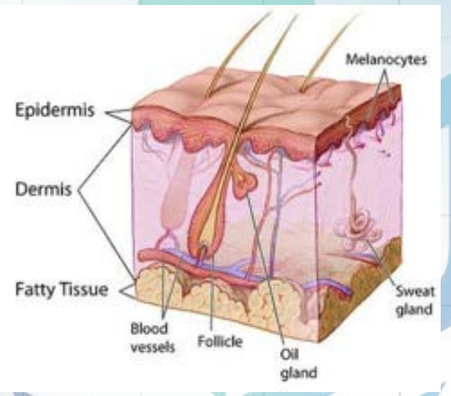
Human Anatomy

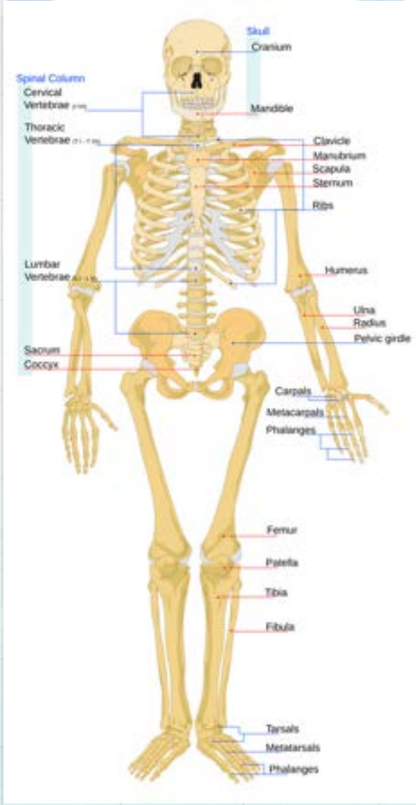
Organ and Organ systems

- Organ systems are groups of organs that work together to perform a specific function in the body.

Integumentary System: Protects the body from external threats, regulates body temperature, synthesizes vitamin D. (Skin, hair, nails, and associated glands)

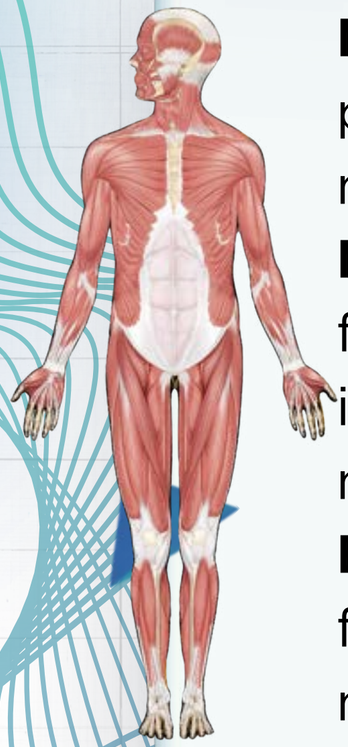
Skeletal System: Provides support and structure, protects internal organs, enables movement, produces blood cells. (Bones, cartilage, ligaments, and tendons.)





Human Anatomy

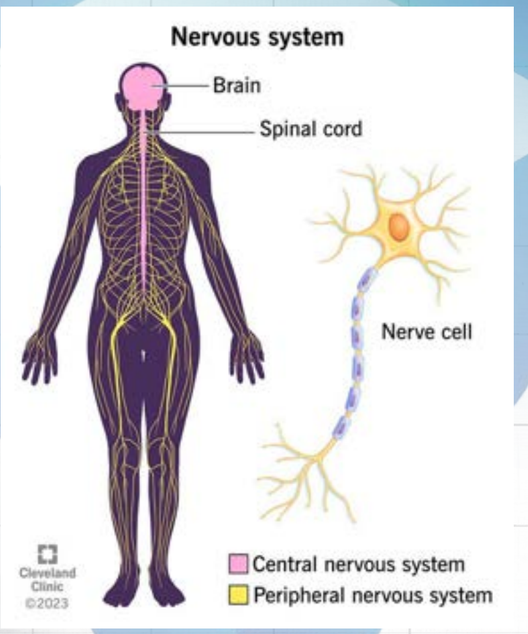
Organ and Organ systems

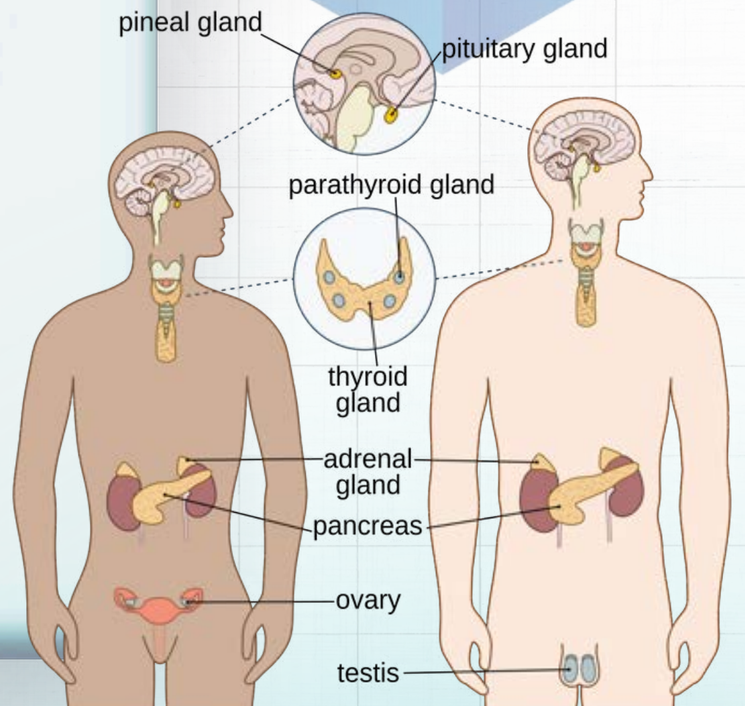


Muscular System: Enables movement, maintains posture, generates heat. (Skeletal muscles, smooth muscles, and cardiac muscle.)

Nervous System: Controls and coordinates bodily functions, receives and processes sensory information, initiates responses. (Brain, spinal cord, nerves.)

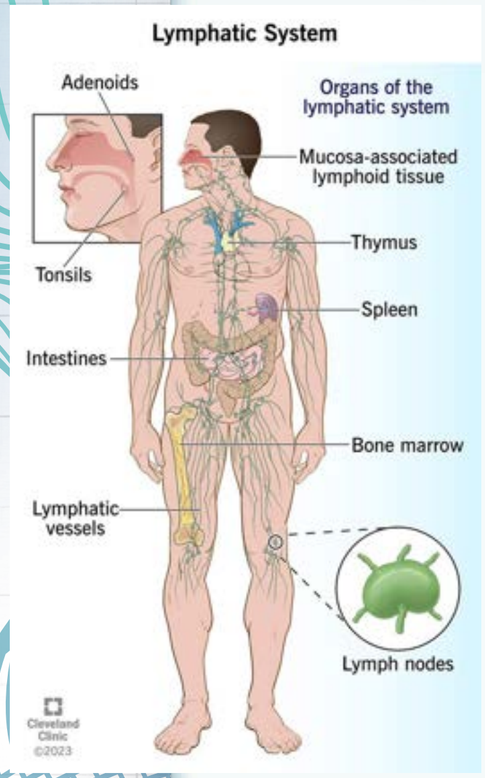
Endocrine System: Regulates various bodily functions through hormones, including growth, metabolism, and reproduction. (Glands that produce hormones (e.g., pituitary, thyroid, pancreas).)





Human Anatomy

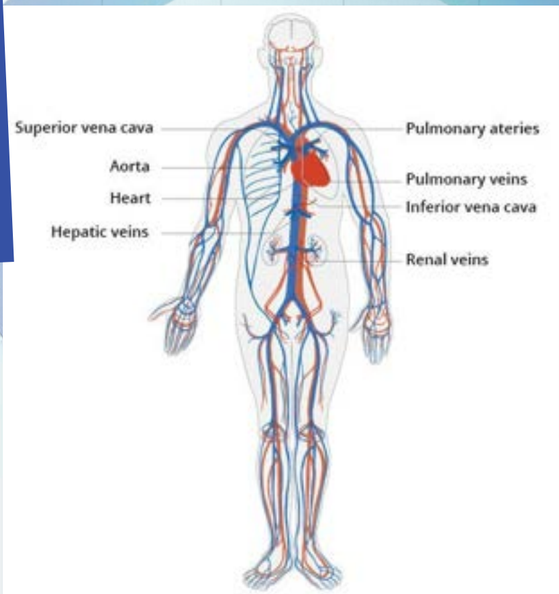
Organ and Organ systems

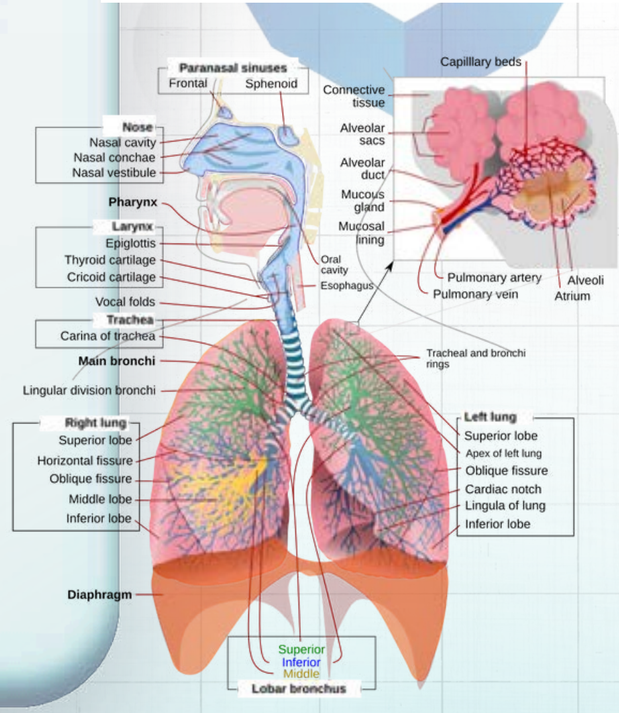


Cardiovascular System (Circulatory System): Transports oxygen, nutrients, hormones, and waste products throughout the body. (Heart, blood vessels (arteries, veins, capillaries), blood.)

Lymphatic System: Returns excess fluid to the bloodstream, plays a role in immune function. (Lymph nodes, lymphatic vessels, lymph, spleen, thymus.)

Respiratory System: Takes in oxygen and eliminates carbon dioxide. (Lungs, trachea, bronchi, and other structures involved in breathing.)





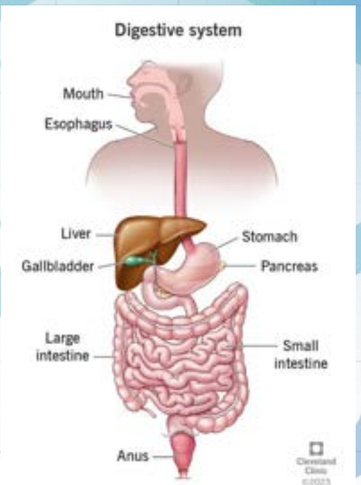
Human Anatomy

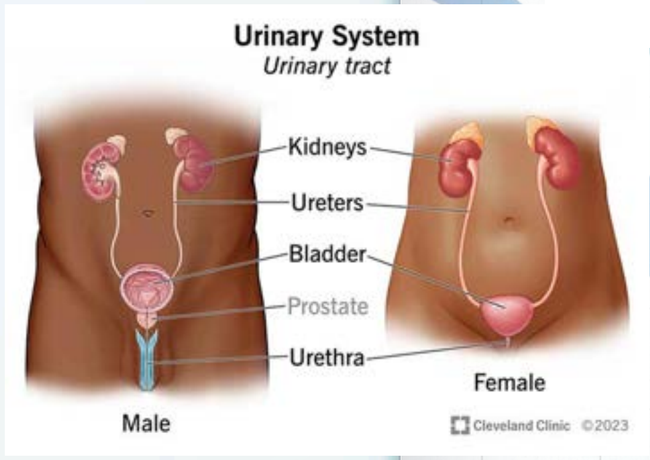
Organ and Organ systems

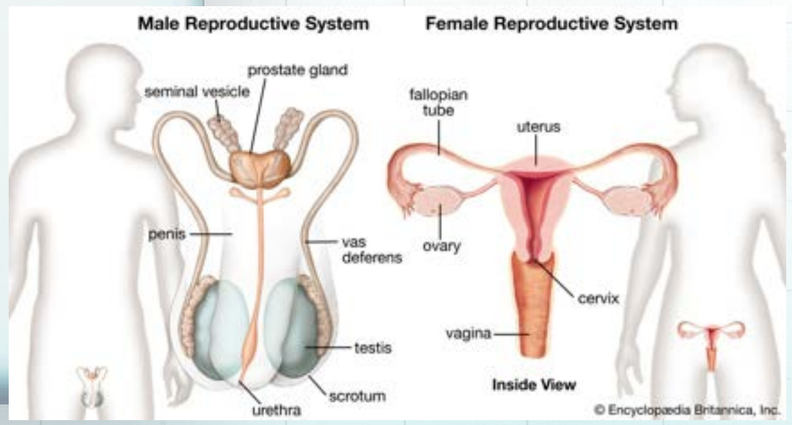
Digestive System: Breaks down food into absorbable nutrients, eliminates waste products. (Mouth, esophagus, stomach, intestines, liver, pancreas, and other organs involved in digestion.)

Urinary System (**Excretory System**):Filters blood and eliminates waste products in the form of urine. (Kidneys, ureters, bladder, urethra.)

Reproductive System: Produces gametes (sperm and eggs) and facilitates reproduction. ((Male) testes, penis, etc.; (Female) ovaries, uterus, vagina, etc.)







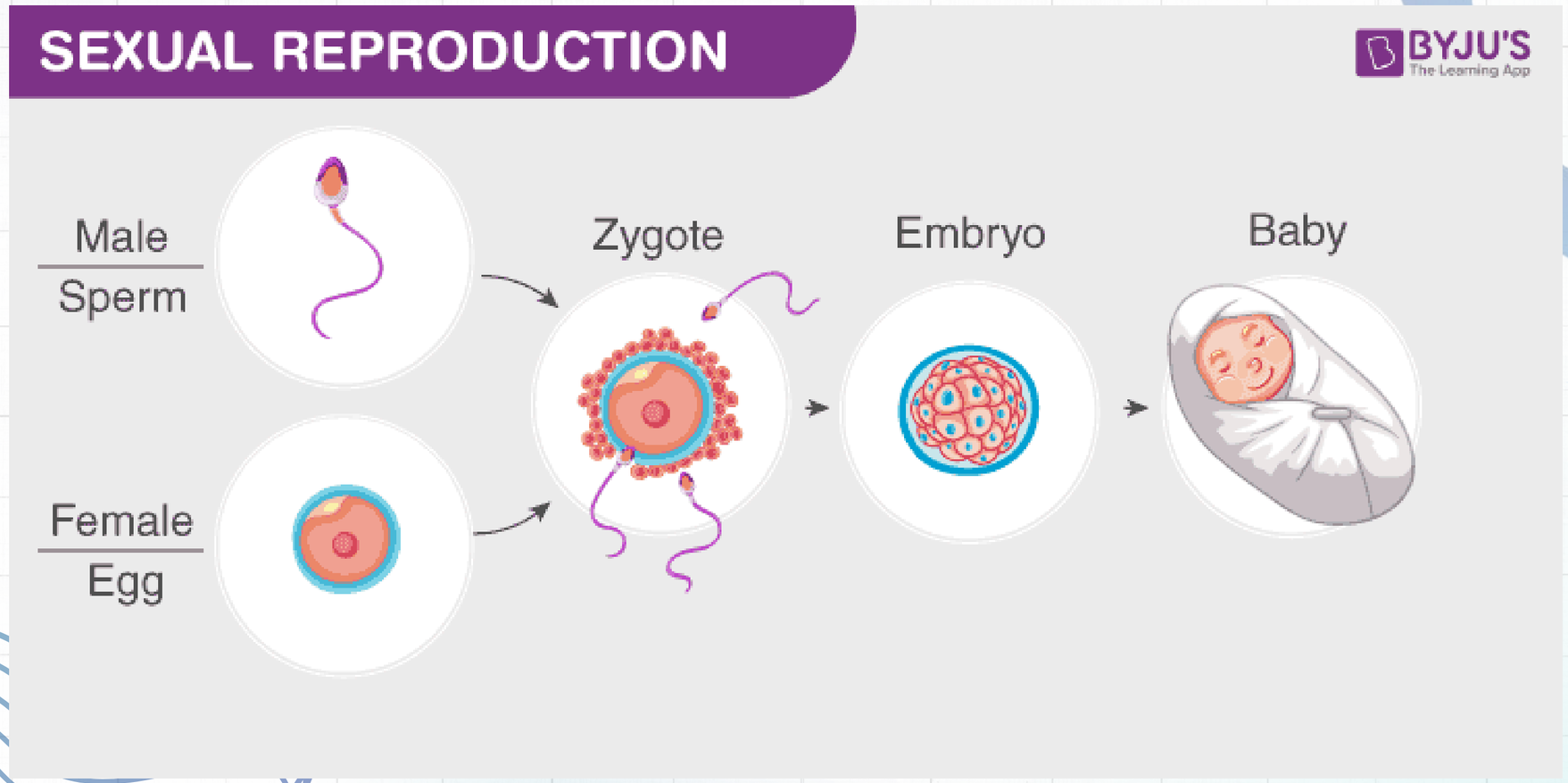
Human Anatomy

Reproduction

	Male Reproductive System	*Female Reproductive System*
Primary Organs	Testes	Ovaries
Gametes Produced	Sperm	Egg (Ovum)
Key Hormones	Testosterone	Estrogen, Progesterone
Other Important Structures	Scrotum, Epididymis, Vas Deferens, Prostate Gland, Seminal Vesicles, Penis, Urethra	Fallopian Tubes, Uterus, Vagina, Cervix, Endometrium
Process of Gamete Production	Spermatogenesis (in testes)	Oogenesis (in ovaries)
Fertilization Location	Typically in the Fallopian Tubes	N/A (egg is released from ovary)
Role in Fertilization	Delivers sperm to female reproductive tract	Provides egg for fertilization, site of fertilization (fallopian tube), and supports fetal development (uterus)
Other Functions	N/A	Menstruation (shedding of uterine lining if no fertilization), pregnancy, childbirth

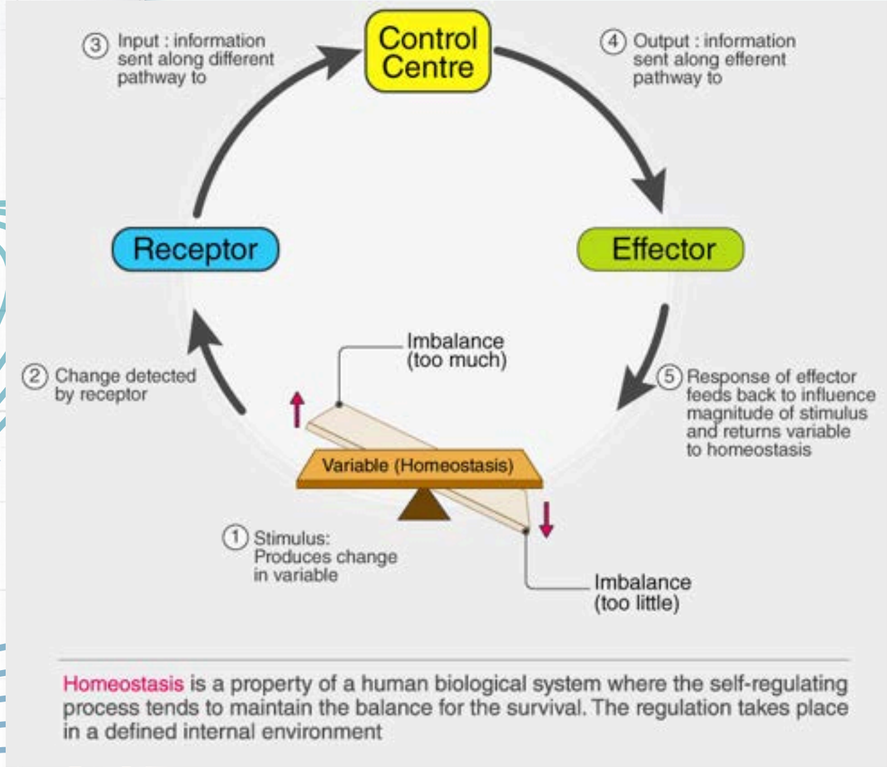
Human Anatomy

Reproduction



Human Anatomy

Homeostasis

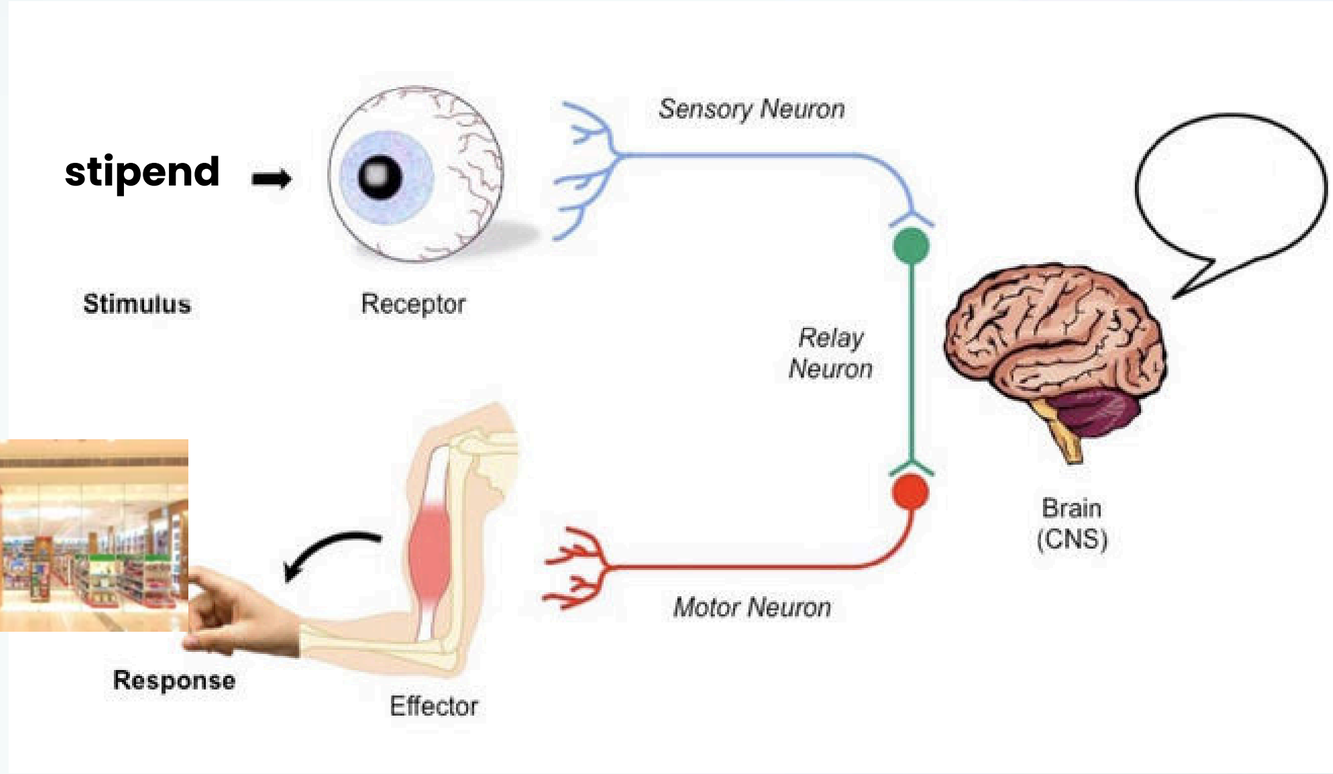


Homeostasis is a property of a human biological system where the self-regulating process tends to maintain the balance for the survival. The regulation takes place in a defined internal environment

	Negative Feedback	Positive Feedback
Goal	Maintain stability	Amplify change
Effect	Counteracts change	Reinforces change
Common in	Homeostasis	Less common, often involved in processes that need to be pushed to completion

Human Anatomy

Stimulus and Response



Short Quiz

Short Quiz

Enumeration

1. Name two types of plants
2. Name one plant organ system
3. With your answer in no. 2, name all the organs included in that organ system
4. Name the male and female reproductive cells
5. Name all the components of homeostasis

Short Quiz

Answers

1. **monocot, dicot**
2. **(root system, shoot system, transport system)**
3. root system**(root, root hair),** shoot system**(stem, leaves, flowers, fruit),** transport system**(xylem, phloem)**
4. **sperm, egg**
5. **variable, receptor, control centre, effector**

Evolution, Taxonomy, and Ecology

Evolution

Definition and Concepts

Evolution is an ongoing process by which populations of organisms change over time, explaining the diversity of life on Earth. Understanding evolution is crucial for many fields, including medicine (antibiotic resistance), agriculture (crop improvement), and conservation biology.

- **Heritable Variation**

Individuals within a population vary in their traits, and these variations are heritable (can be passed on to offspring).

- **Natural Selection**

The process by which individuals with certain heritable traits (adaptations) survive and reproduce more successfully than others because those traits make them better suited to their environment.

- **Adaptation**

A trait that increases an organism's survival and reproductive success in a particular environment.

- **Descent with Modification**

The idea that all living organisms share a common ancestor and have evolved over time, accumulating modifications that make them different from their ancestor.

Evolution

Major Theories

Theory of Acquired Characteristics (Early 1800s) *by Jean-Baptiste Lamarck*

- traits acquired during an organism's lifetime could be passed on to its offspring
- first theories to suggest that organisms change over time
- evidence shows that acquired traits are not heritable.

Theory of Natural Selection (Mid-1800s) *by Charles Darwin and Alfred Russel Wallace*

- states that individuals with advantageous heritable traits (adaptations) are more likely to survive and reproduce, passing those traits to their offspring
- provided a mechanism for how evolution occurs
- explained the diversity and adaptation of life

Mutation Theory (Early 1900s) *by Hugo de Vries*

- mutations (sudden changes in genes) are the primary source of evolutionary change
- highlighted the role of genetic variation in evolution
- incomplete, as mutations are not the sole driver of evolution.

Modern Synthesis (Mid-1900s) *by Theodosius Dobzhansky, Ernst Mayr, and G.G. Simpson etc.*

- combines Darwin's theory of natural selection with Mendelian genetics
- explains how genetic variation arises (through mutation and recombination), how it's inherited, and how natural selection acts on it to drive evolution

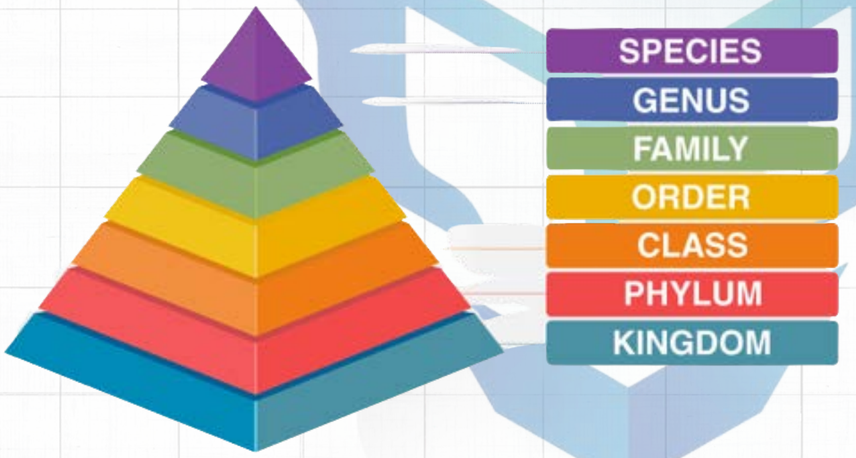
Evolution

Mechanisms

Mechanisms	Definition	Description	Example
Natural Selection	Differential survival & reproduction based on heritable traits.	Individuals with advantageous traits survive and reproduce more, changing the population over time.	Camouflaged moths survive better, changing moth color distribution.
Genetic Drift	Random changes in allele frequencies due to chance.	Chance events (like disasters) alter allele frequencies, especially in small populations.	Population bottleneck reduces genetic diversity.
Gene Flow	Gene movement between populations.	Migration and interbreeding introduce or alter allele frequencies.	Pollen moving between plant populations.
Mutation	Changes in DNA sequence.	Creates new alleles; can be beneficial, harmful, or neutral.	A mutation changes fur color.

Taxonomy

Rank	Description	Example (Human)	Example (Rose)
Domain	The highest taxonomic rank, representing the largest and most inclusive grouping of organisms based on fundamental differences in cellular structure.	Eukarya	Eukarya
Kingdom	A large taxonomic group composed of one or more phyla/divisions. Organisms within a kingdom share general characteristics.	Animalia	Plantae
Phylum (Anima	A taxonomic group composed of one or more classes. Organisms within a phylum/division share a common body plan or structural organization.	Chordata	Angiospermae
Class	A taxonomic group composed of one or more orders. Organisms within a class share similar characteristics.	Mammalia	Dicotyledoneae
Order	A taxonomic group composed of one or more families. Organisms within an order share more specific characteristics than those in a class.	Primates	Rosales
Family	A taxonomic group composed of one or more genera. Organisms within a family share even more specific characteristics.	Hominidae	Rosaceae
Genus	A taxonomic group composed of one or more species. The genus name is always part of the scientific name. Organisms within a genus share very similar characteristics.	*Homo*	*Rosa*
Species	The most specific taxonomic rank. A group of individuals that can interbreed and produce fertile offspring. The species name is always part of the scientific name (genus + species).	*Homo sapiens*	*Rosa gallica*



Dear King Philip Came Over For a Good Savory Soup

Taxonomy

- developed by Carolus Linnaeus in 18th century
- formal system of naming species of living things using two terms: the genus and the species
- standardized
- unique
- stable

1. The first part of the name is the ***genus***, which is a broader group of related species. It's always capitalized.
2. The second part is the ***species***, which is a more specific group within the genus. It's written in lowercase.
3. Both parts of the name are usually *italicized* (or underlined when handwritten)

ex. Human - *Homo sapiens*
Dog - *Canis lupus (subp. familiaris)*
Onion - *Allum cepa*

Heirarchy of Biological Organizations

- reflects the increasing complexity of life, from the smallest atom to the entire biosphere
- each level builds upon the previous one, with emergent properties arising at each level

Heirarchy of Biological Organizations

	Description	Examples	Key Characteristics
Atom	The smallest unit of matter that retains the chemical properties of an element.	Hydrogen (H), Carbon (C), Oxygen (O), Iron (Fe)	Basic building blocks of all matter.
Molecule	Two or more atoms held together by chemical bonds.	Water (H_2O), Carbon Dioxide (CO_2), Glucose ($C_6H_{12}O_6$), DNA	Can be simple or complex; essential for biological processes.
Macromolecule	Large molecules, often polymers, essential for life.	Proteins, Carbohydrates, Lipids, Nucleic Acids	Formed by the joining of smaller subunits (monomers).
Organelle	Specialized structures within a cell that perform specific functions.	Mitochondria (energy production), Chloroplasts (photosynthesis), Nucleus (controls cell)	Membrane-bound in eukaryotes.
Cell	The basic unit of life. The smallest structure capable of performing all the functions of life.	Nerve cell, Muscle cell, Epithelial cell, Bacterial cell	Can be prokaryotic (no nucleus) or eukaryotic (with nucleus).
Tissue	A group of similar cells working together to perform a specific function.	Muscle tissue, Nervous tissue, Connective tissue, Epithelial tissue	Composed of cells and extracellular matrix.
Organ	Two or more tissues working together to perform a specific function.	Heart, Lungs, Stomach, Brain, Leaf, Root	Has a specific shape and function.
Organ System	A group of organs working together to perform a major bodily function.	Digestive system, Respiratory system, Circulatory system, Root system (plants), Shoot system (plants)	Coordinated activity for a common purpose.
Organism	An individual living being, composed of one or more organ systems.	Human, Tree, Bacteria, Insect	Can be unicellular or multicellular.
Population	A group of individuals of the same species living in a particular area.	A herd of deer, a forest of pine trees	Interacting and capable of interbreeding.
Community	All the different populations of organisms living and interacting in a particular area.	A forest ecosystem with deer, trees, insects, fungi, and bacteria	Includes all living organisms in a given area.
Ecosystem	A community of living organisms interacting with each other and their physical environment (biotic and abiotic factors).	A coral reef, a desert, a rainforest	Includes both living and non-living components.
Biosphere	The sum of all ecosystems on Earth, encompassing all living organisms and their environments.	Earth	The zone of life on Earth.

All My Owls Can't Tell Old Opossums Playing Cards Except Bears.

Ecological Interactions

Interaction Type	Definition	Effects on Species Involved	Example
Competition	Two or more species (or individuals within a species) require the same limited resource (e.g., food, water, shelter, light) and negatively affect each other by trying to obtain it.	Both species are negatively affected (-/-)	Two species of birds competing for the same type of insect prey.
Predation	One species (the predator) kills and consumes another species (the prey).	Predator benefits (+), prey is harmed (-)	A lion hunting and eating a zebra.
Symbiosis	A close and long-term interaction between two different species.	Varies depending on the type of symbiosis.	
Mutualism (Symbiosis Subcategory)	Both species benefit from the interaction.	Both species benefit (+/+)	A bee pollinating a flower (both get food).
Commensalism (Symbiosis Subcategory)	One species benefits, and the other is neither harmed nor helped.	One species benefits (+), the other is neutral (0)	A bird nesting in a tree (bird gets shelter, tree is unaffected).
Parasitism (Symbiosis Subcategory)	One species benefits (the parasite), and the other is harmed (the host).	Parasite benefits (+), host is harmed (-)	A tick feeding on a dog.

Ecological Interactions

Energy flow

FIGURE IN FOCUS

Ecologists gain insights into how ecosystems function by examining energy flow and the energy content of each trophic level.

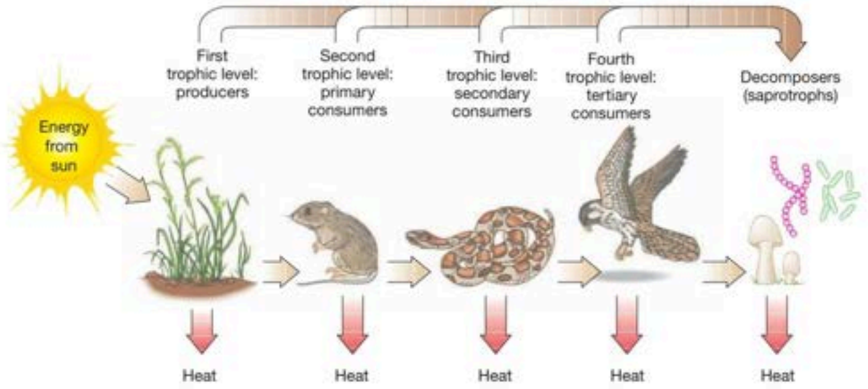


FIGURE 26-15 Trophic levels in a food chain.
Energy from an external source (the sun) enters a food chain and exits as heat loss. Most of the energy acquired by a given trophic level is used for metabolic purposes (and released as heat) and is therefore unavailable to the next trophic level.

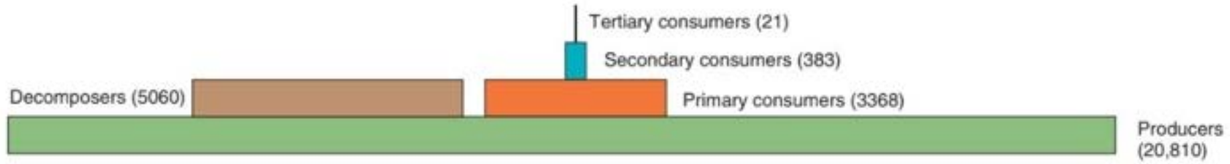


FIGURE 26-17 A pyramid of energy.
Energy values for this pyramid of energy for Silver Springs, Florida, are given in kilocalories per square meter per year. Representative organisms include tape grass (producers), snails (primary consumers), young river turtles (secondary consumers), gar fish (tertiary consumers), and bacteria and fungi (decomposers). Note the substantial loss of usable energy from one trophic level to the next. (Based on H. T. Odum, "Trophic Structure and Productivity of Silver Springs, Florida," *Ecological Monographs*, Vol. 27, 1957.)

FIGURE IN FOCUS

Food webs in all but the simplest ecosystems are too complex to depict all the species and links actually present. Rarely do food-web diagrams take into account that some links are strong and others are weak. Moreover, food webs change over time, with additions and deletions of links.

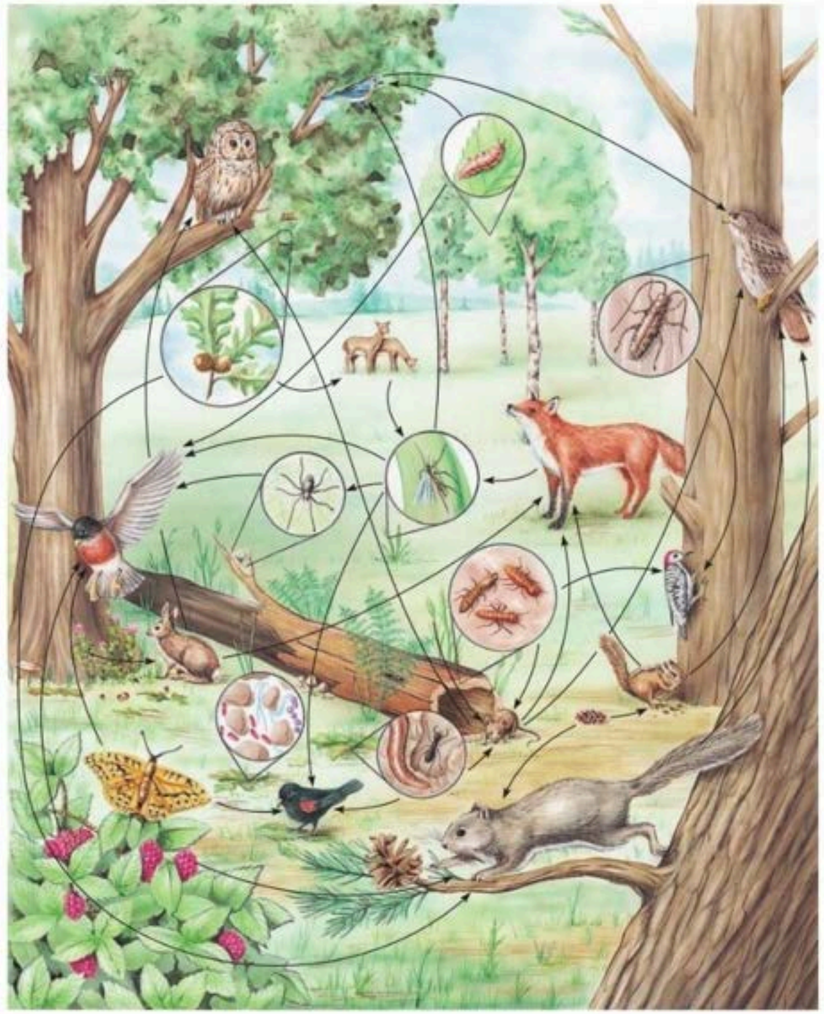


FIGURE 26-16 A food web at the edge of a deciduous forest.
This food web is greatly simplified compared to what actually happens in nature.

Ecology

Growth Curves - graphical representation of how the size of a population changes over time.

Exponential Growth:

- occurs when resources are unlimited
- population grows at an increasingly rapid rate
- represented by a J-shaped curve

Logistic Growth:

- occurs when resources are limite
- population growth rate slows as it approaches the carrying capacity
- represented by an S-shaped curve

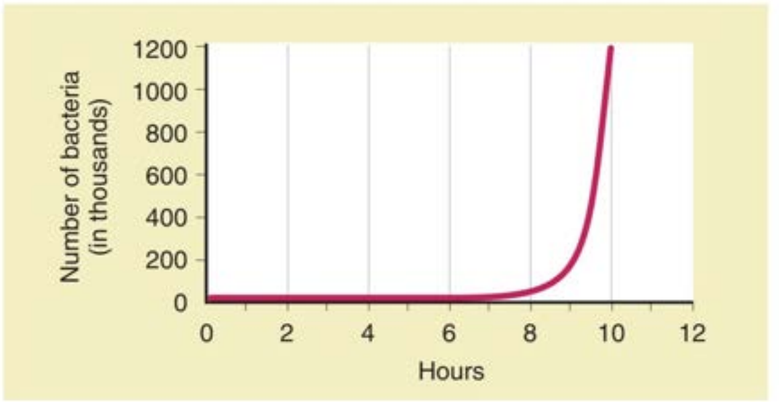


FIGURE 26-3 Exponential population growth.
When bacteria divide every 20 minutes, their numbers increase exponentially. The curve of exponential growth has a characteristic J shape. The ideal conditions under which bacteria or other organisms reproduce exponentially rarely occur in nature, and when these conditions do occur, they are of short duration.

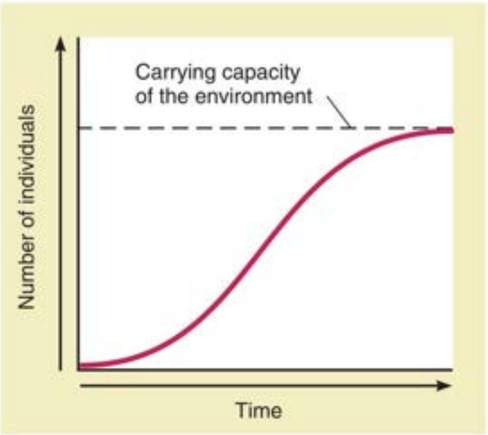


FIGURE 26-4 Carrying capacity and logistic population growth.
In many laboratory studies, exponential population growth slows as the carrying capacity of the environment is approached. The logistic model of population growth, when graphed, has a characteristic S-shaped curve.

Ecology

Carrying Capacity

- The maximum population size that an environment can sustainably support, given the available resources (food, water, shelter, etc.).
- Represents the point at which limiting factors start to significantly impact population growth.

Limiting Factors

- Environmental factors that restrict population growth, preventing it from reaching its biotic potential (the maximum reproductive capacity under ideal conditions).

Density-dependent factors: Influence population growth based on the population density (e.g., competition, predation, disease).

Density-independent factors: Affect population growth regardless of density (e.g., natural disasters, weather events).

Conservation Biology

Biodiversity: variety of life on Earth

Threats to Biodiversity

- Habitat loss and degradation (deforestation, urbanization)
- Overexploitation (overfishing, hunting)
- Pollution (air, water, soil)
- Climate change
- Invasive species

Conservation Strategies

- Habitat restoration
- Species management
- Community-based conservation
- Policy and legislation

Sustainability

- **Intergenerational Equity:** Meeting the needs of the present without compromising the ability of future generations to meet their own needs.
- **Triple Bottom Line:** Balancing environmental, social, and economic considerations to achieve long-term sustainability.
- **Resource Management:** Using resources responsibly and efficiently to minimize environmental impact and ensure their availability for the future.
- **Ecological Footprint:** Measuring human demand on nature, i.e., the quantity of nature it takes to support people or an economy. It tracks this demand through an ecological accounting system. This accounting contrasts with most conventional accounting, which measures only one source of demand, money.
- **Sustainable Development:** Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.
- **Circular Economy**: Shifting from a linear "take-make-dispose" model to a circular model that emphasizes reducing waste, reusing materials, and recycling.
- **Renewable Energy:** Transitioning to renewable energy sources (solar, wind, hydro) to reduce reliance on fossil fuels and mitigate climate change.
- **Sustainable Agriculture:** Practices that produce food in an environmentally and socially responsible manner, conserving resources and minimizing negative impacts.
- **Education and Awareness:** Raising public awareness about environmental issues and promoting sustainable behaviors.

Short Quiz

Short Quiz

Identification

1. ongoing process by which populations of organisms change over time
2. individuals with advantageous heritable traits (adaptations) are more likely to survive and reproduce
3. maximum population size that an environment can sustainably support
4. variety of life on Earth
5. practices that produce food in an environmentally and socially responsible manner

Short Quiz

Answers

1. **evolution**
2. **Natural Selection**
3. **carrying capacity**
4. **biodiversity**
5. **sustainable agriculture**

"'Di mo malalaman kung 'di mo malalasahan - sarap maging iskolar ng bayan."

-Tonii fowleris-

Thank you!

Padayon, future iskolar ng agham at teknolohiya!