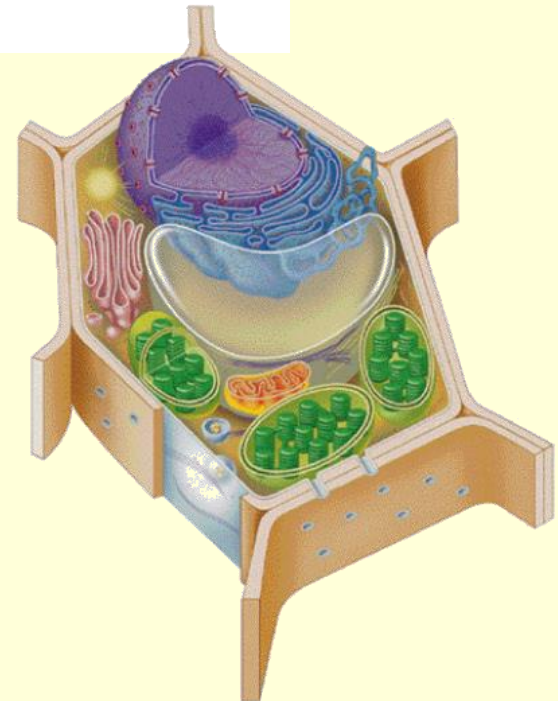
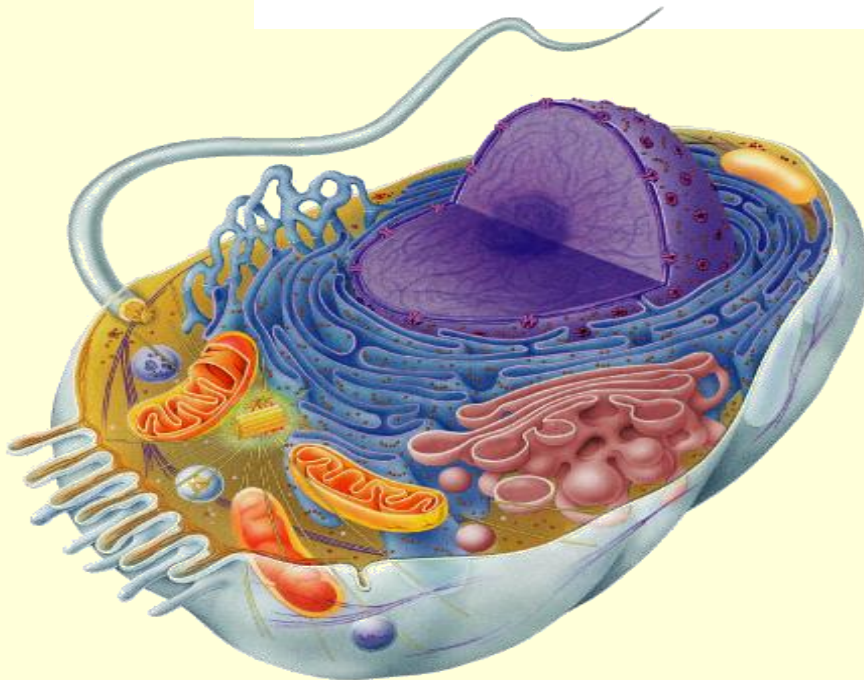


# Living Environment Review

The University of the State of New York  
REGENTS HIGH SCHOOL EXAMINATION

## LIVING ENVIRONMENT



# Regents Exam Format

A: 30 Multiple Choice

B-1: Multiple Choice

B-2: MC and Short constructed response  
Reading passages, graphing, lab skills

C: Constructed Responses

D: Labs and Lab Skills

Making Connections

Beaks of the Finches

Relationships and Biodiversity

Diffusion Through a Membrane

Part	Maximum Score	Student's Score
<b>A</b>	<b>30</b>	
<b>B-1</b>	<b>12</b>	
<b>B-2</b>	<b>13</b>	
<b>C</b>	<b>17</b>	
<b>D</b>	<b>13</b>	
<b>Total Raw Score</b> (maximum Raw Score: 85)		<input type="text"/>
<b>Final Score</b> (from conversion chart)		<input type="text"/>
<b>Raters' Initials</b>		
Rater 1 . . . . . Rater 2 . . . . .		

# Living Environment Core Content and Material

## STANDARD 4

Students will understand and apply scientific concepts, principles, and theories pertaining to the physical setting and living environment and recognize the historical development of ideas in science.

### Unit 1 Web of Life: Interactions and Interdependence

**Ecology:** The branch of biology that deals with the interactions between organisms and the relationship between organisms and the environment.



# Ecology is the study of the interactions of organisms and the environment

Ecology can be studied at different levels:

**Organism:** an individual of life by means of organs separate in function but mutually dependent : a living being

**Populations:** all the individuals of a single species that live in a specific area

**Communities:** a combination of all the different populations that live and interact in the same environment

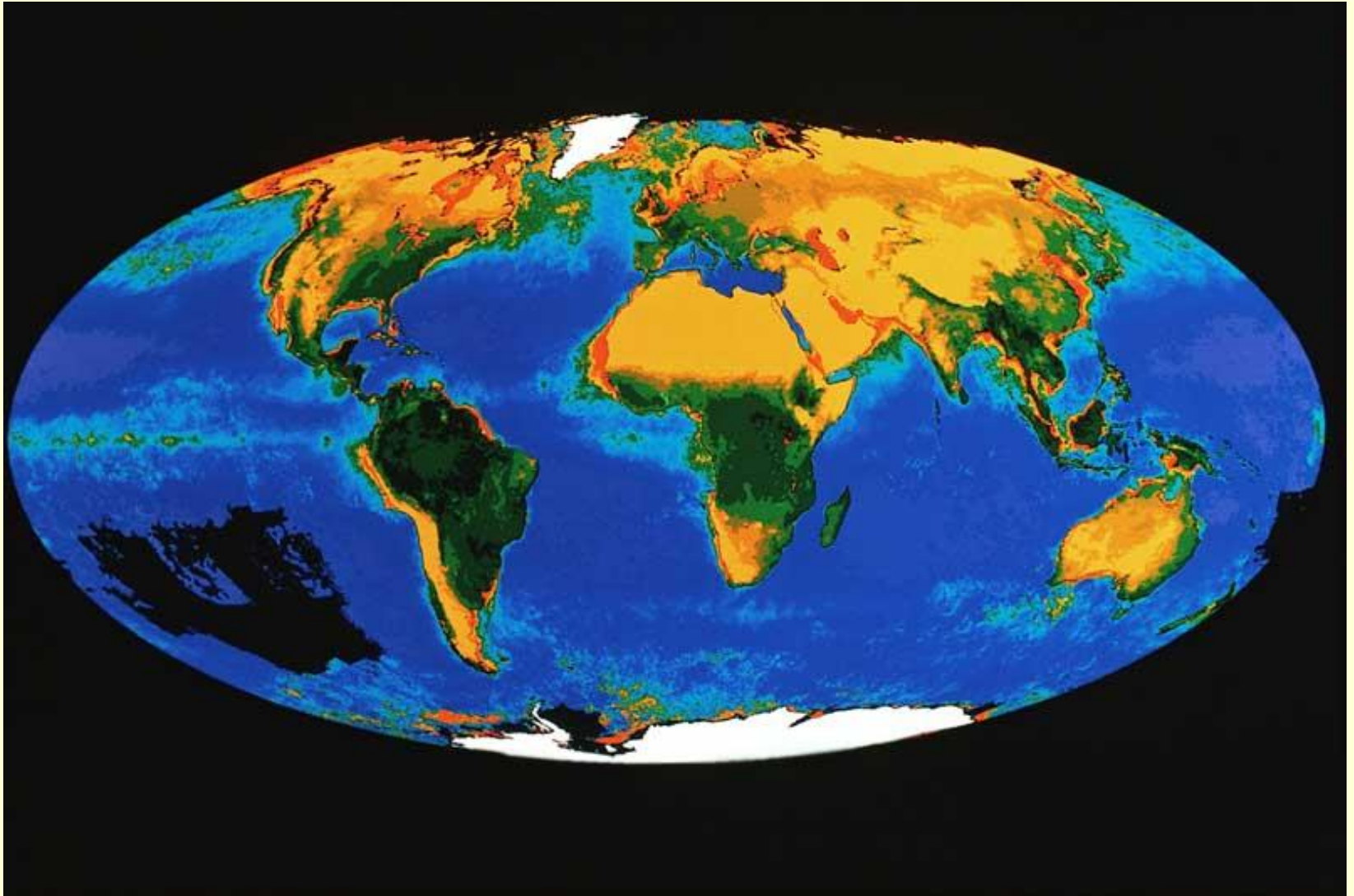
**Ecosystems:** all the living and nonliving things that interact in a specific area; a subdivision of the environment

**Biosphere:** all of Earth's ecosystems, collectively; the biologically inhabited portions of Earth, including all of the water, land, and air in which organisms survive





# Factors Affect the Distribution of Organisms



**The Biosphere**

**Abiotic Factors** are the non-living, physical conditions that define the characteristics of the region.

**Climate**

**Temperature**

**Water**

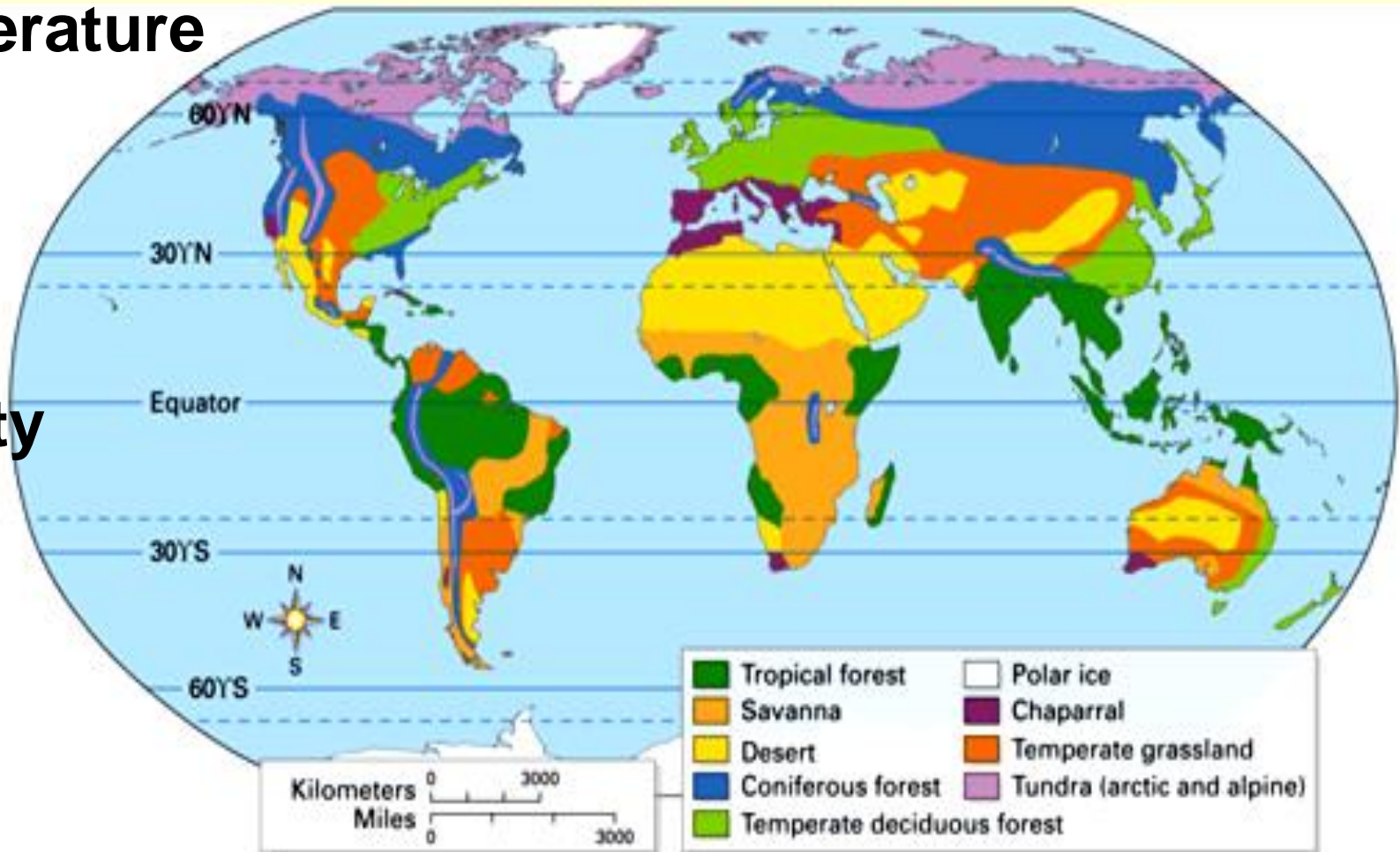
**Light**

**Wind**

**Soil**

**Salinity**

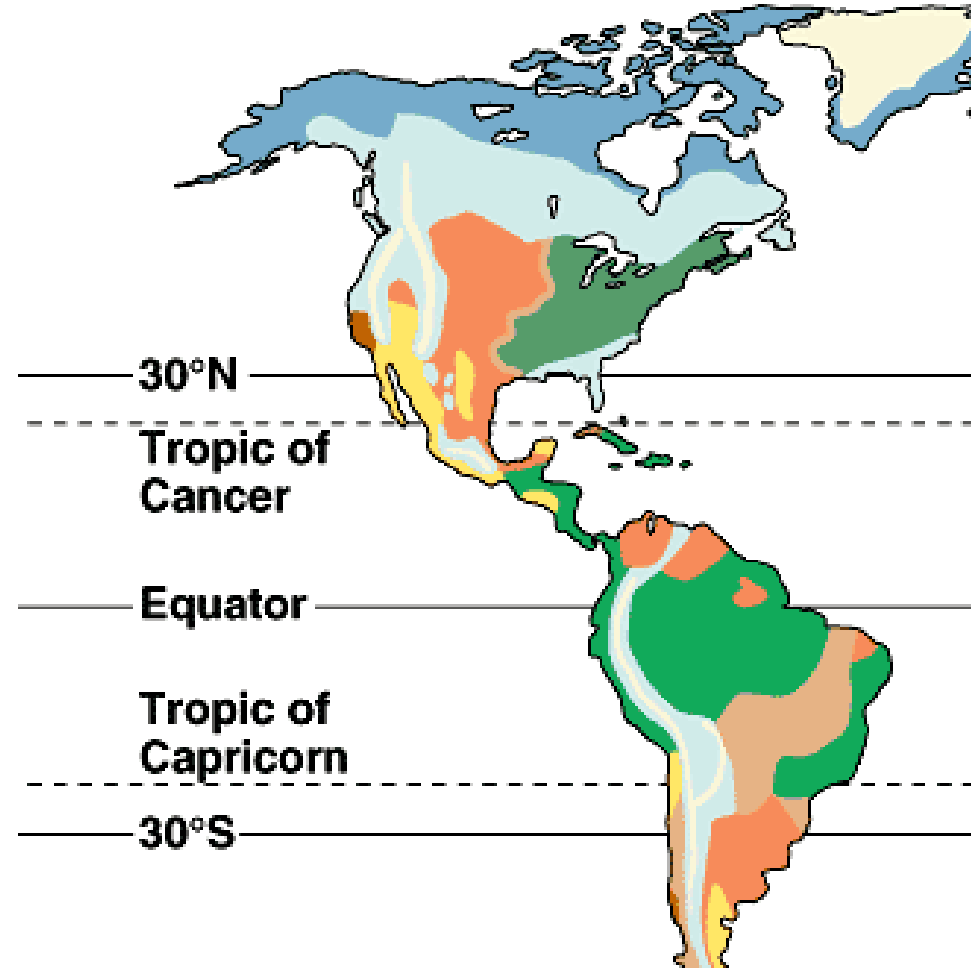
**pH**












# Abiotic Factors can be Limiting Factors:

Determines the types of organisms which may exist in that environment.

The amount of rain fall and temperature range determines the types of plant communities



- |   |   |  |
|---|---|--|
|  Tropical forest |  Polar and high-mountain ice |  Temperate deciduous forest |
|  Savanna         |  Chaparral                   |  Coniferous forest          |
|  Desert          |  Temperate grassland         |  Tundra (arctic and alpine) |

**Biotic Factors** involve interactions among living things.

**Nutritional Interactions**

**Predator/Prey**

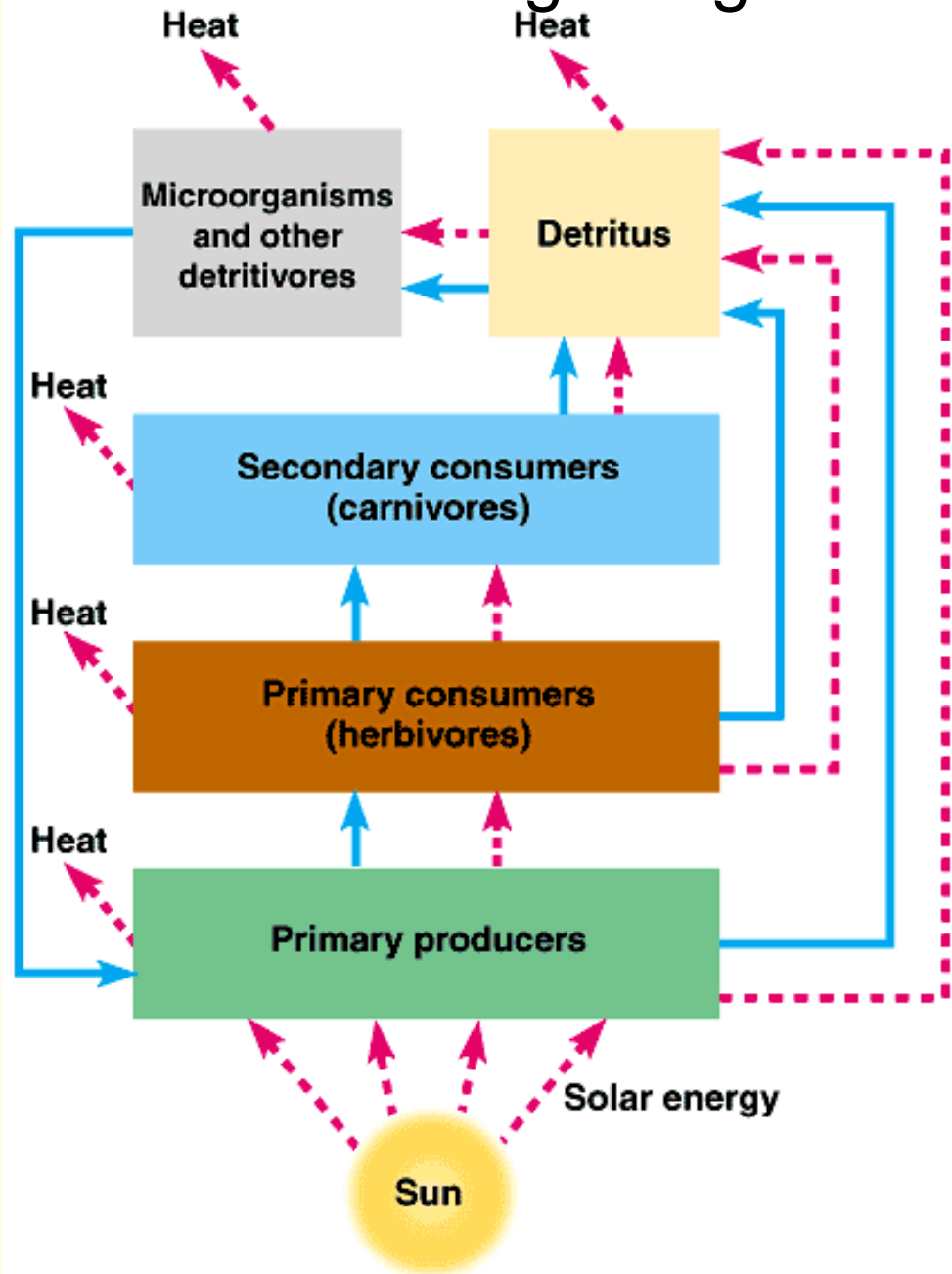
**Parasite/Host**

**Producer/Consumer**

**Decomposition**

**Competition**

**Food Webs**

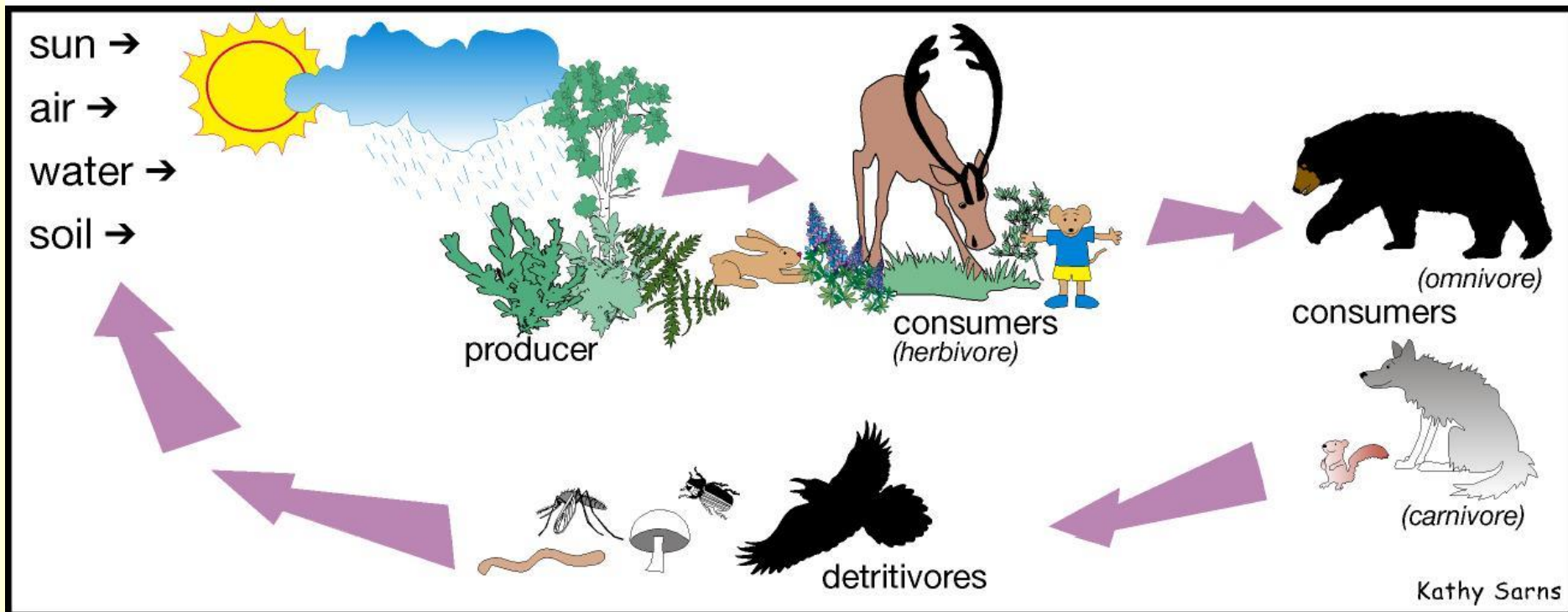




# Nutritional Interactions

Involves the transfer of nutrients from one organism to another within an ecosystem.

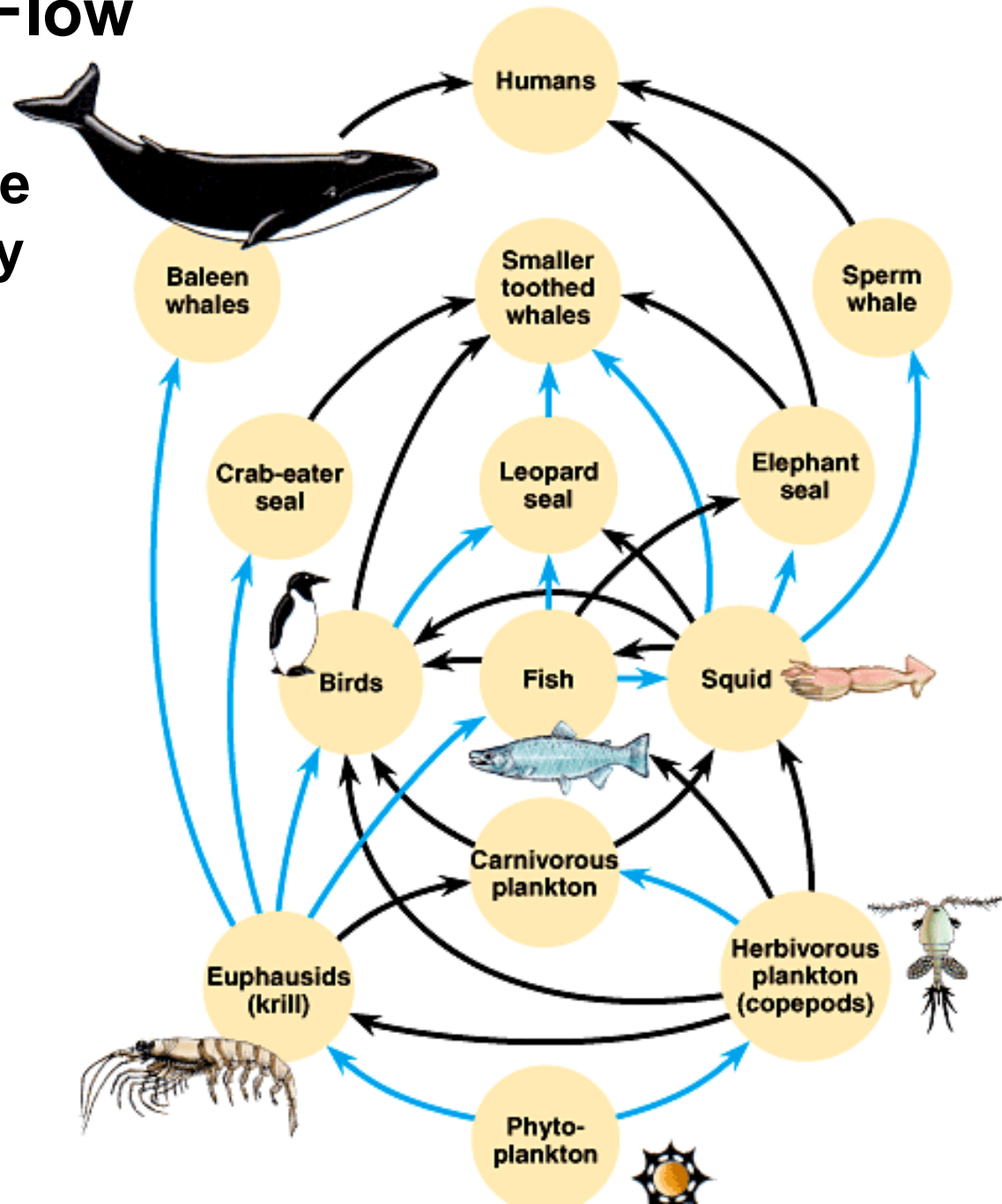
In terms of nutrition, organisms are either autotrophs or heterotrophs.



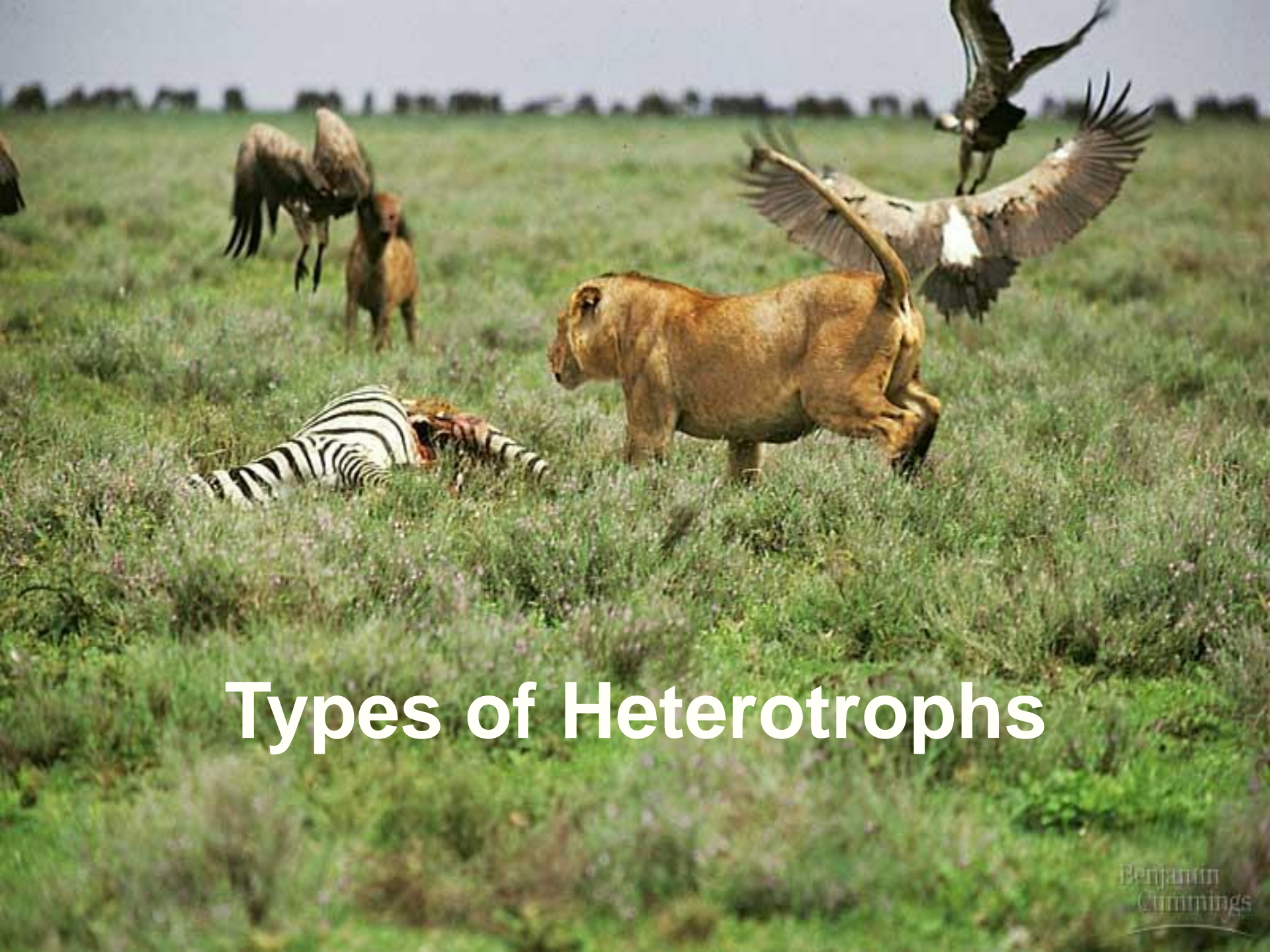
# Pathway of Energy Flow

Food Chain involves the linear transfer of energy and material through a series of organisms.

Food Web shows the interrelationship between food chains.







# Types of Heterotrophs



**Saprophytes**- fungi, and bacteria which feed on dead organisms. (also called decomposers)





# Herbivores- animals that feed on plants



**Carnivores**- animals that consume other animals.

a) **predator** – kills and consume their prey.

b) **scavenger**- feed on the remains of animals they did not kill.

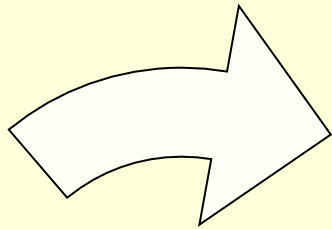




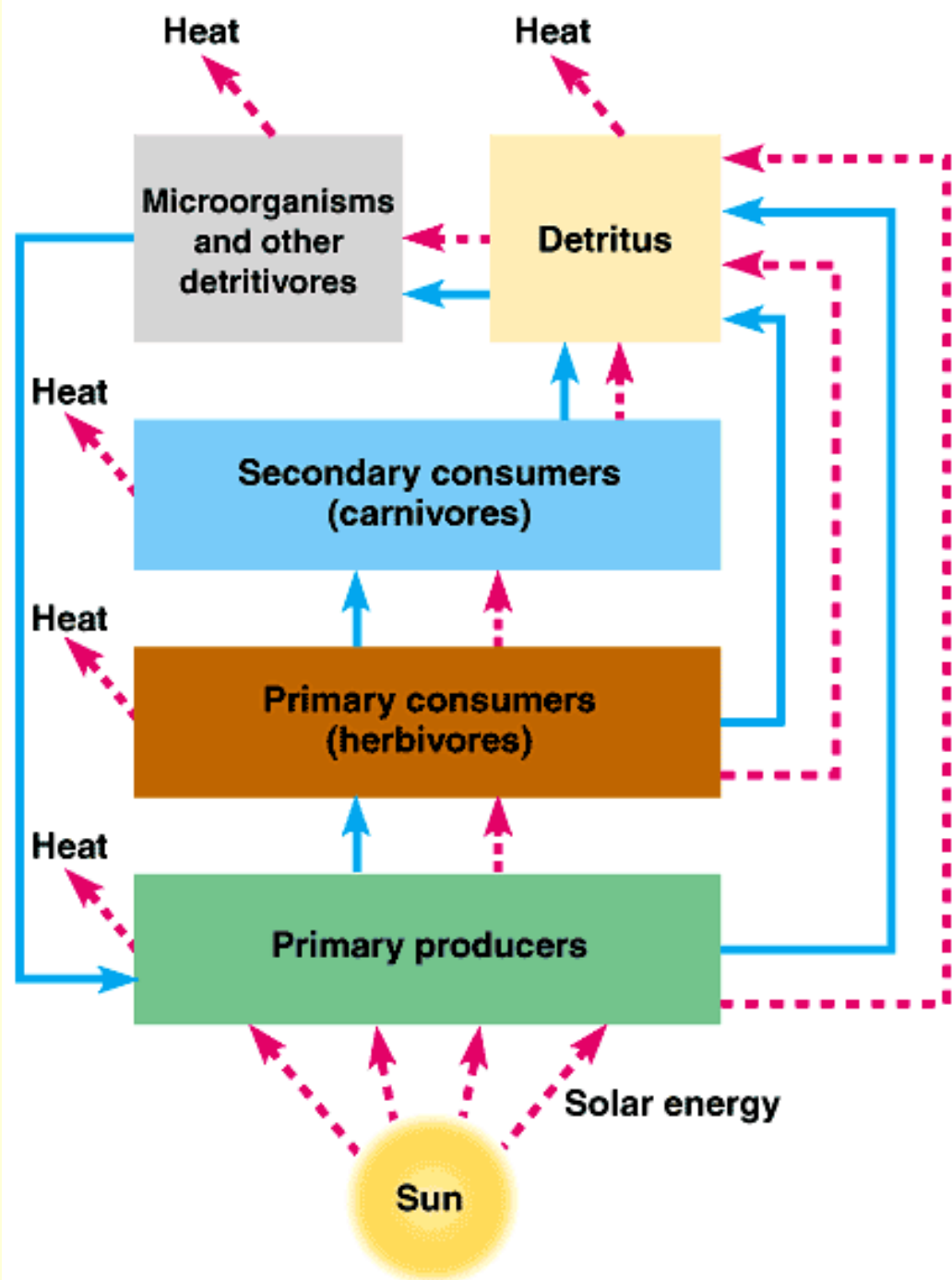
# Omnivores- animals that consume both plants & animals (humans)



**What do the arrows show?**



**The flow of energy from one organism to another.**



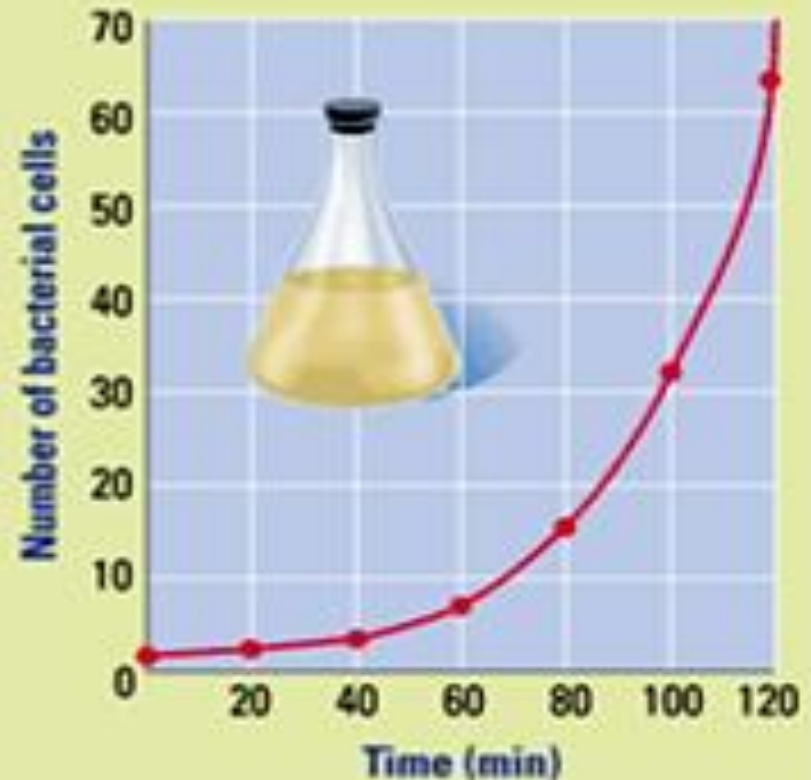


# Population Growth: Members of a species

This table shows how many bacteria are in a population that doubles every 20 minutes. The graph is another way to show the same data.

## Exponential Growth of Bacteria

Time	Number of Cells	
0 min	1	$= 2^0$
20 min	2	$= 2^1$
40 min	4	$= 2^2$
60 min	8	$= 2^3$
80 min	16	$= 2^4$
100 min	32	$= 2^5$
120 (2 hr)	64	$= 2^6$
⋮	⋮	⋮
4 hr	4,096	$= 2^{12}$
⋮	⋮	⋮
12 hr	68,719,476,736	$= 2^{36}$

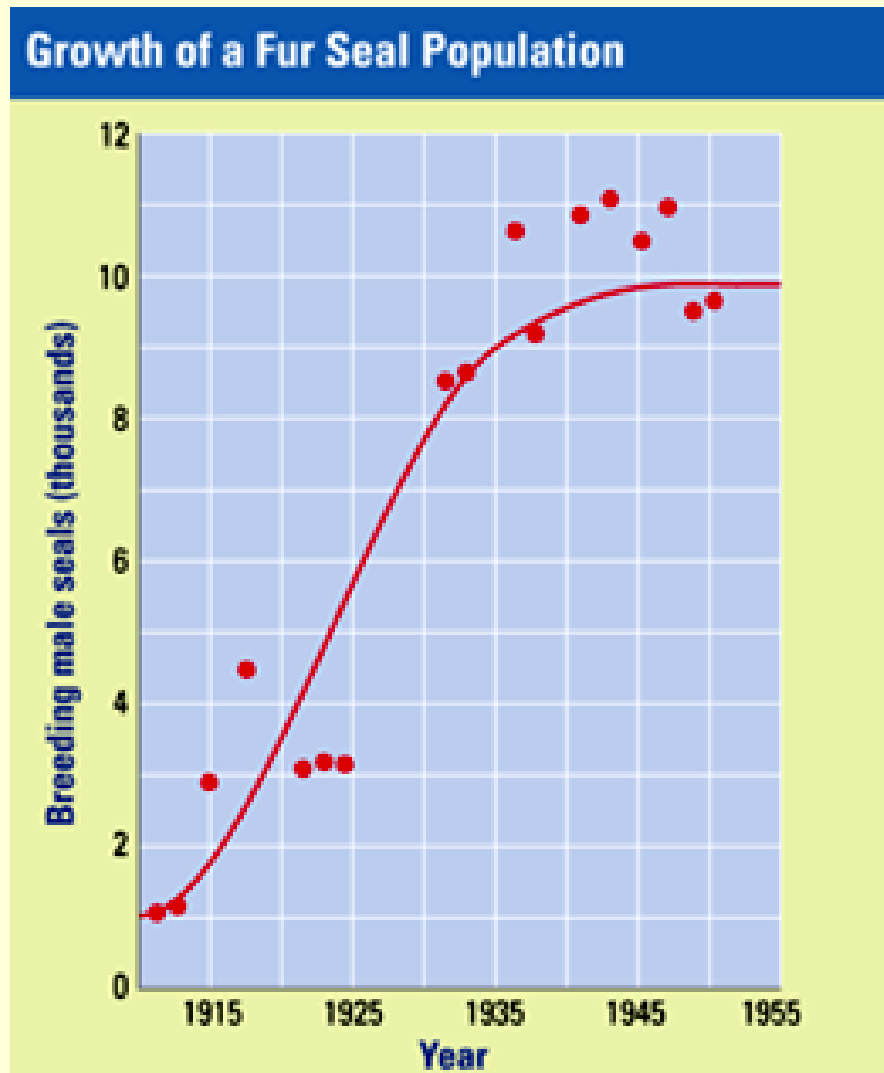


**Population Growth:** limiting factors determine the size of a population.

**Carrying Capacity:** is the maximum population size that a particular environment can support without degradation to the habitat.

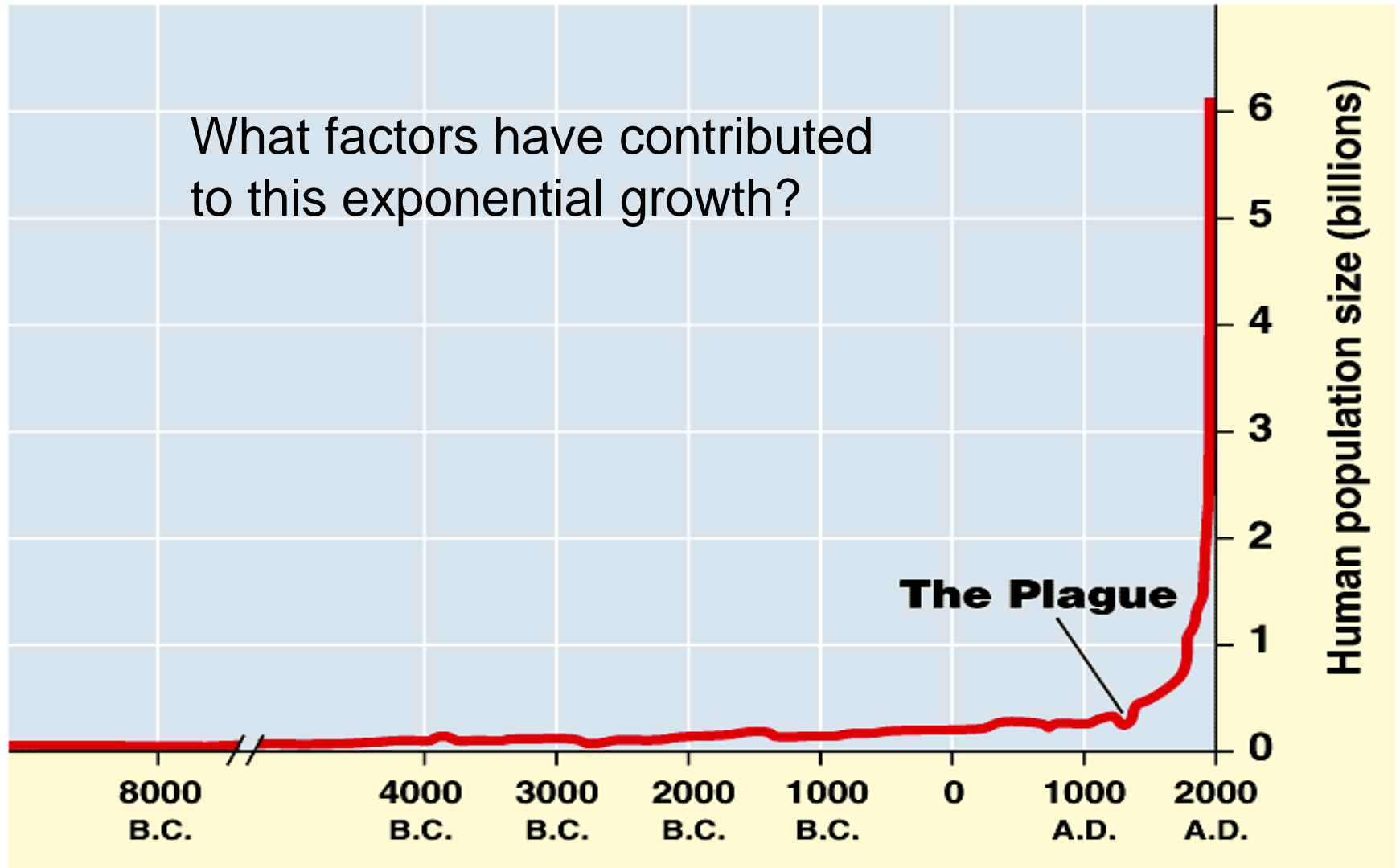
What factors contribute to determining the carrying capacity of an area?

Food, territory, water, predators, limiting resources...



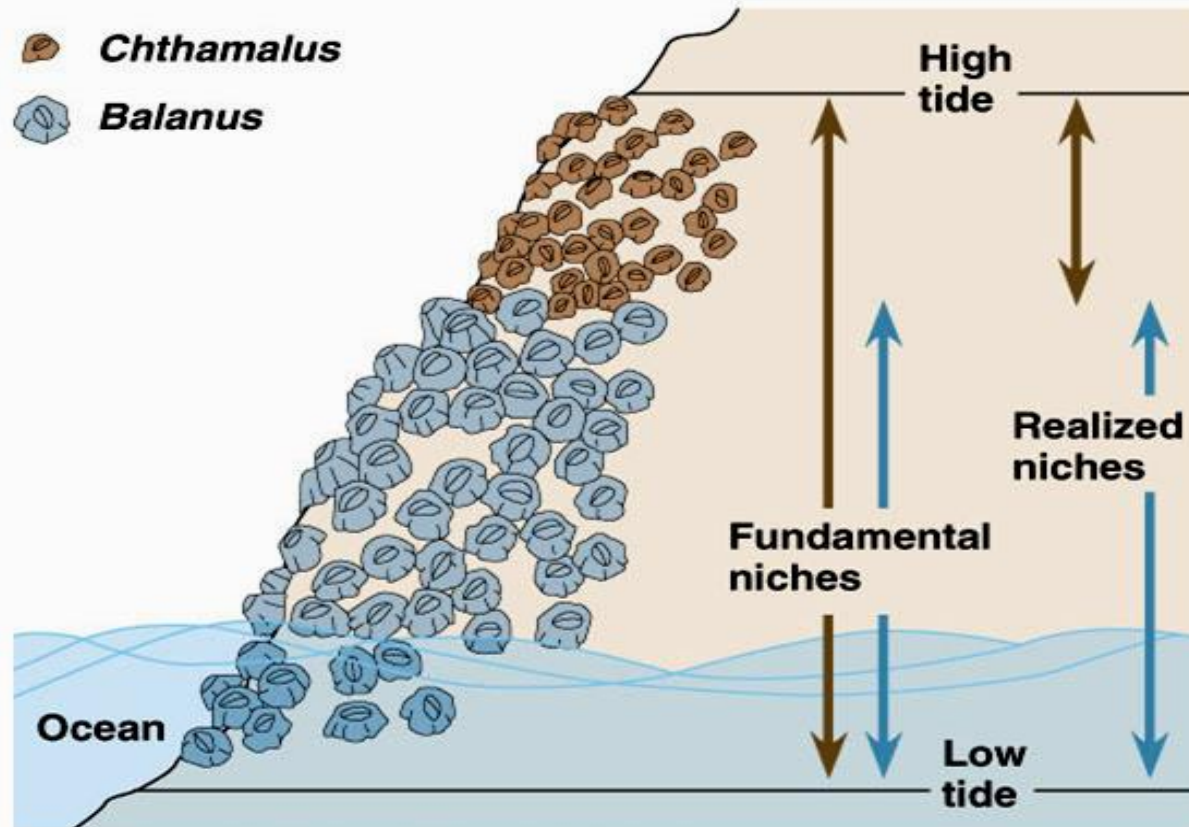
# Human Population Growth

The size of the human population is the cause of many of issues detrimental to our ecosystems.



**Ecological Niche:** sum of all activities and relationships a species has while obtaining and using the resources needed to survive and reproduce

**Ecological Habitat:** the location or environment of a species

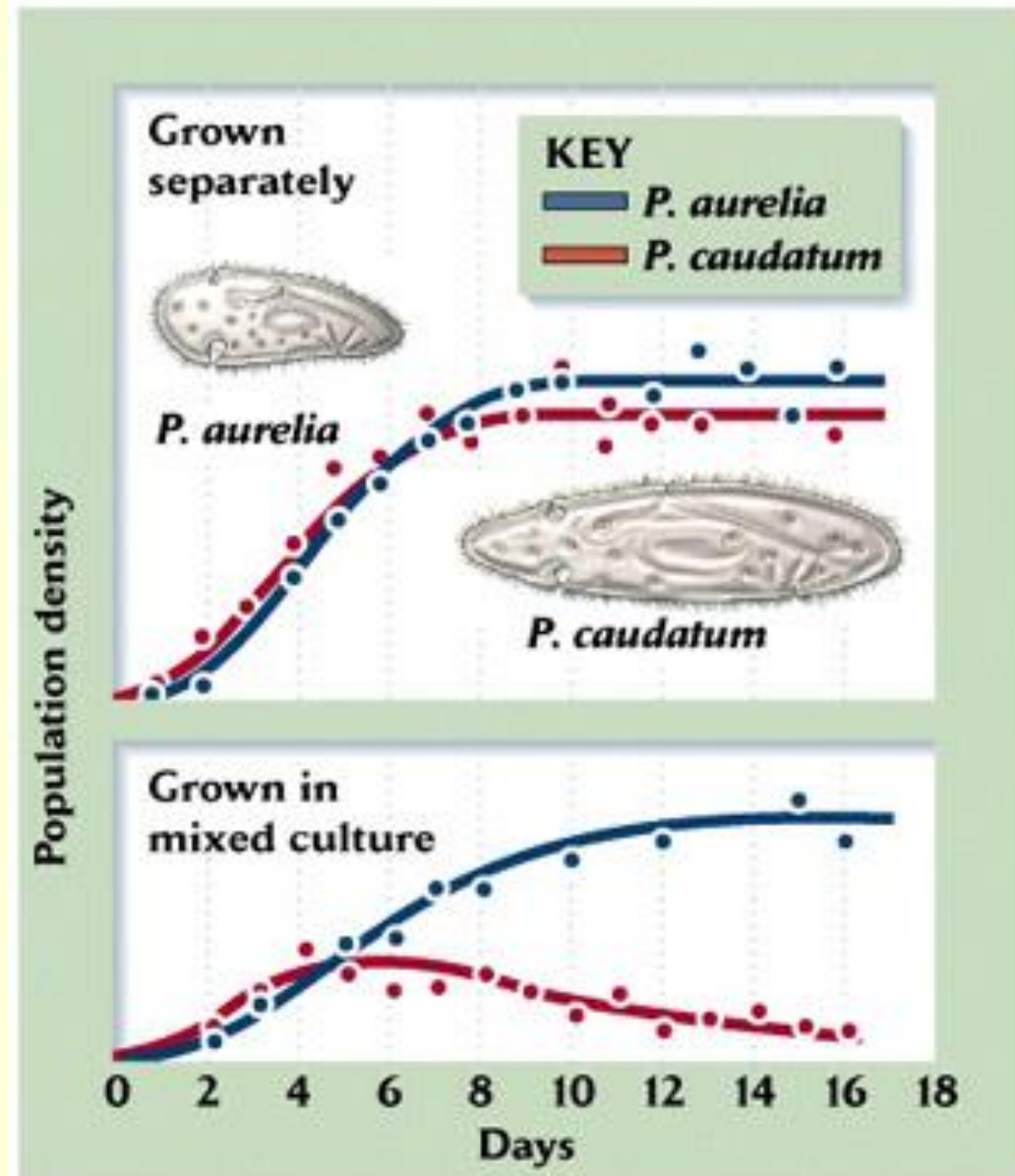




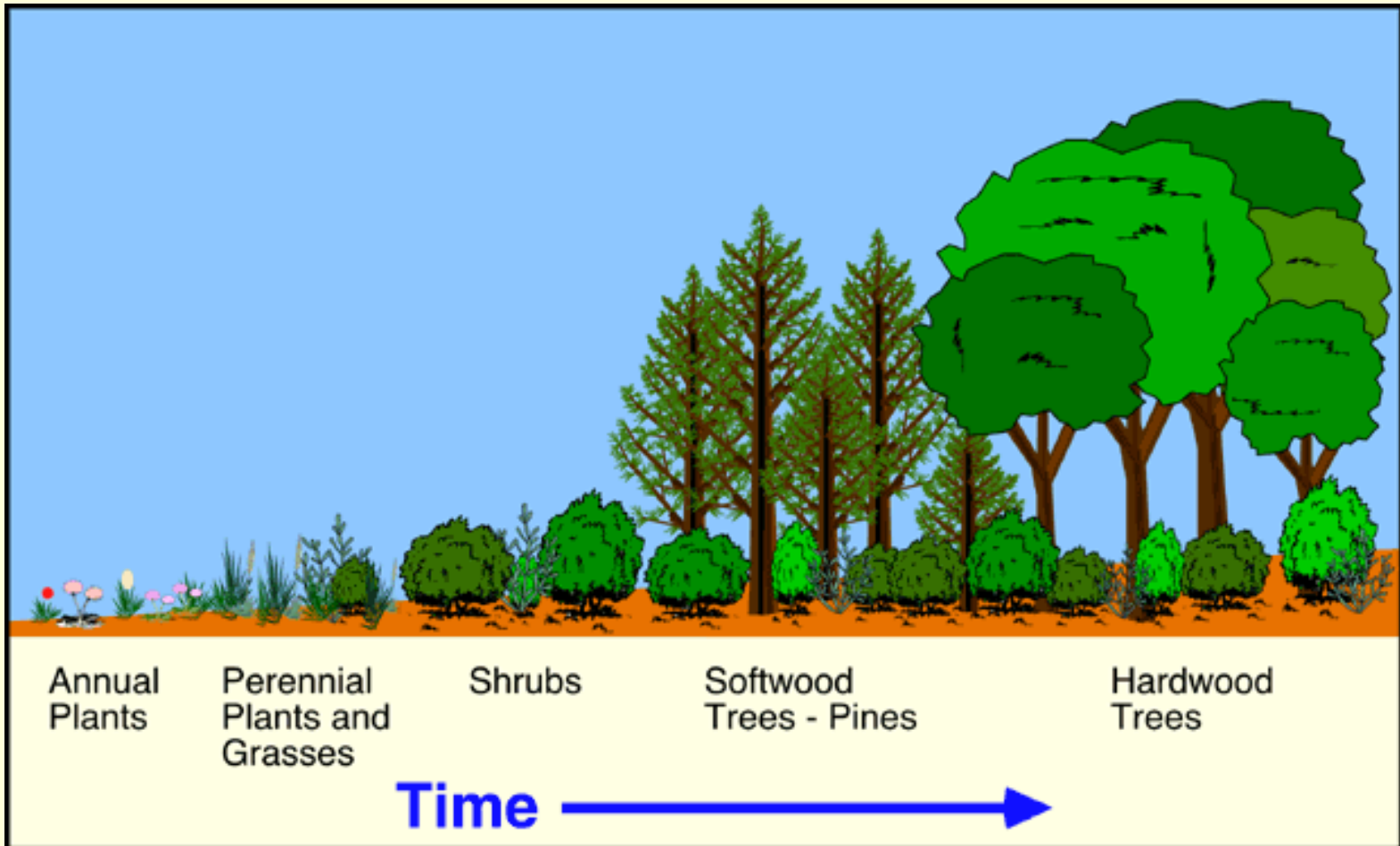
# What happens if two species occupy the same niche?

## Competition

No two similar species occupy the same niche at the same time.

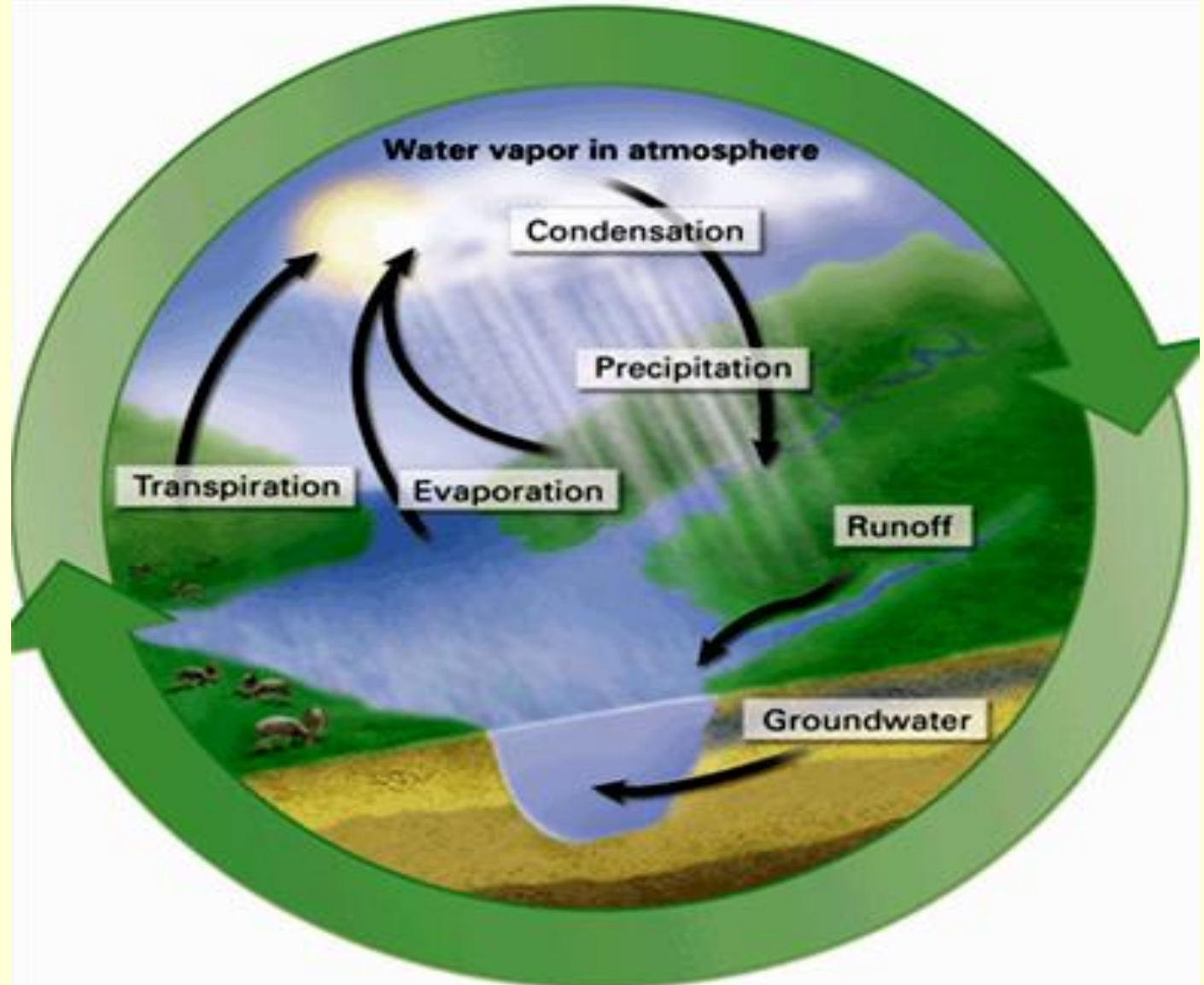


**Ecological Succession** is the sequence of changes in the composition or structure of an ecological community



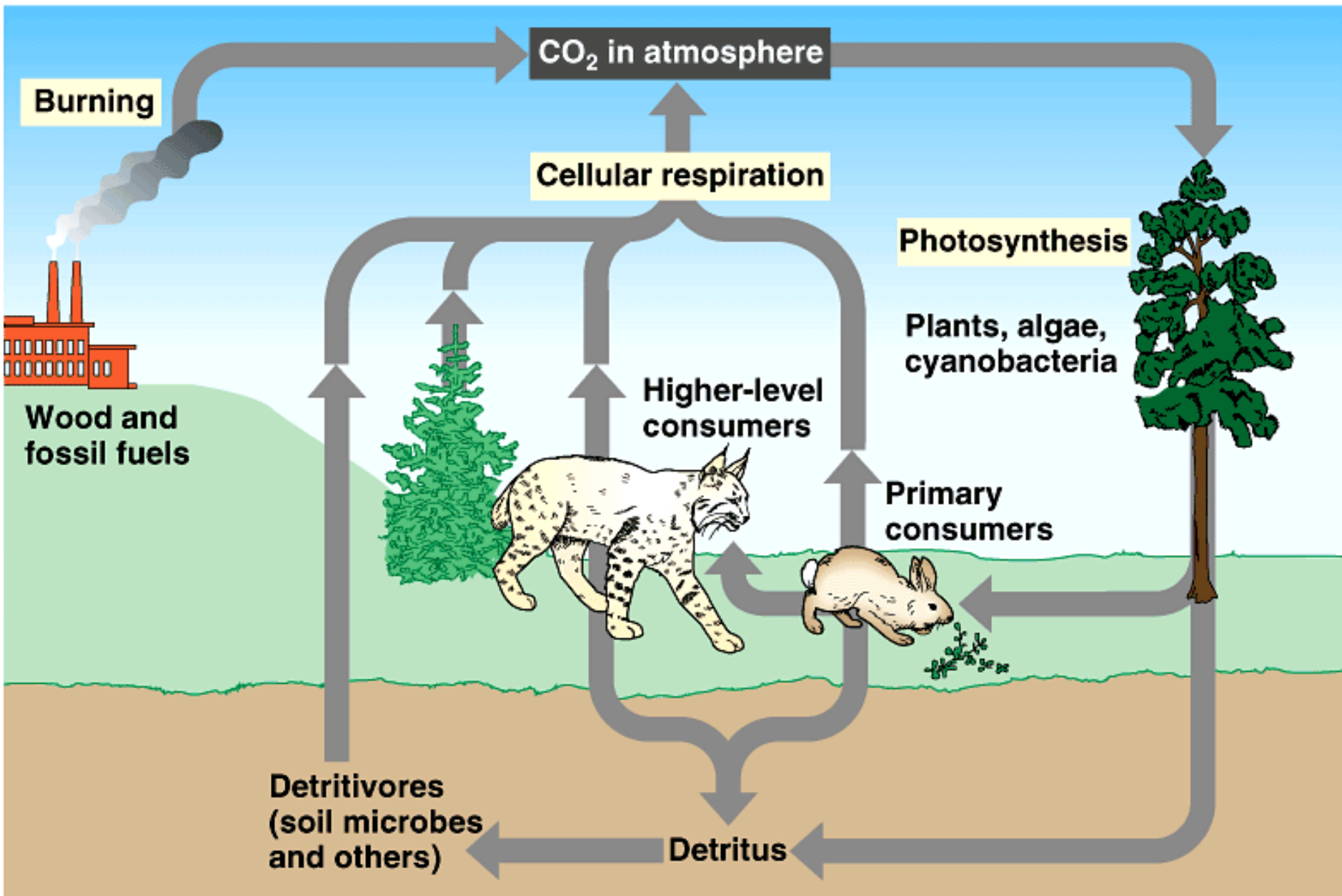
**Cycling of Chemical Elements:** pathway by which an element or molecule moves through both biotic and abiotic components of an ecosystem.

## Water Cycle

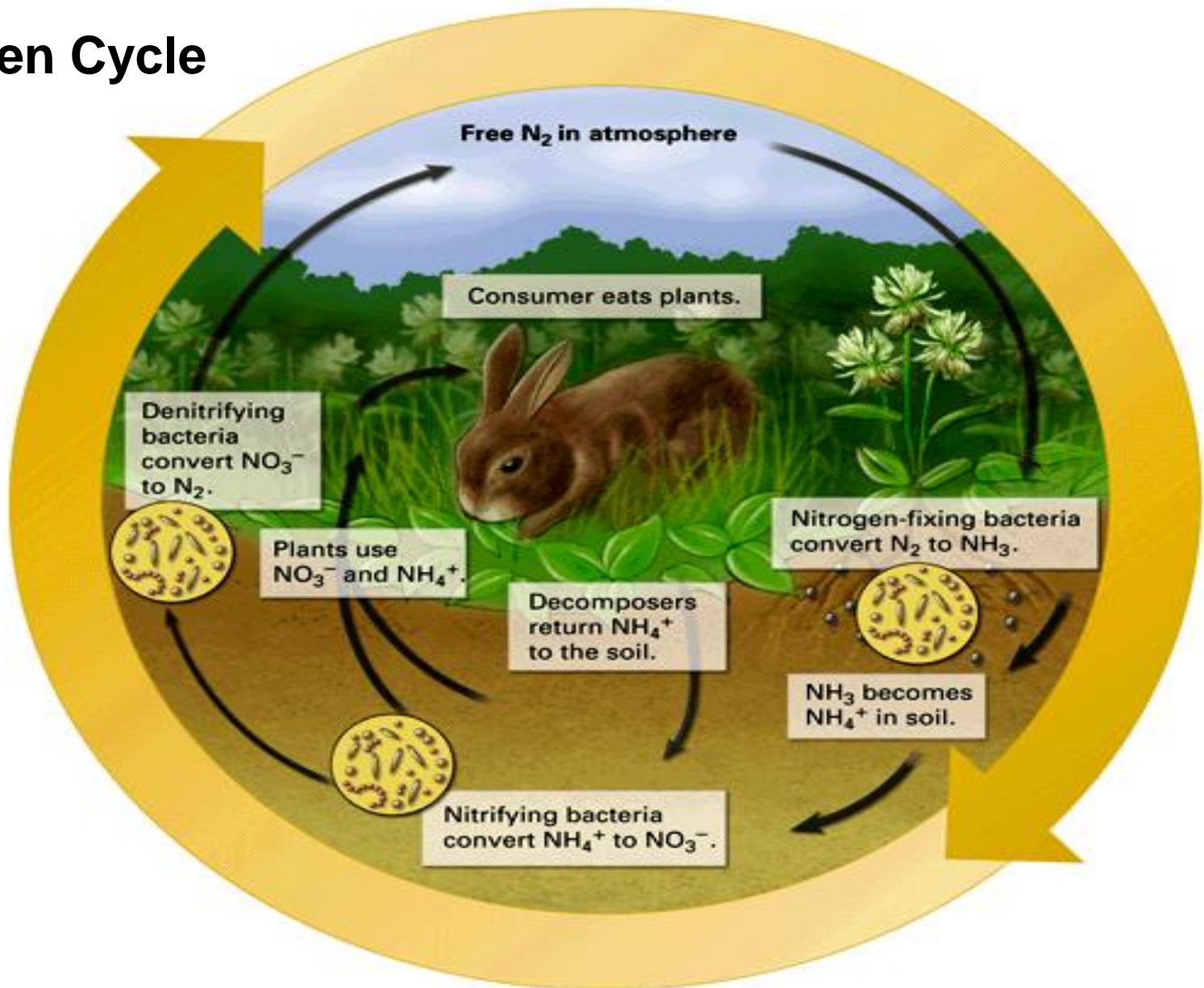




# Carbon Cycle



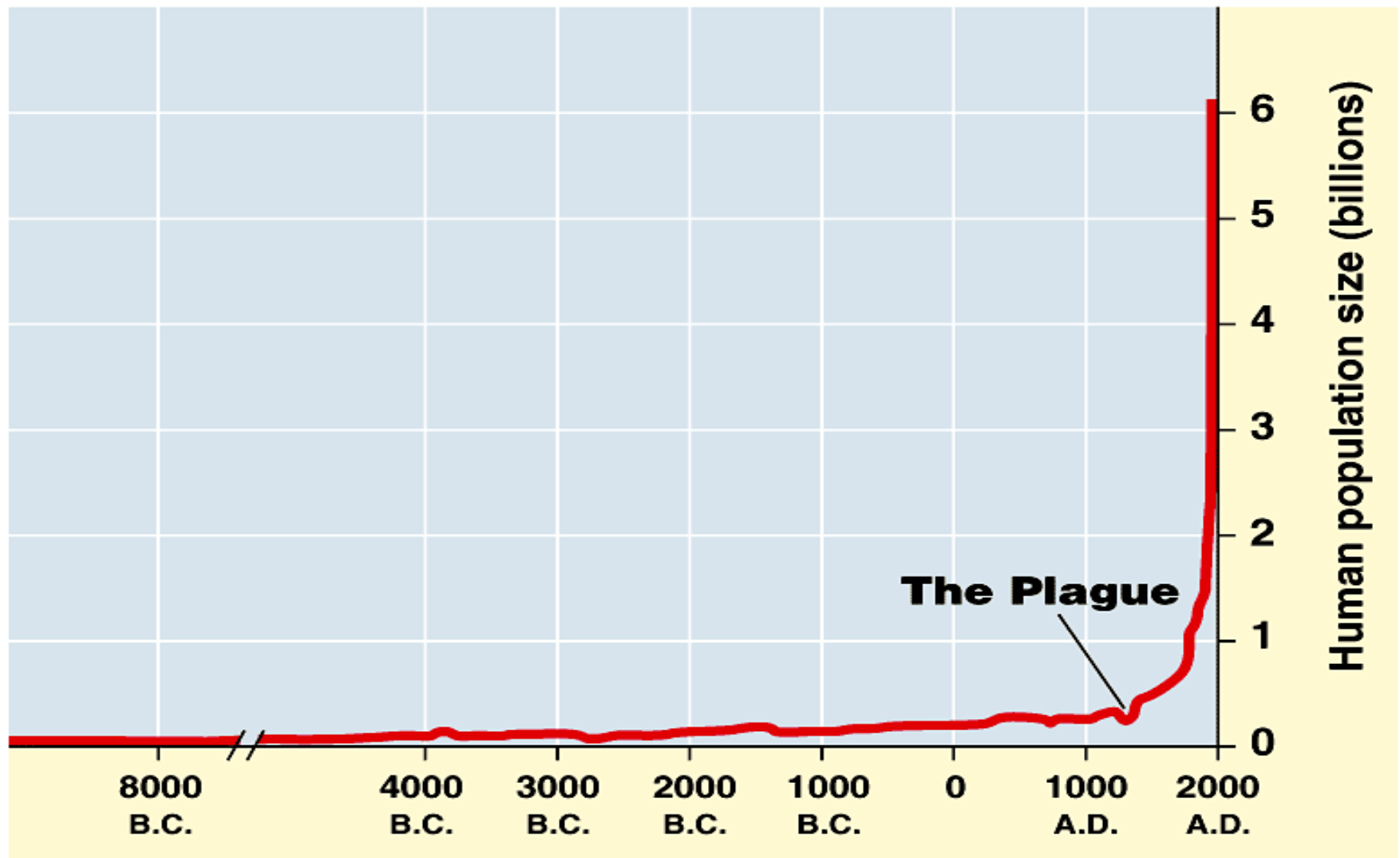
# Nitrogen Cycle



Nitrogen gas is converted by bacteria to forms that plants and animals can use to build amino acids, proteins, and nucleic acids.

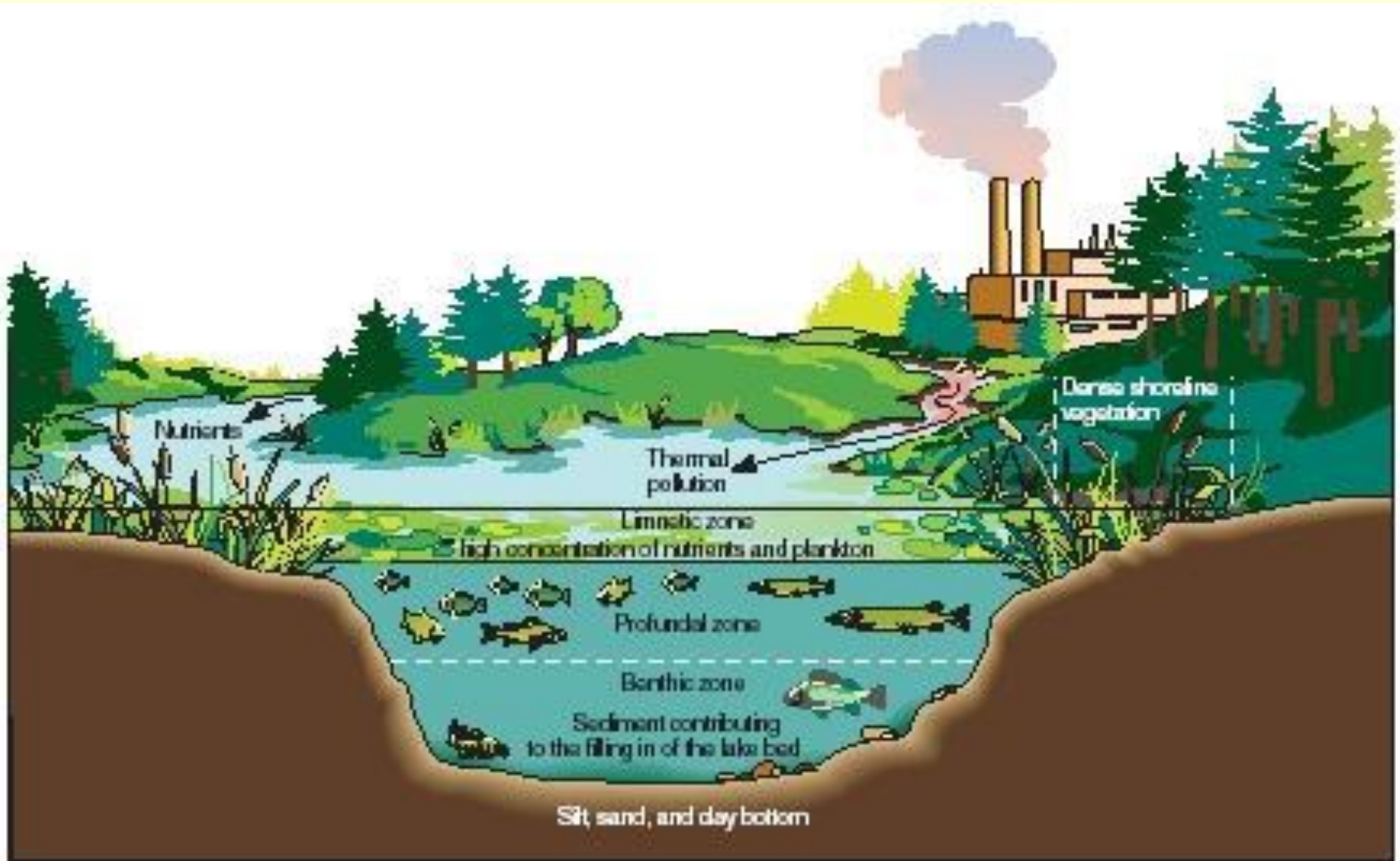
# Human Impact on Ecosystems and the Biosphere

Human population growth is the root of many environmental issues.

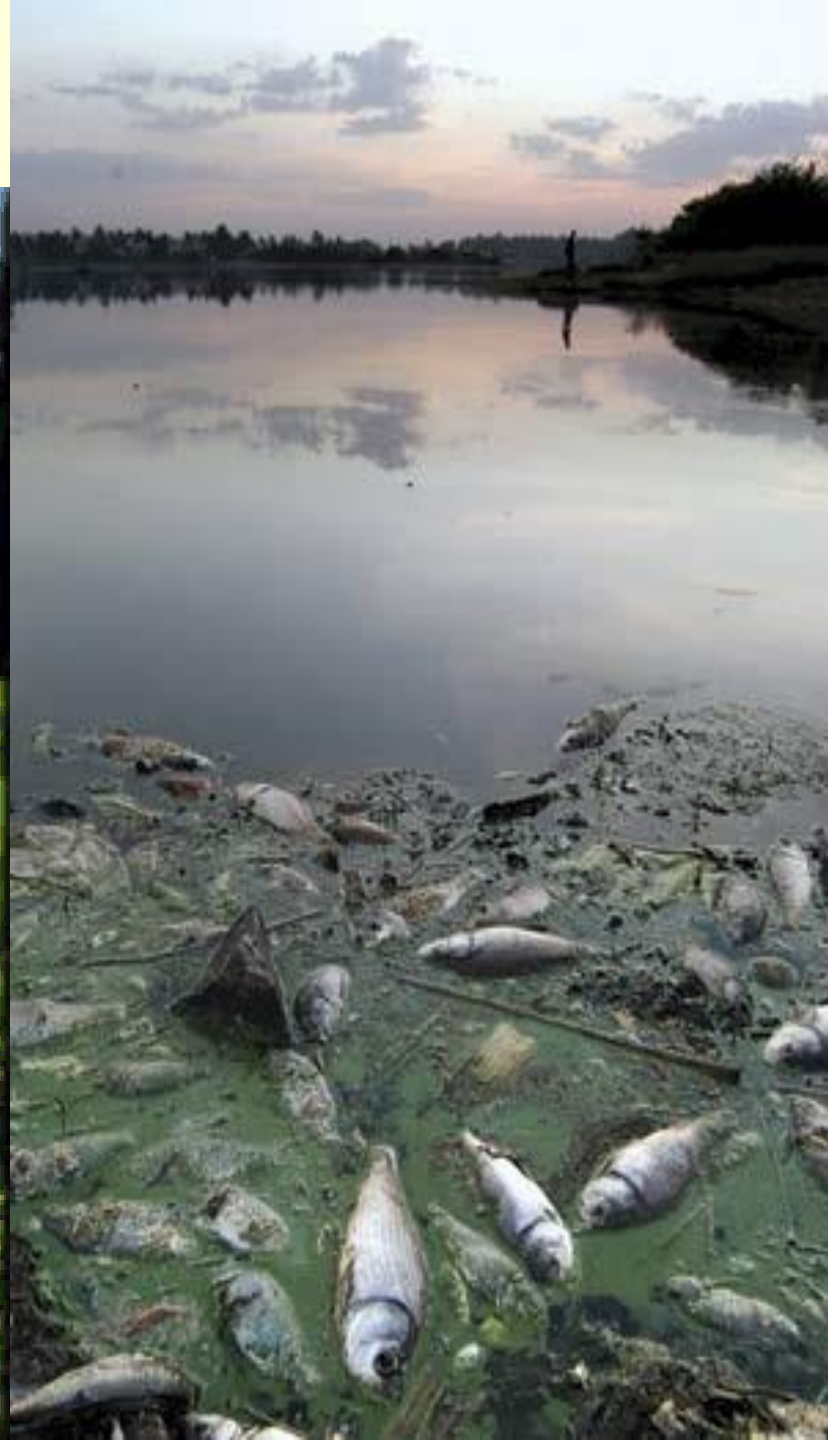




**Eutrophication** is caused by enrichment of the aquatic biomes from fertilizers and wastes. (too much of a good thing)



# Eutrophic Lake



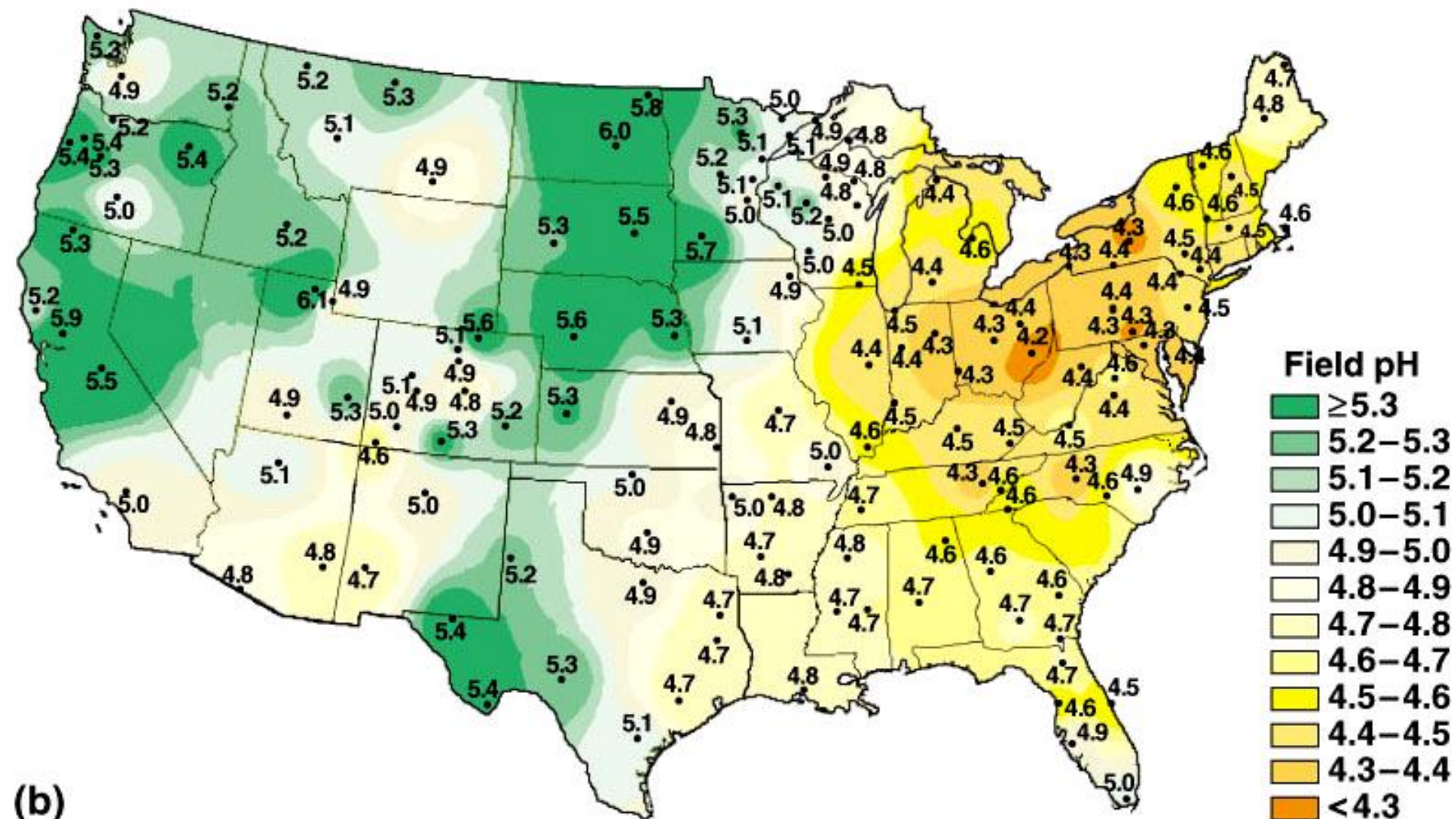
**Acid Precipitation** is caused mainly by combustion of fossil fuels.



Acid rain cause the rapid erosion of statues and destruction of lakes



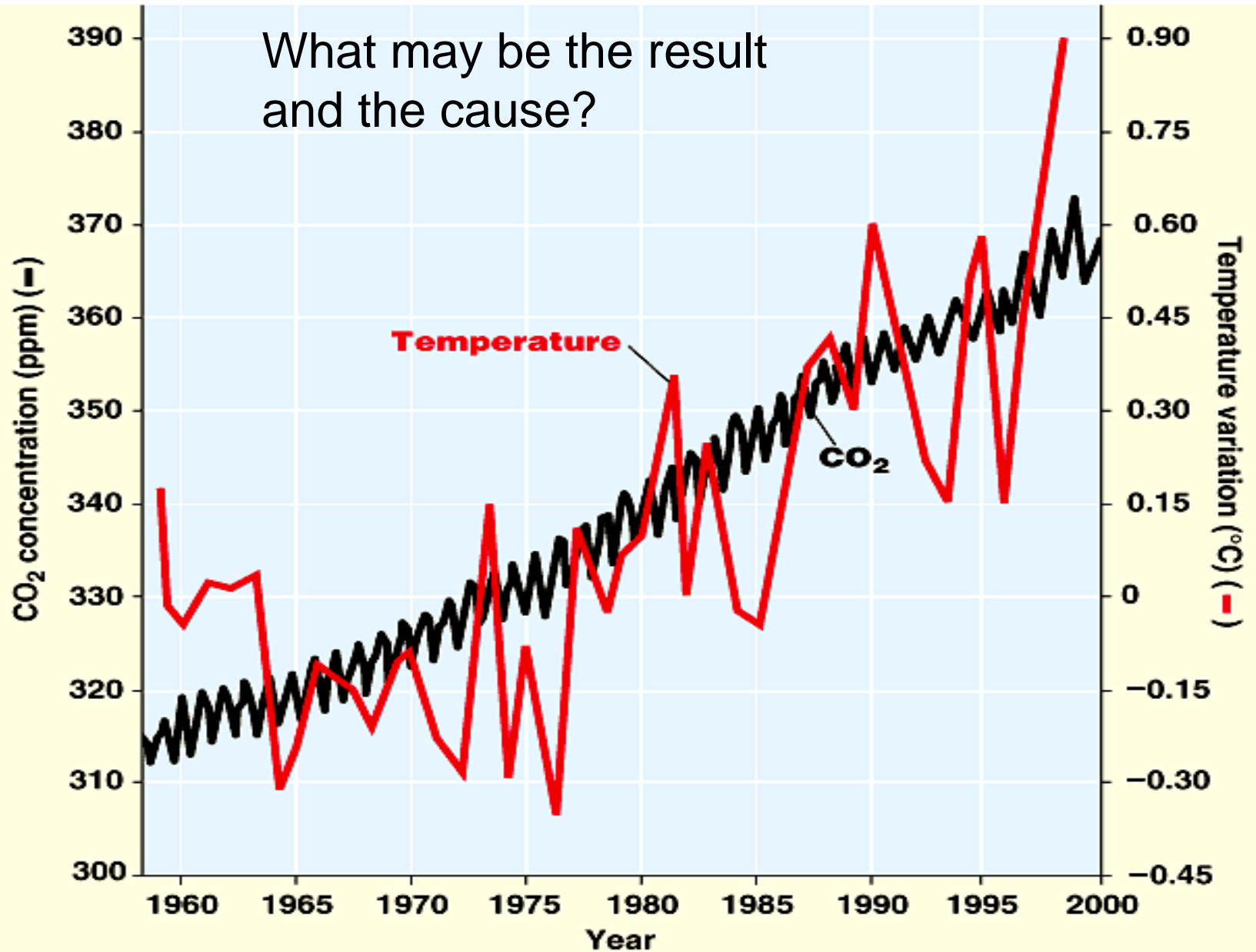
# Average pH profiles in U.S. in 1999



(b)

Why is the eastern U.S. so high in acid rain?  
Air Pollution

# Green House Effect: Climatic change caused by increasing Greenhouse Gases (carbon dioxide)





**Introduced Species:** species from another ecosystem is a problem because there usually aren't natural checks  
**May reduce Biodiversity!**

Nile perch (Lake Victoria)



Brown tree snake (Guam)



Argentine ants



Caulerpa (seaweed)





Purple Loosestrife 4013  
Raf.Ollivier

In the Northeast, purple loosestrife and gypsy moths





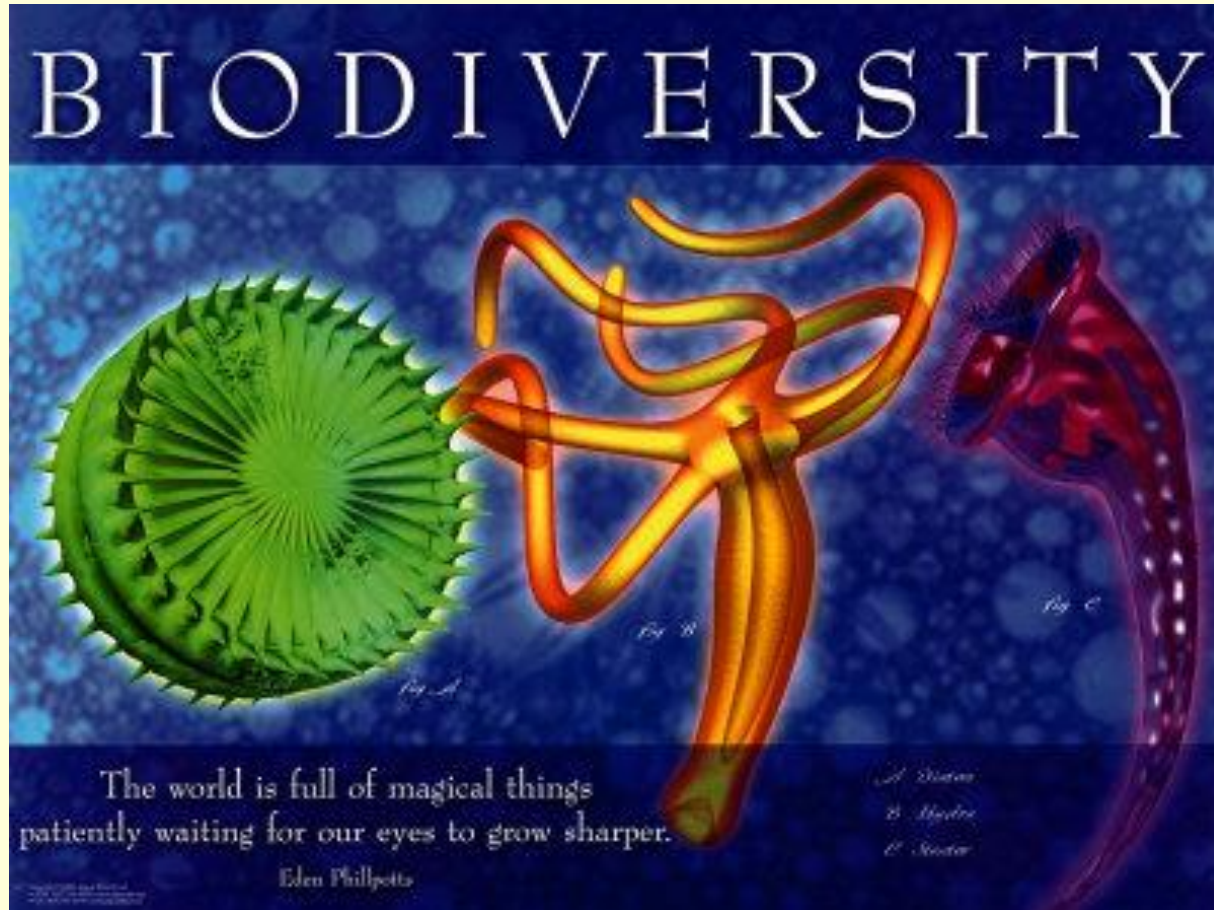
# Zebra Mussels in the Great Lakes Has reduced Biodiversity!



Zebra mussel



# What is Biodiversity



**Biodiversity** is the variation of life forms within an ecosystem

High biodiversity leads to a **more stable ecosystem**.



**Trade-offs:** solving environmental issues involves trade-offs. There are always costs associated with social decisions.

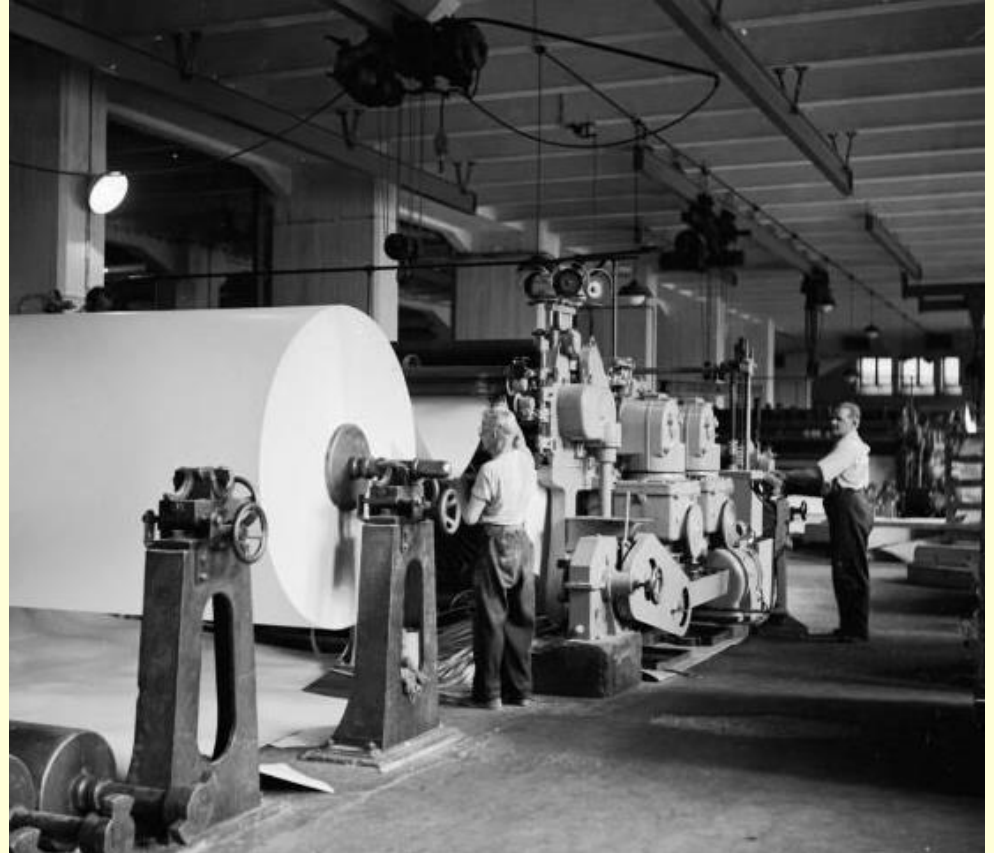


Nuclear Power provides electricity without fossil fuel but generates nuclear wastes.

# Industrialization

Increased industrialization demands more resources and energy use.

This has positive and negative effects on humans and ecosystems





**Societies must decide** on proposals and assess risks, costs, benefits and trade-offs.





**Solar Energy** reduces dependence on fossil fuel but it is expensive.

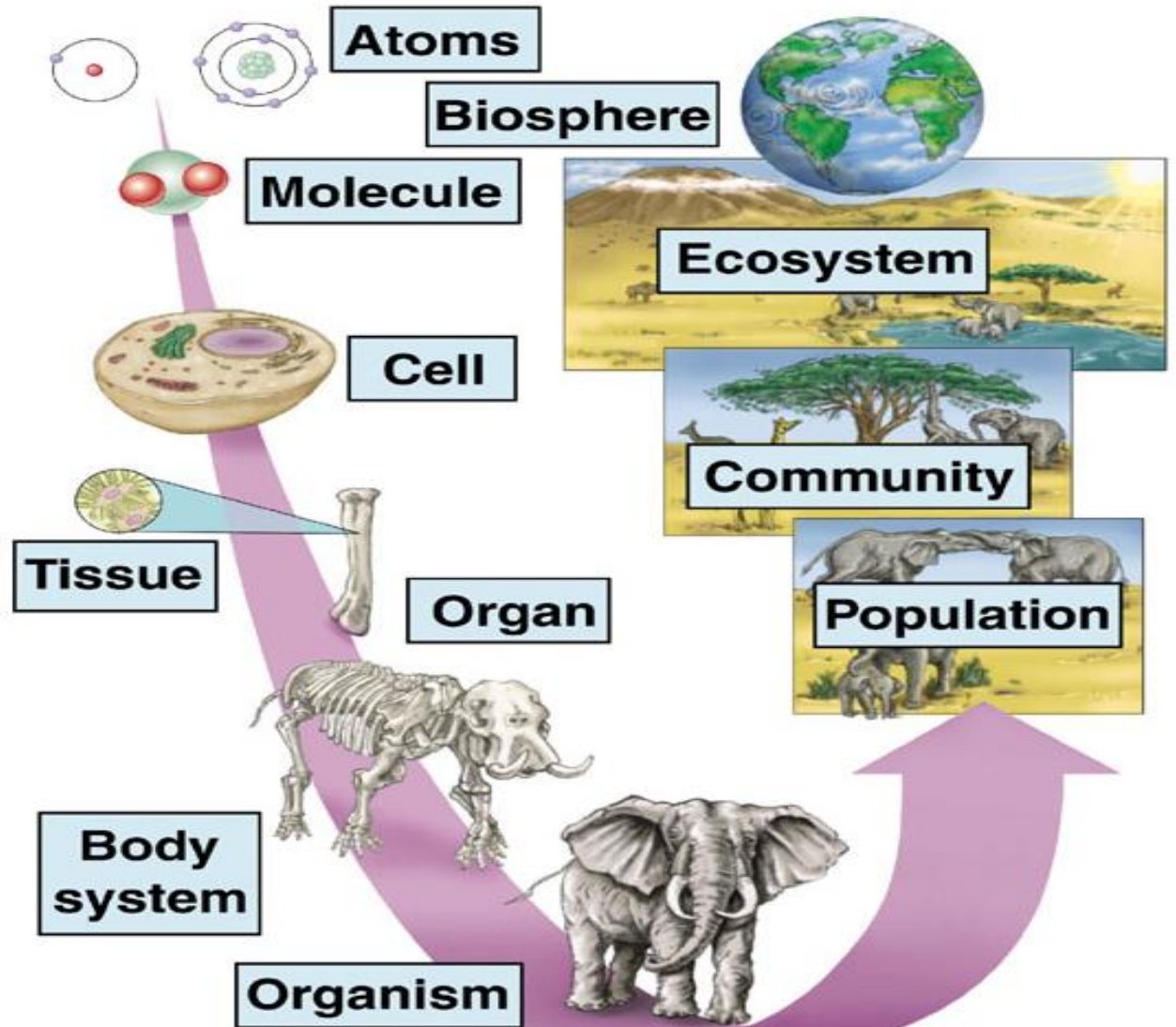


# Processes and Cellular Nature of Life

PERFORMANCE  
INDICATOR 1.2

Describe and explain the structures and functions of the human body at different organizational levels (e.g., systems, tissues, cells, organelles).

Levels of  
organization:  
Begins with  
molecules





# Level of Organization

Organelles

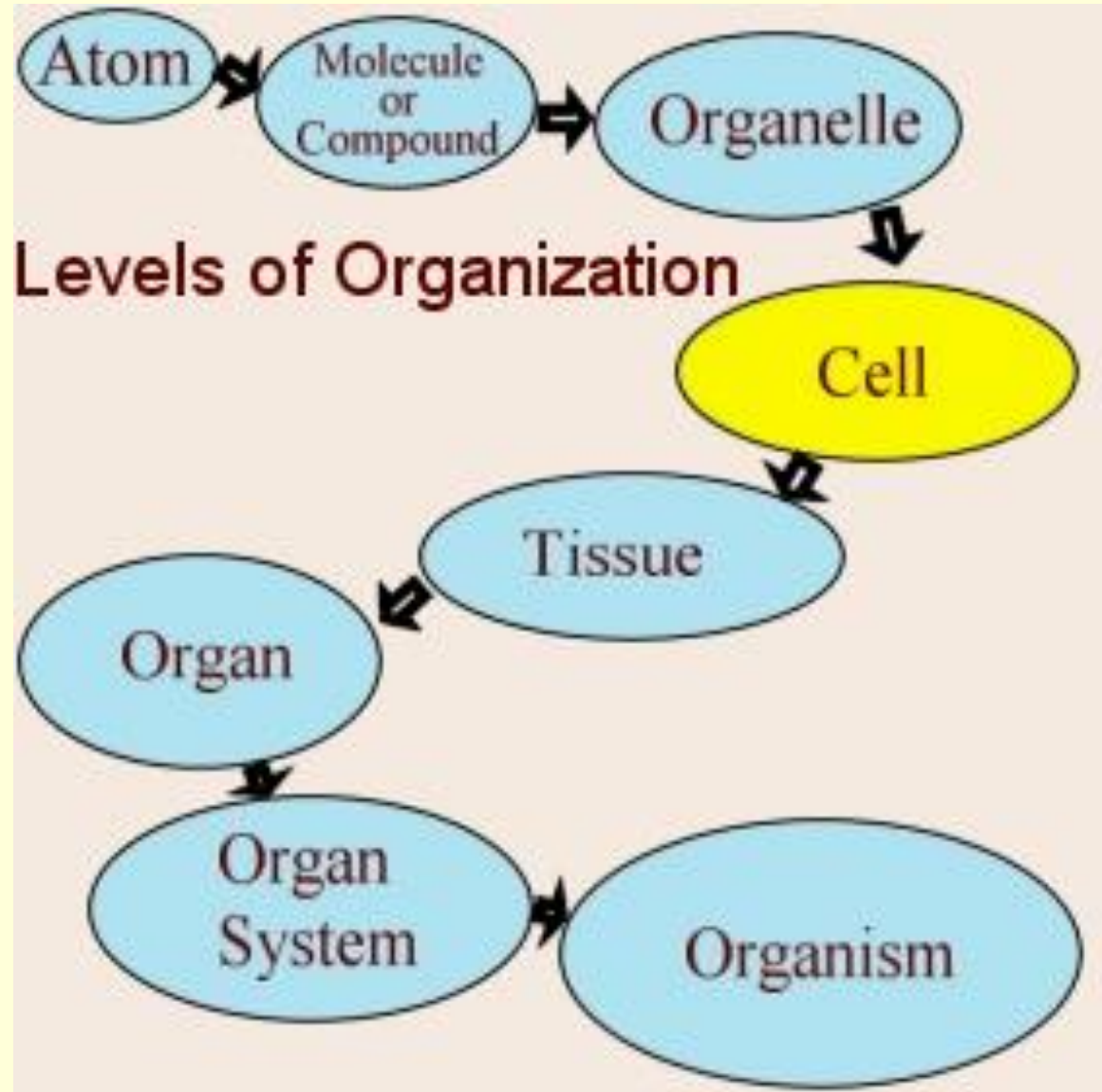
Cells

Tissues

Organs

Organ systems

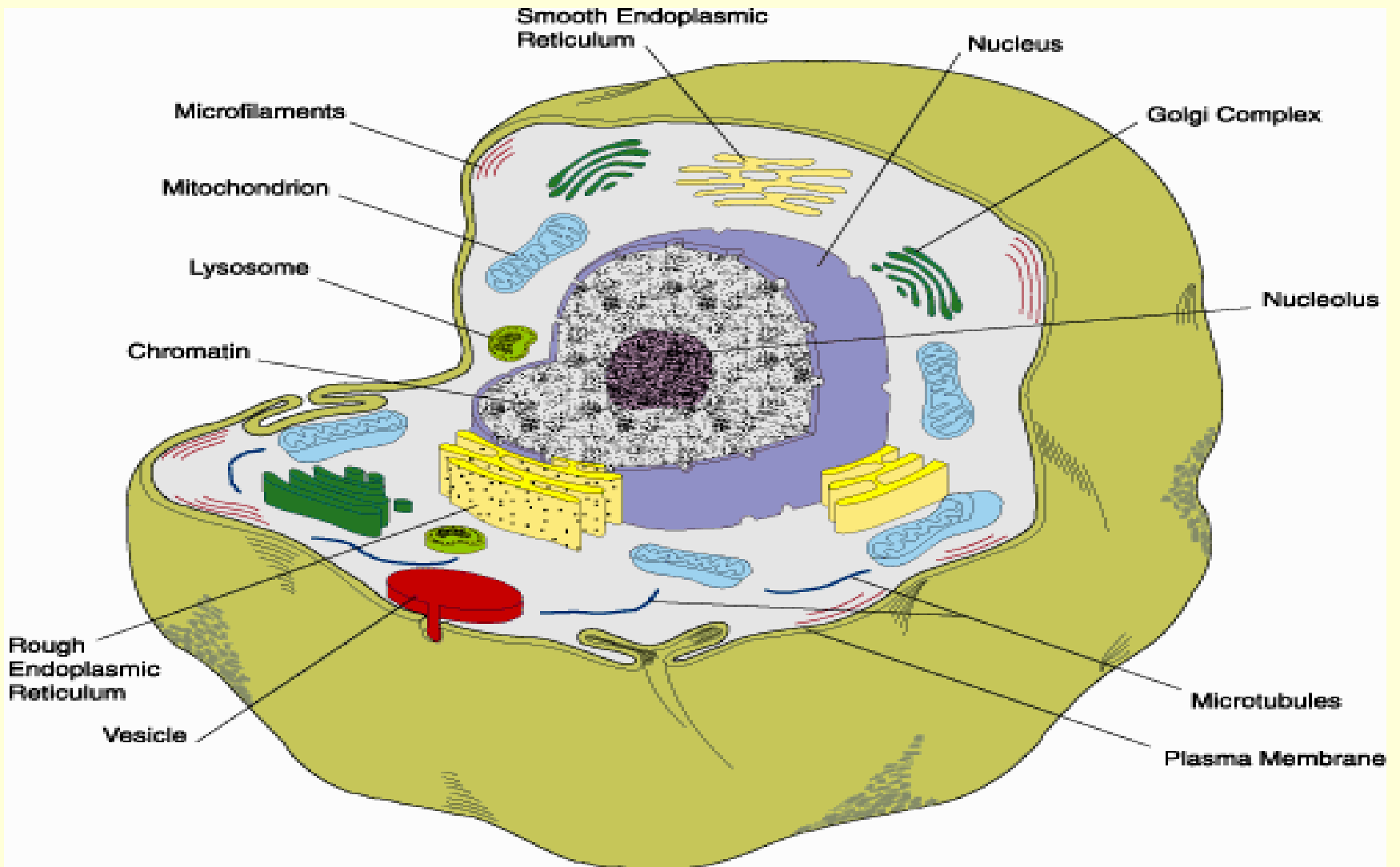
Whole organisms





# Cells have organelles for specific jobs.

Just as body systems are coordinated, cell parts work together



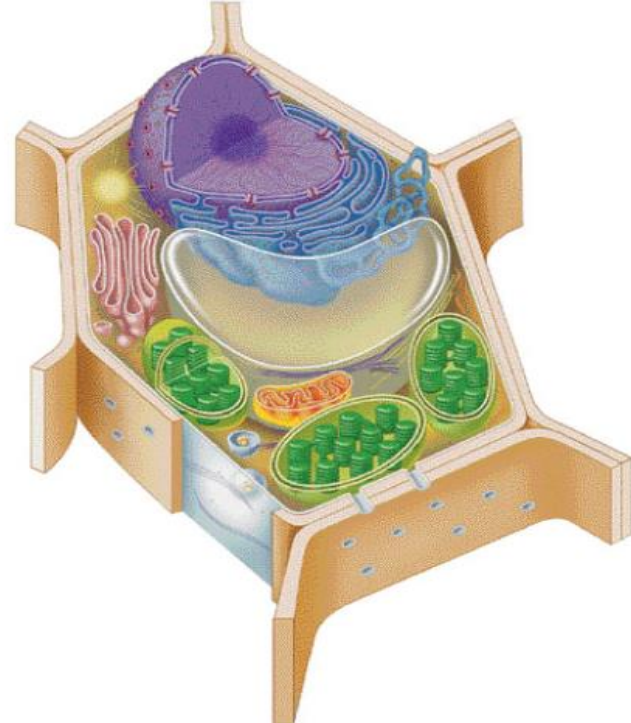
# Eukaryotic Plant cell

Chloroplasts

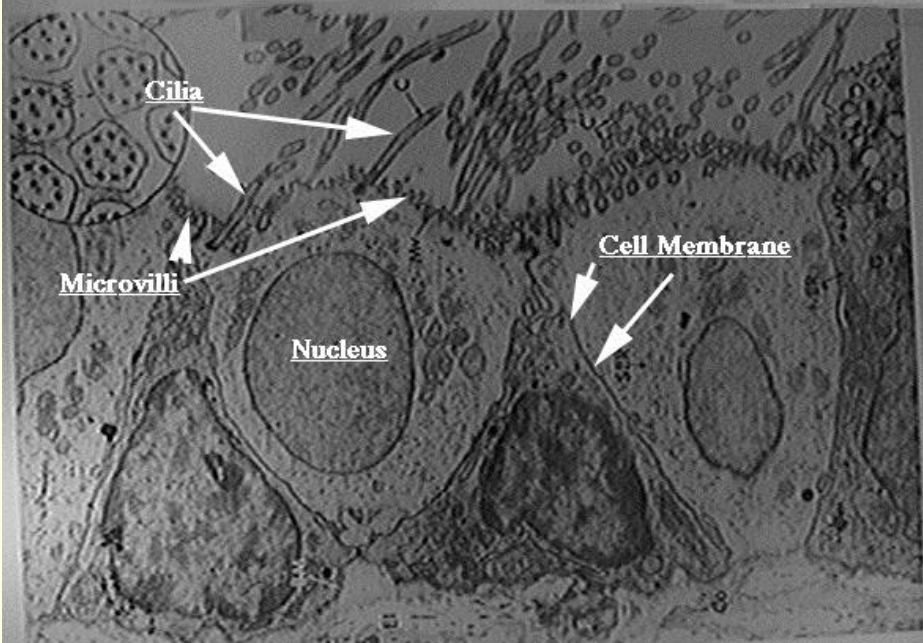
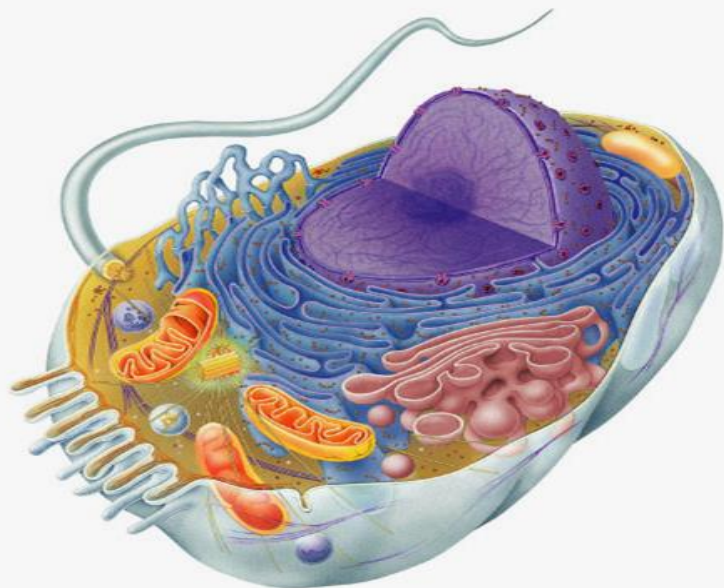
Nucleus

Vacuole

Cell Wall



# Eukaryotic Animal Cell

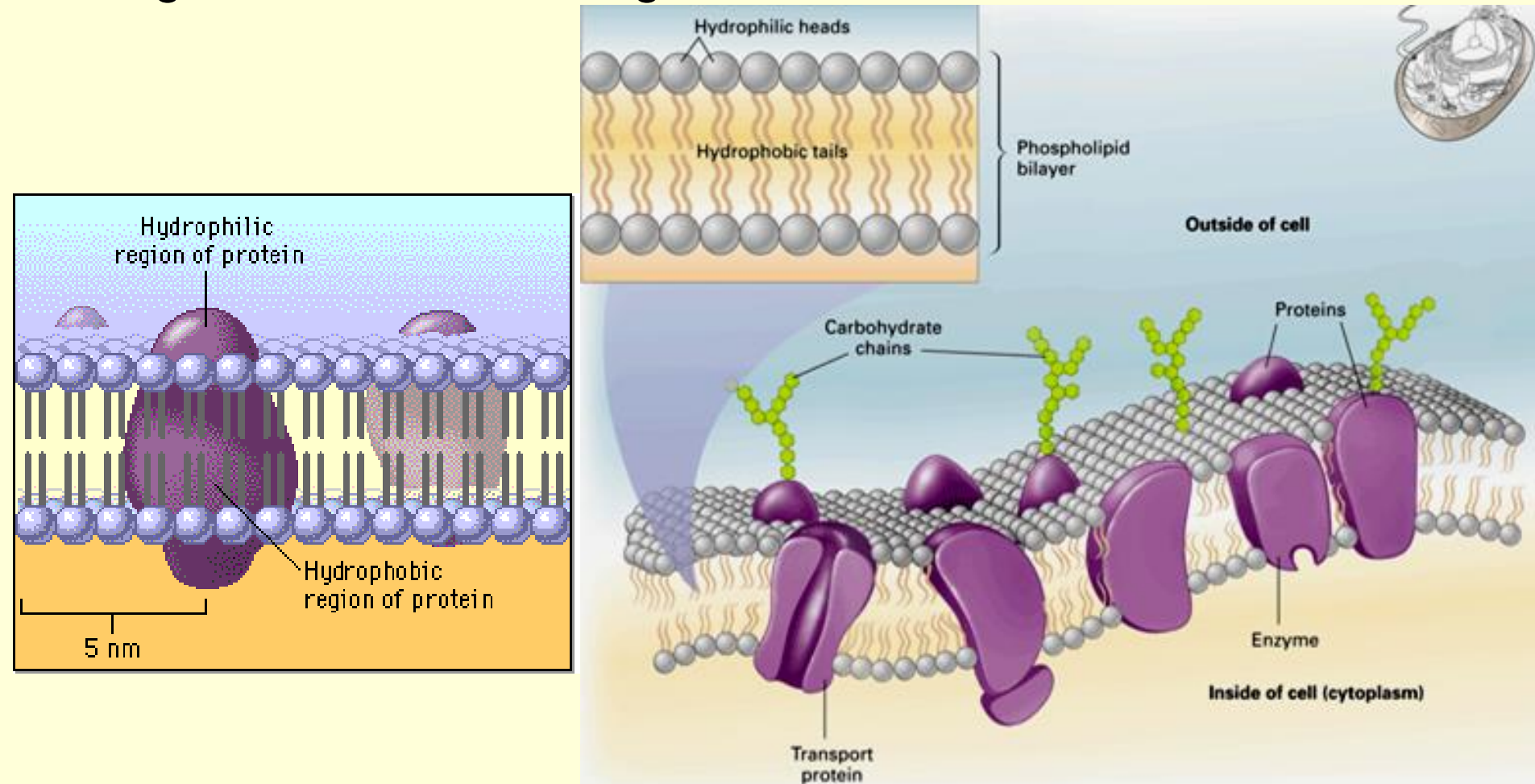


<b>Cell Organelles</b>	<b>Function</b>
Cytoplasm	the jellylike substance that is between the cell membrane and the nucleus and that contains specialized structures
Cell membrane	the thin boundary between the cell and its environment
Nucleus	a large structure within a cell that controls the cell's metabolism and stores genetic information, including chromosomes and DNA
Ribosome	one of the tiny structures in the cell that is the site of protein production
Mitochondria	pod shaped organelles that contain enzymes used to extract energy from nutrients
Chloroplast	the green organelle that contains chlorophyll; where photosynthesis takes place
Vacuole	storage sacs within the cytoplasm of a cell that may contain either wastes or useful materials, such as water or food



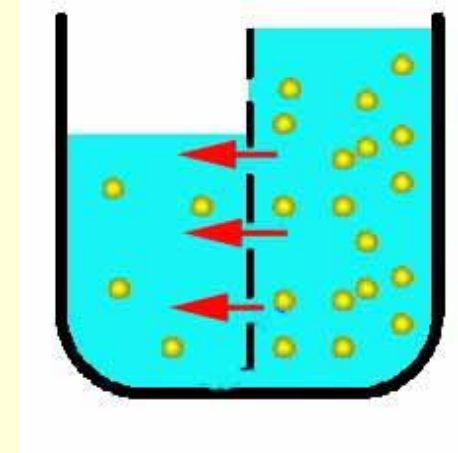
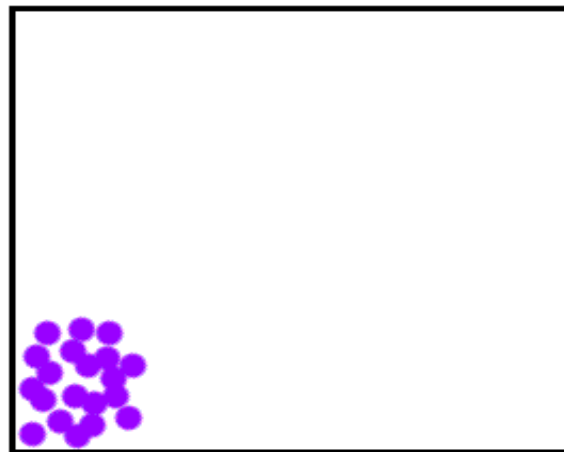
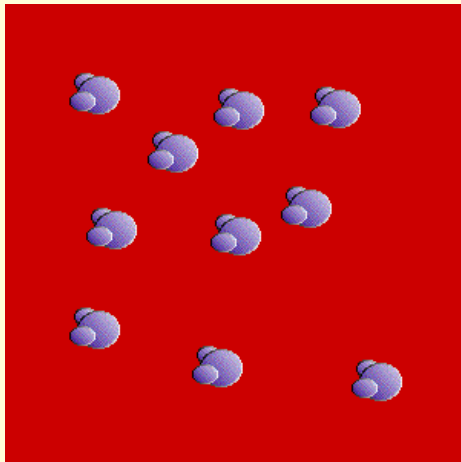
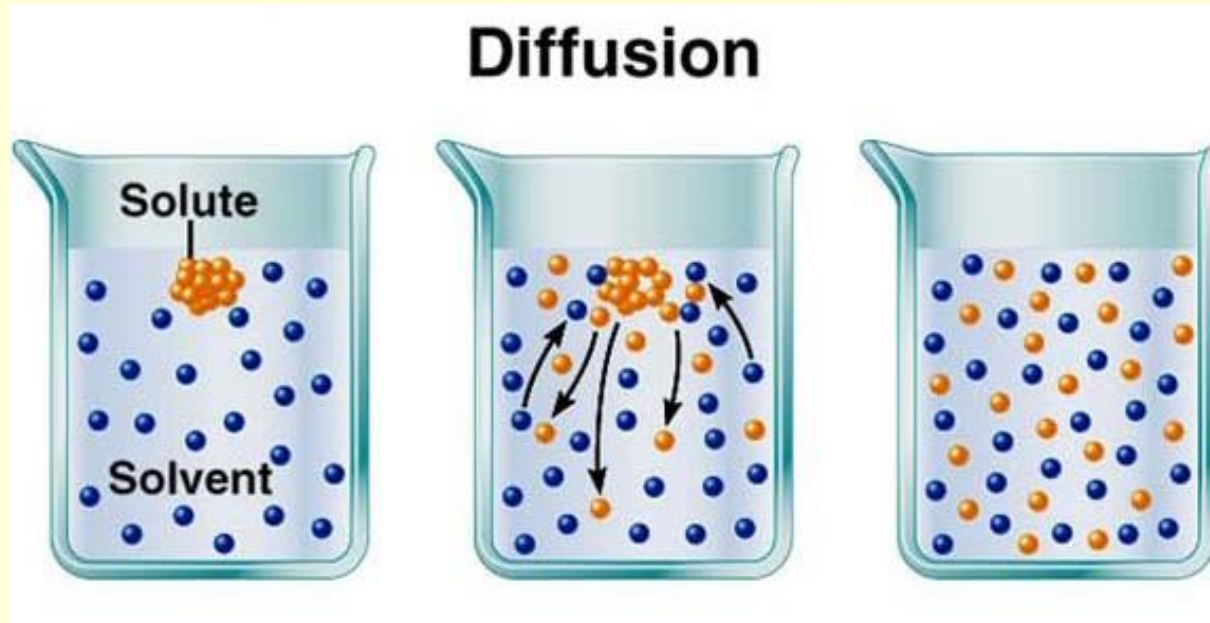
# Cell Membranes have several functions

- Separation from outside environment
- Control transport in/out of cell
- Recognition of chemical signals



# Membrane Transport

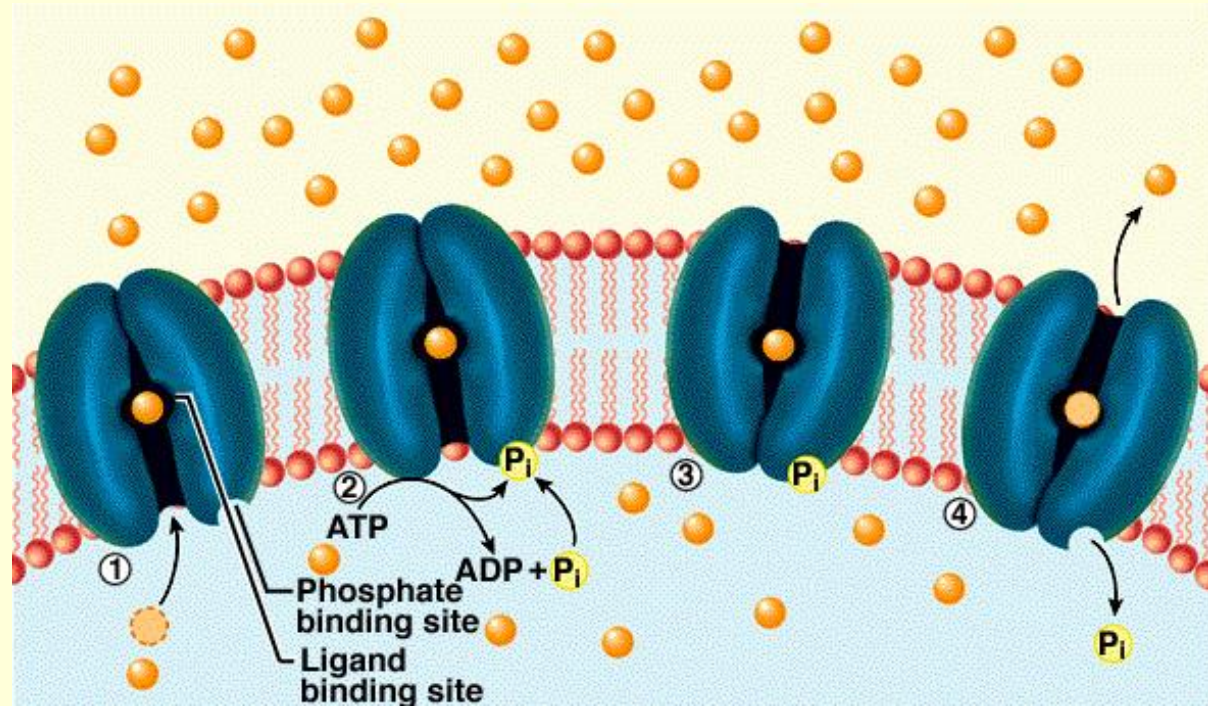
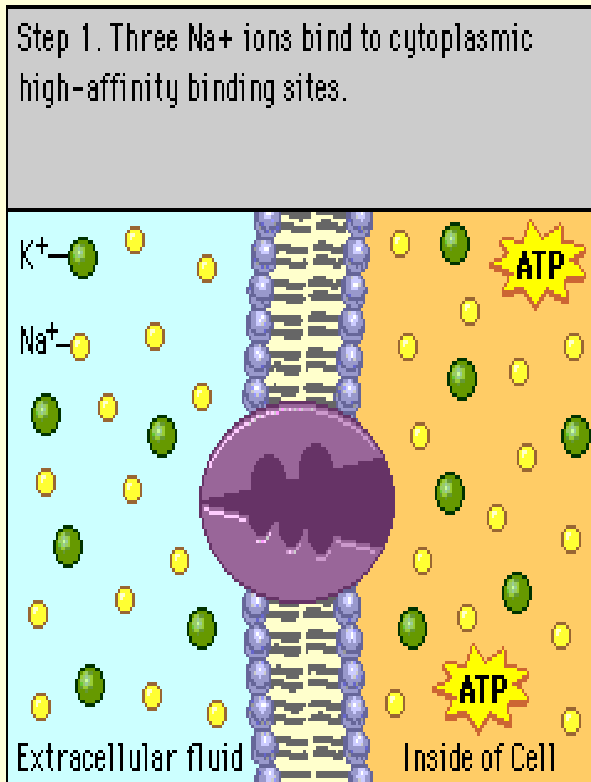
**Passive transport** doesn't require cell input of energy (ATP)



# Active Transport

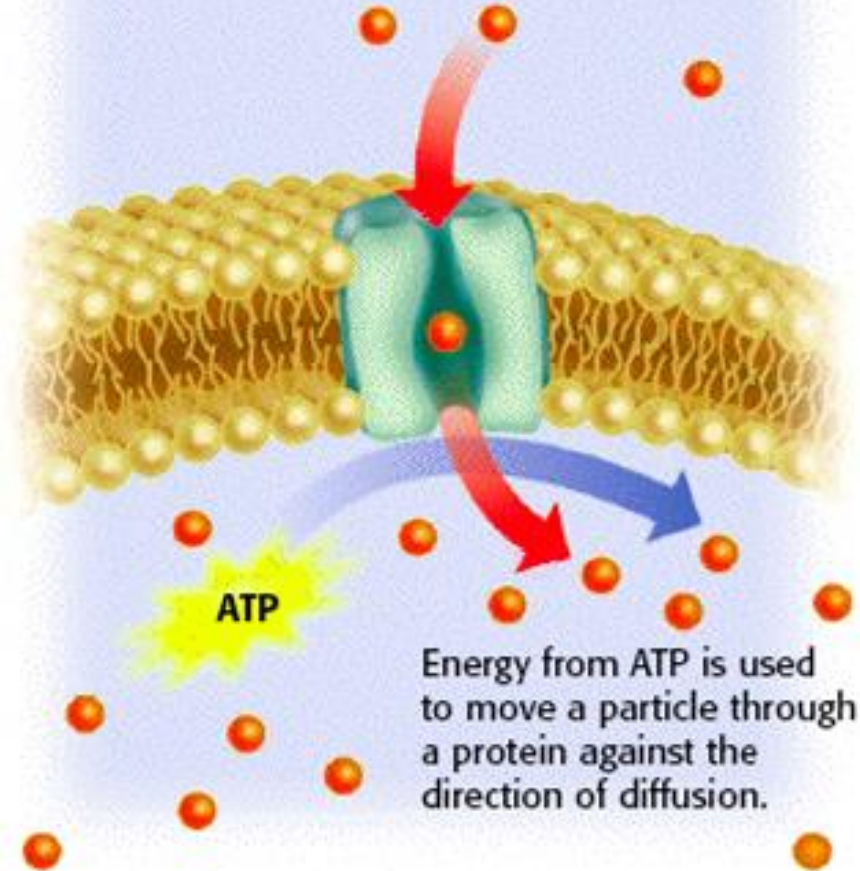
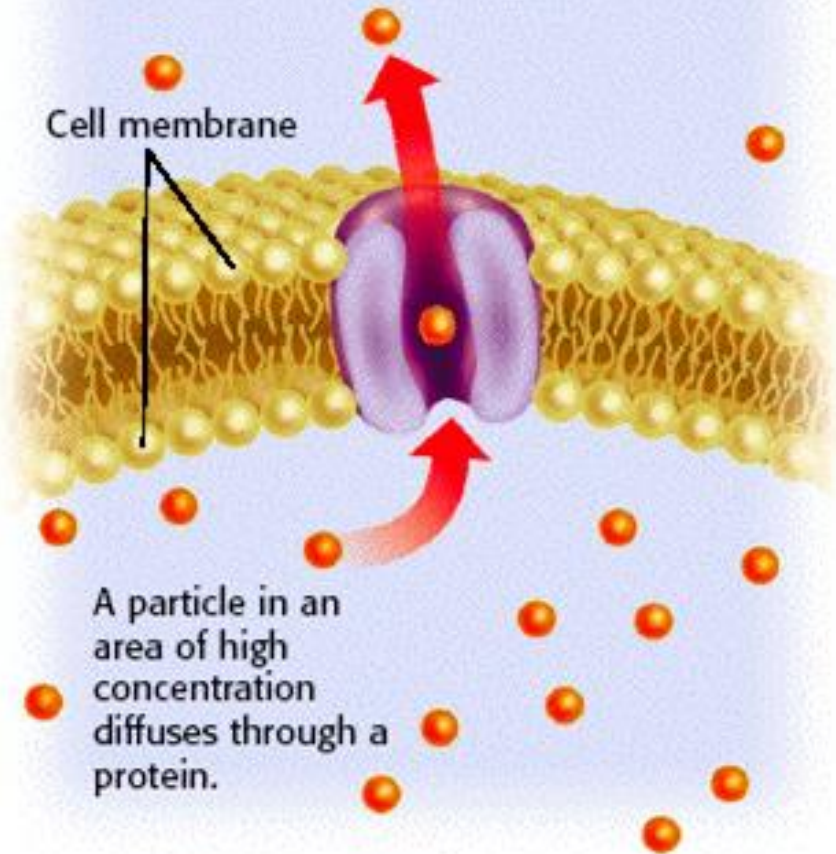
Molecules transport from lower to higher concentration with the use of cellular energy (uses ATP)

Special proteins transport molecules help transport



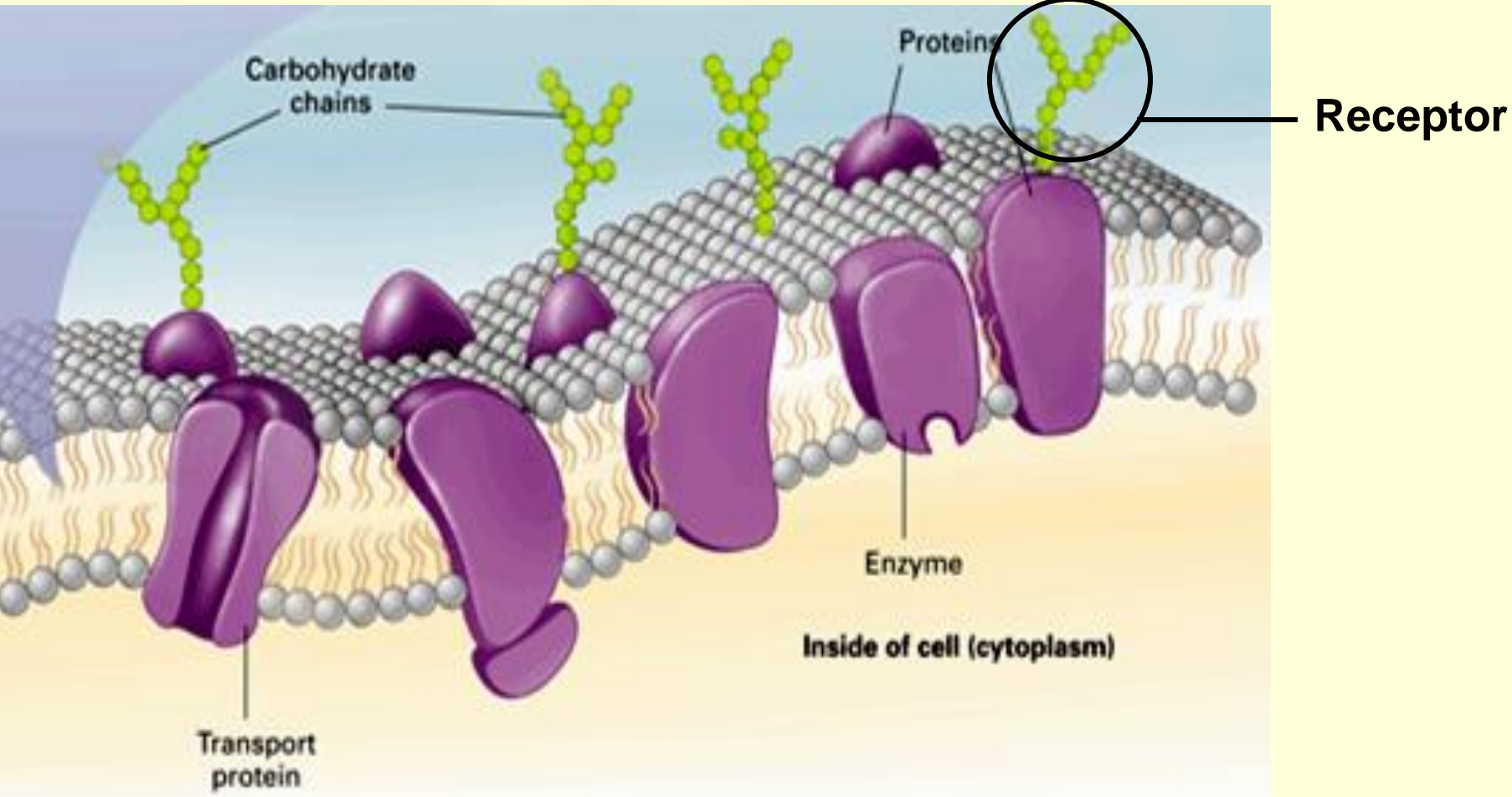


# How can you determine which is passive or active transport?



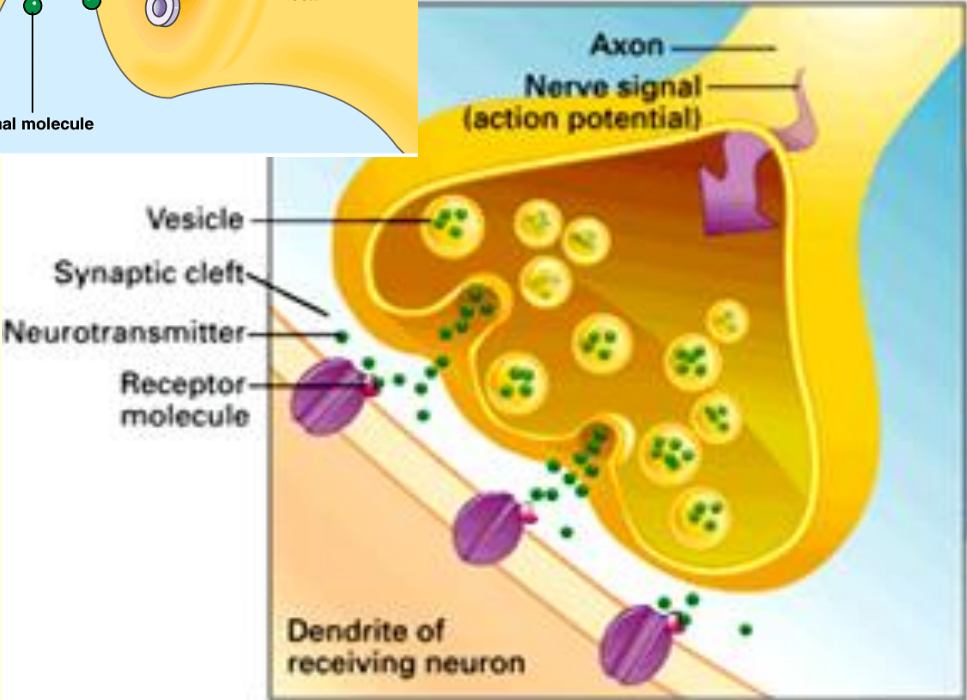
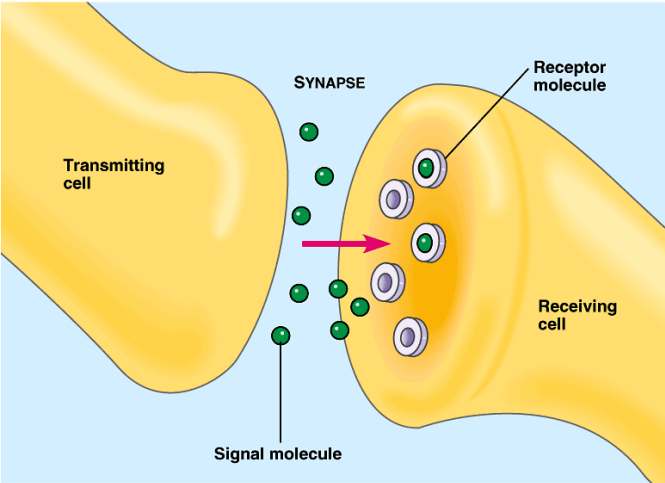
Diffusion may use special proteins  
**moves from high to low**

# Receptor molecules are important for cell communication



The receptors are specific in shape and to the individual organism

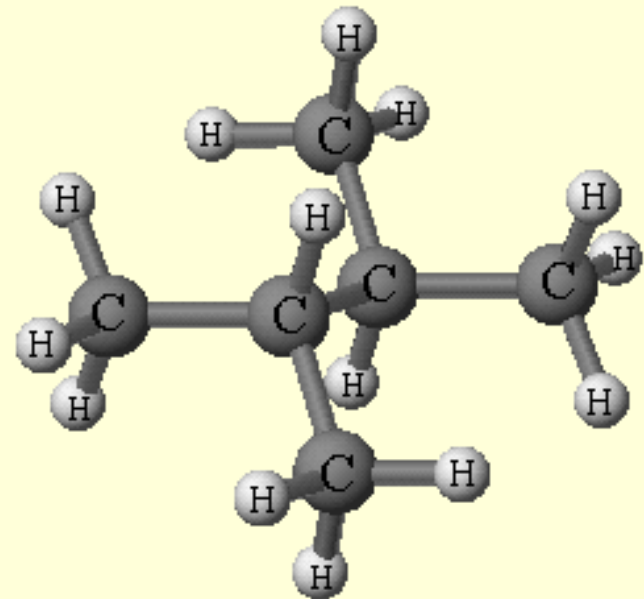
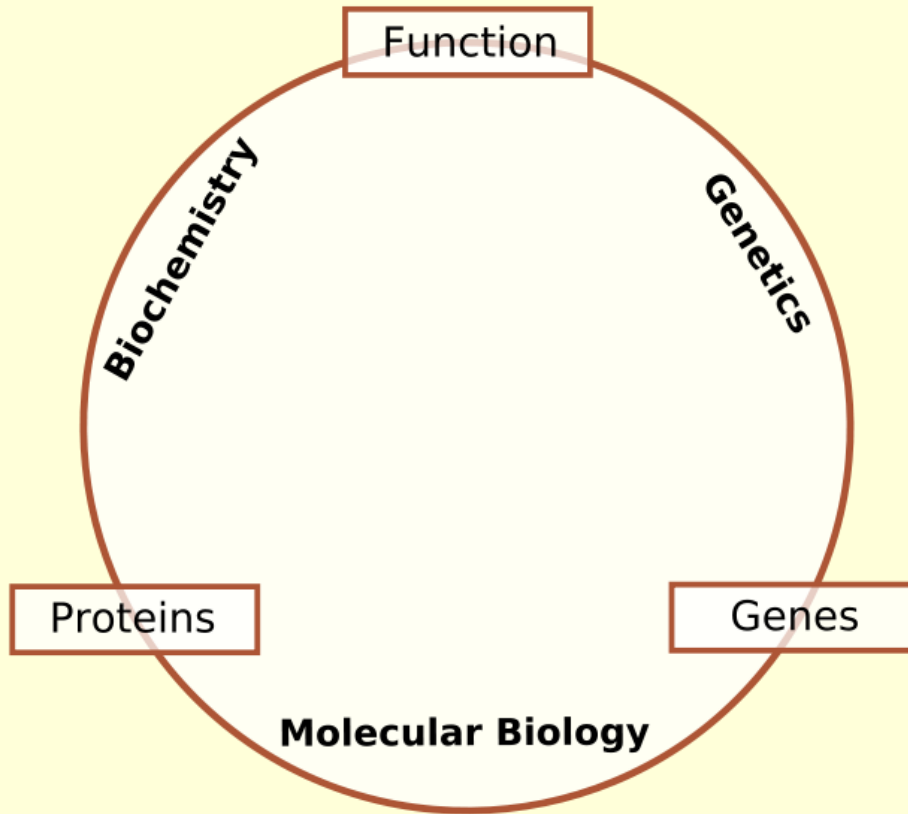
Nerves and hormones use specific chemical signals to communicate.



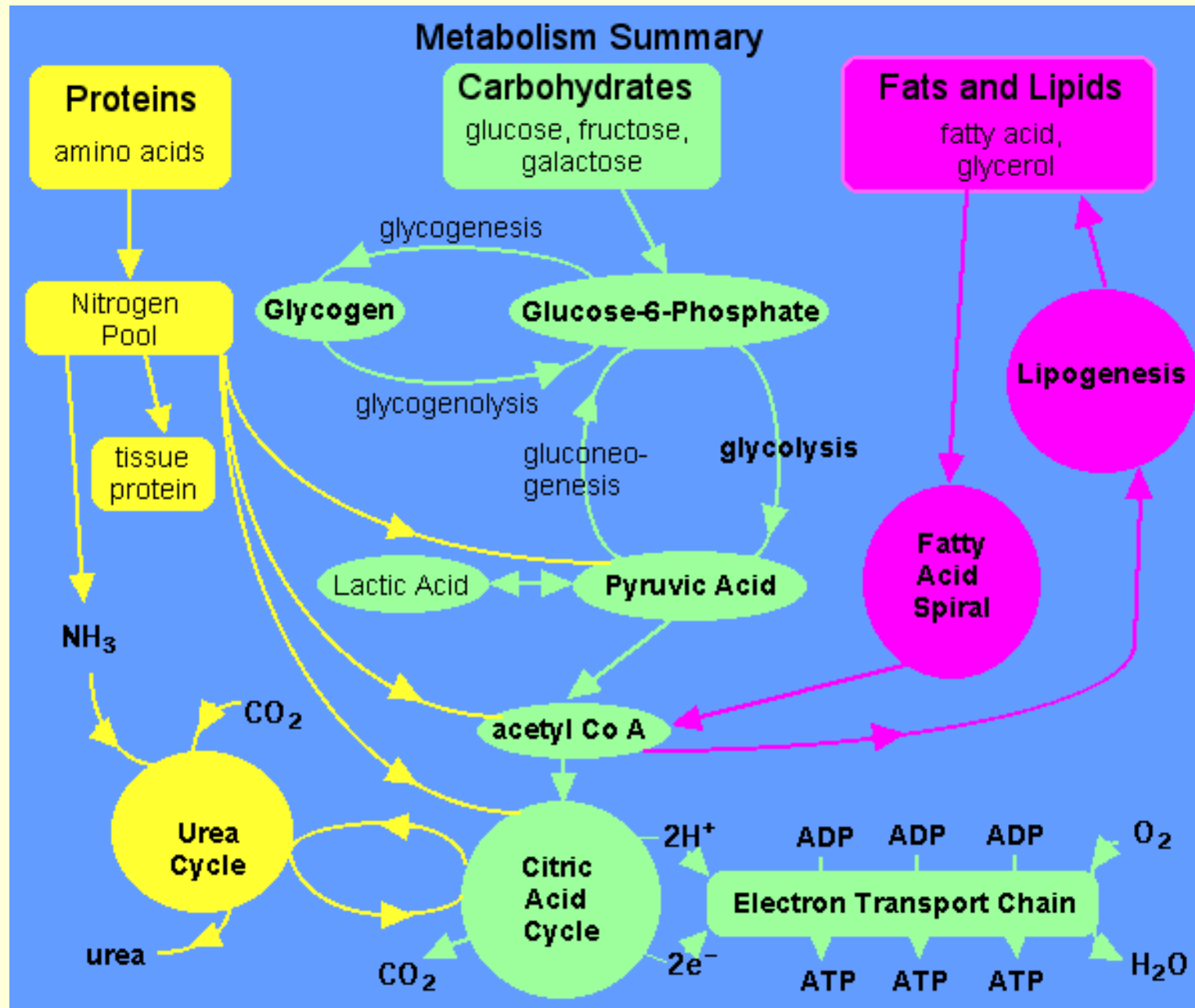


# Biochemical Nature of Life

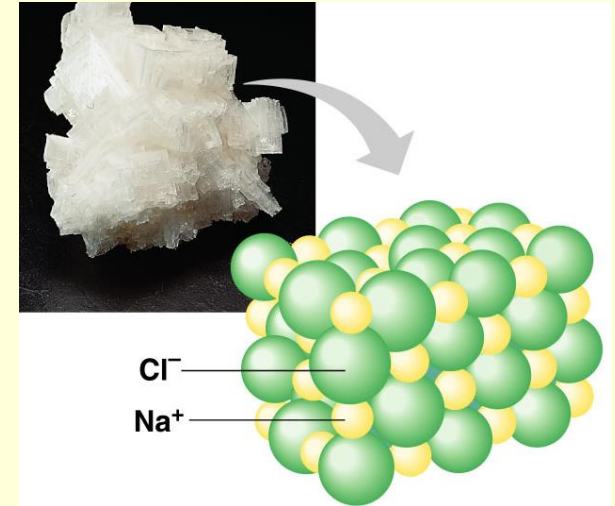
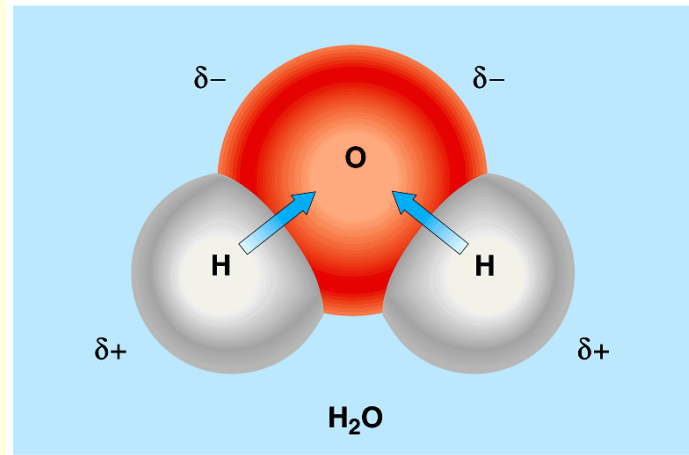
Biochemical processes and molecules are essential for maintaining dynamic equilibrium.



Metabolism is the sum of the processes in an organism



# Carbon is the main ingredient of organic molecules



**Organic compounds** are carbon based and contain carbon and hydrogen.

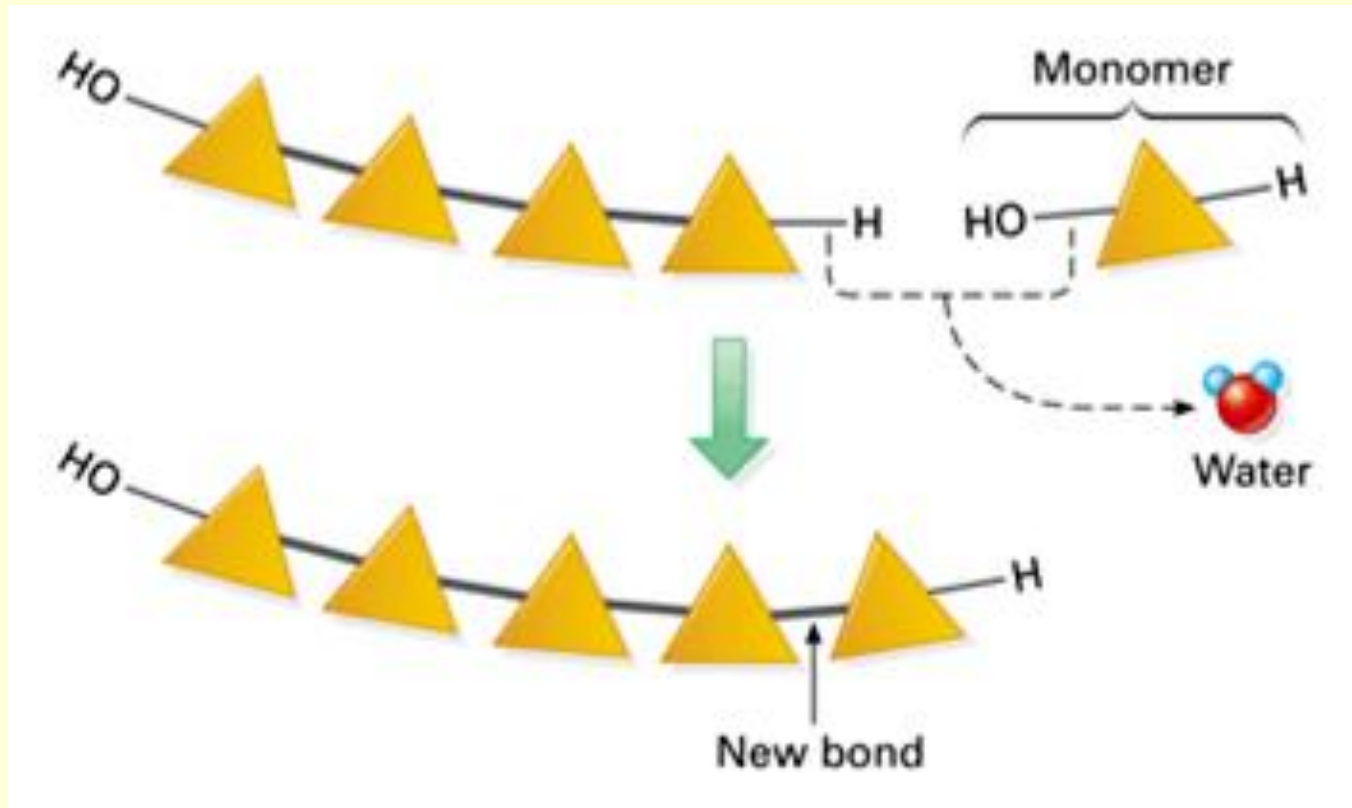
**Inorganic compounds** are not carbon based. (Water, salt, minerals...)



# Large and Small Organic Molecules

Small molecular units that are the building block of a larger molecules

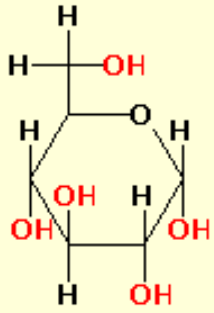
**Polymer:** long chain of small molecular units (monomers)



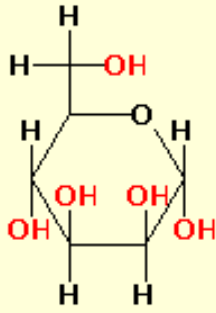
Living things must both synthesize (build) large molecules and break them down.

# Organic chemistry is the study of carbon compounds

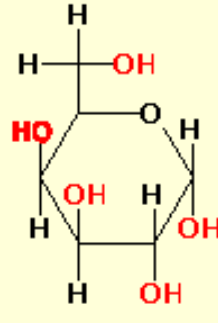
## Carbohydrates, Proteins, Fats, Nucleic Acids



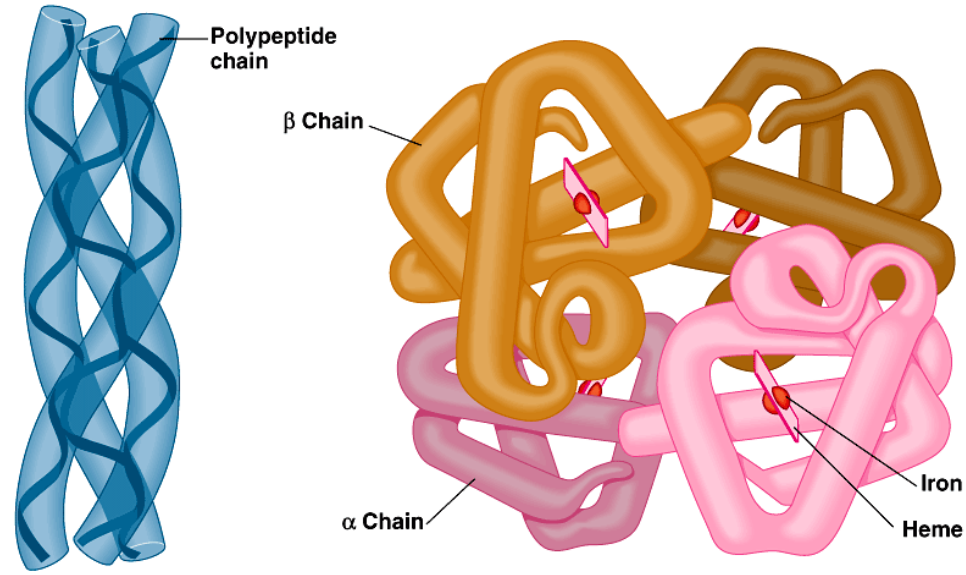
Glucose



Mannose

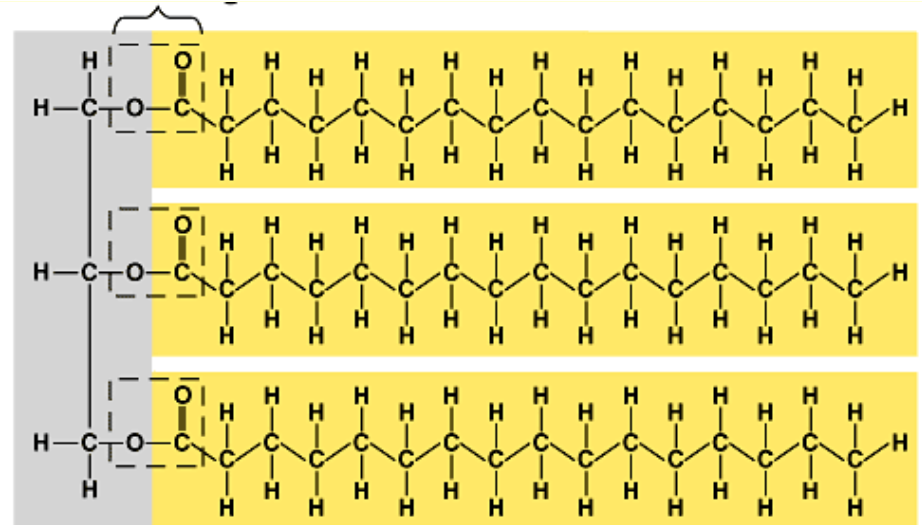
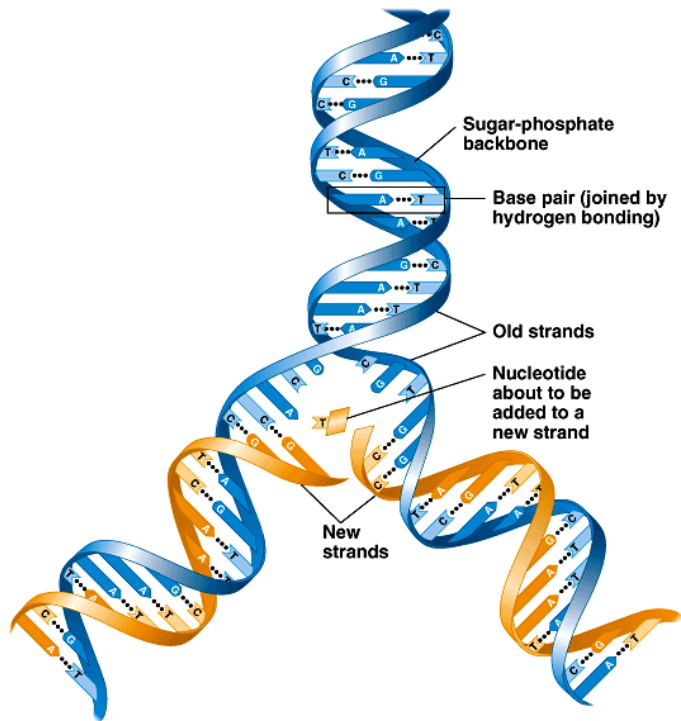


Galactose



(a) Collagen

(b) Hemoglobin

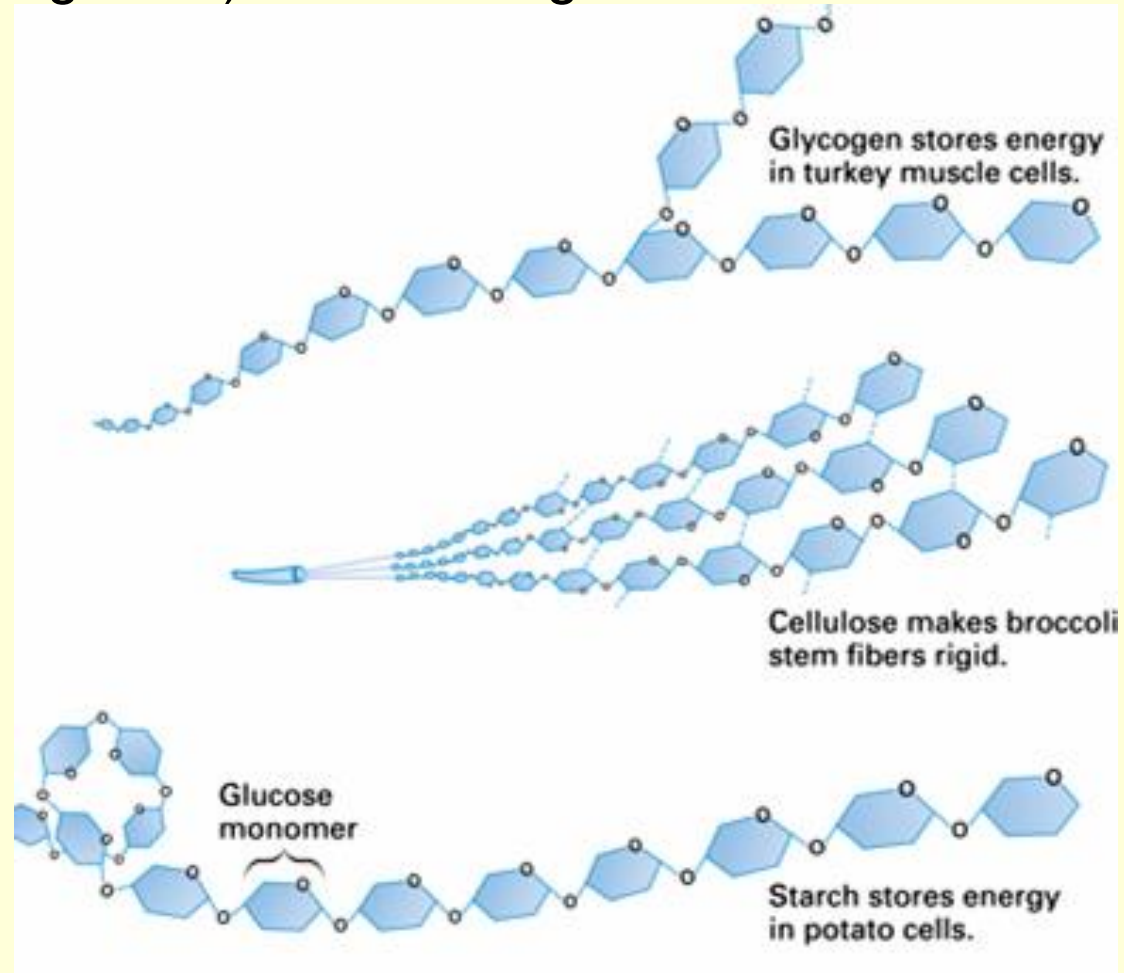
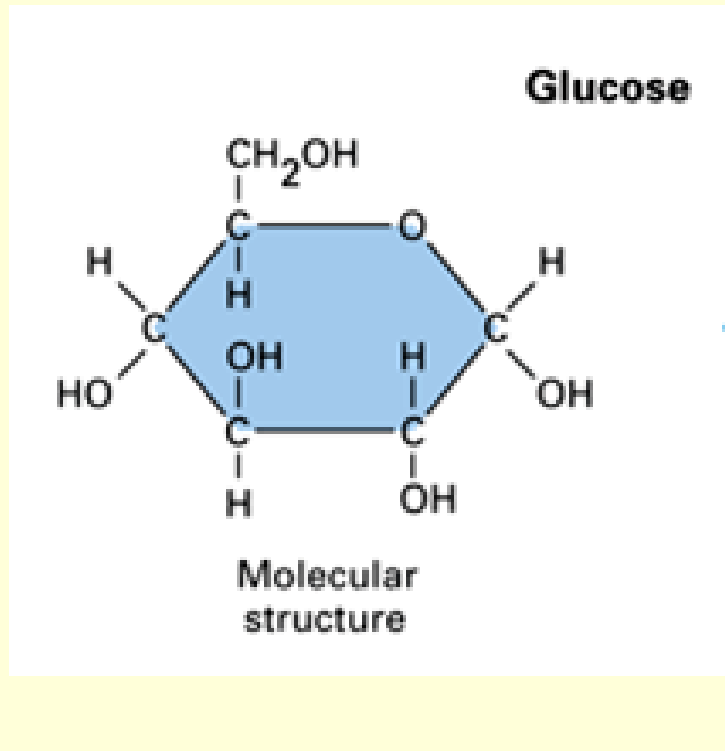


# Carbohydrates provide fuel and building material

Carbohydrates are organic compounds made of sugar molecules.

Sugars are combined to synthesize starch.

Starches are broken down (digested) to make sugars.

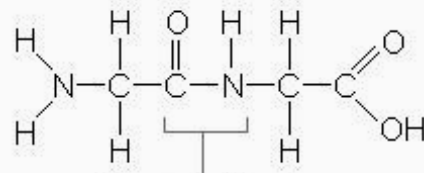
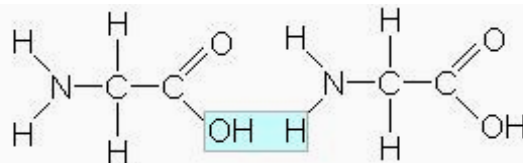
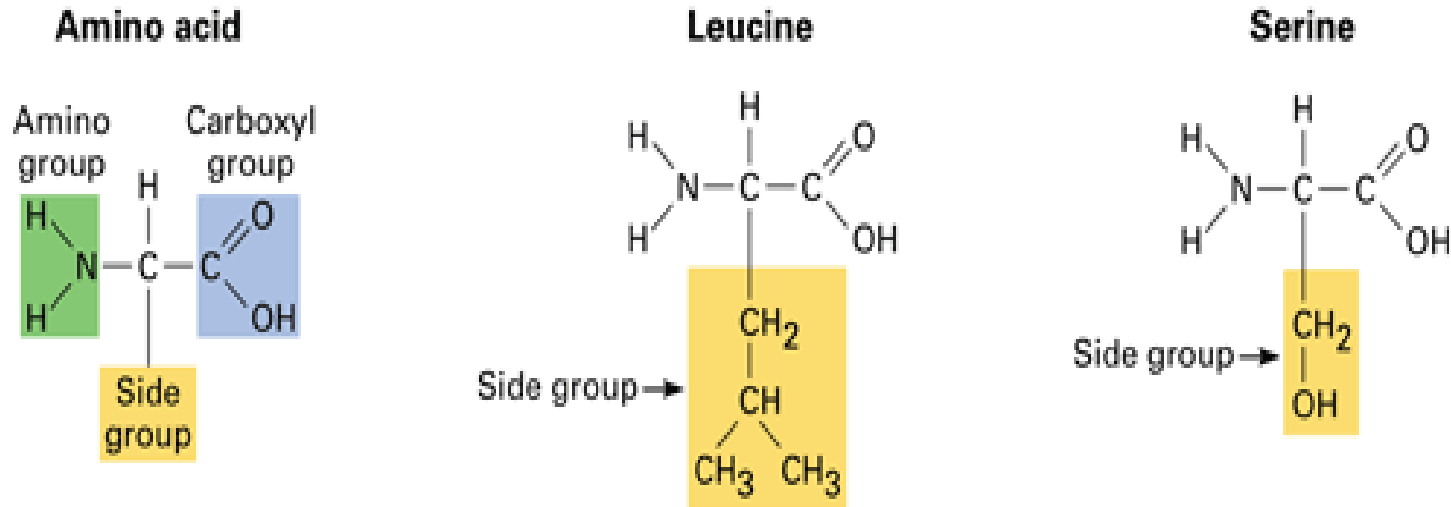






# Proteins are long folded chains made of 20 different kinds of amino acids

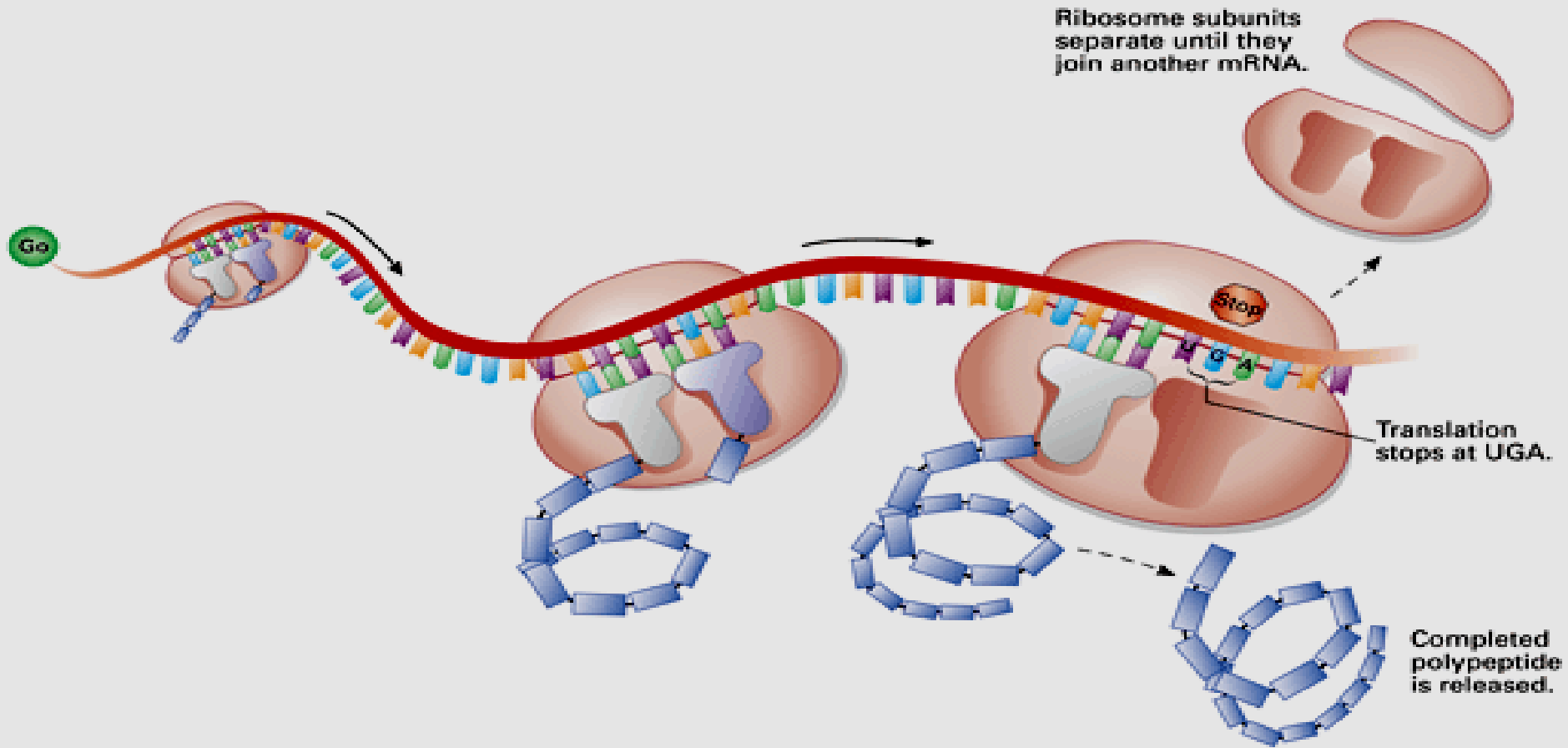
Specific shape determines its function.



Peptide Bond

A molecule of water is removed from two glycine amino acids to form a peptide bond.

Proteins are synthesized at the ribosomes and folded into specific shapes



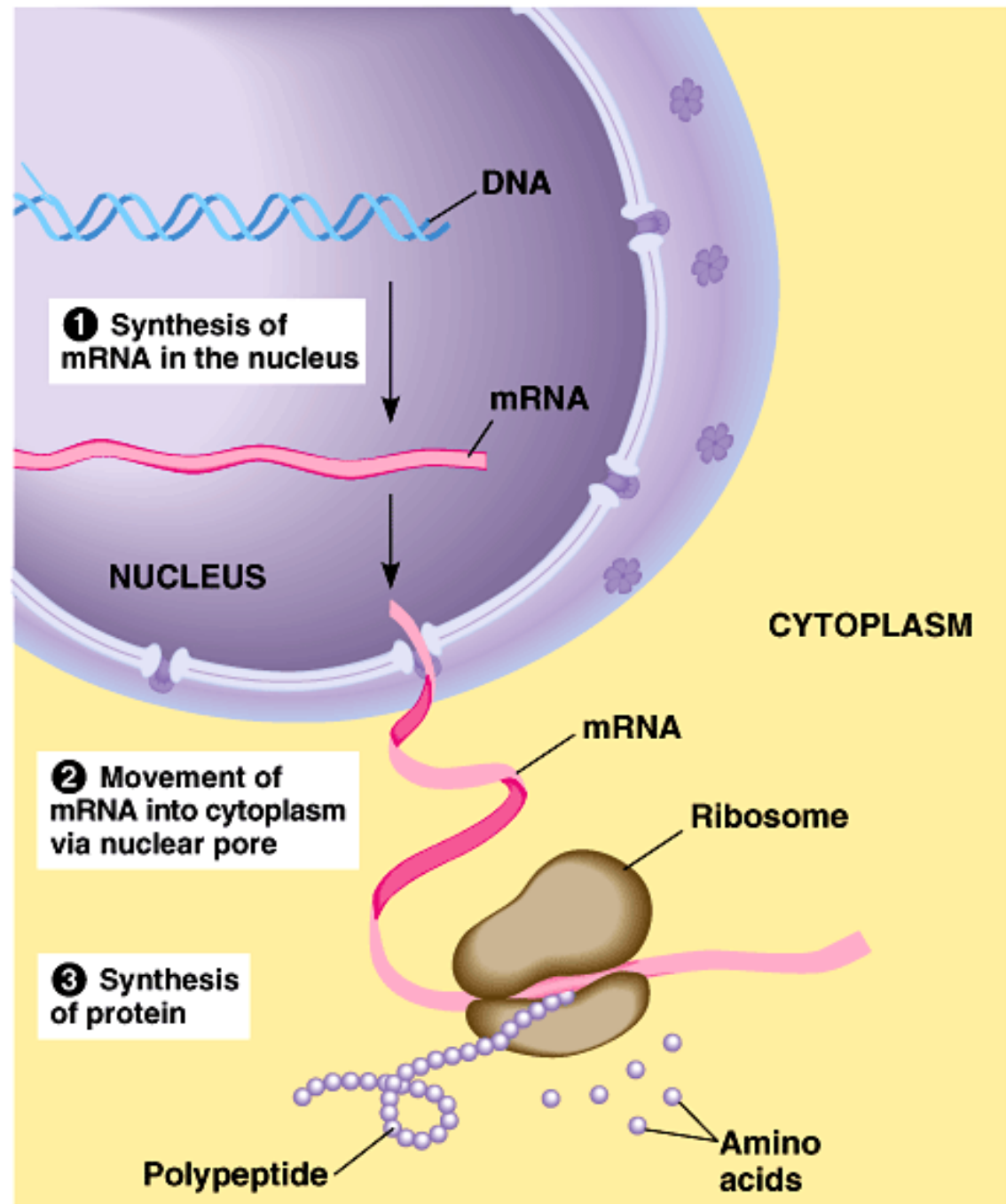
**Protein shape is essential to function**



# Protein Synthesis

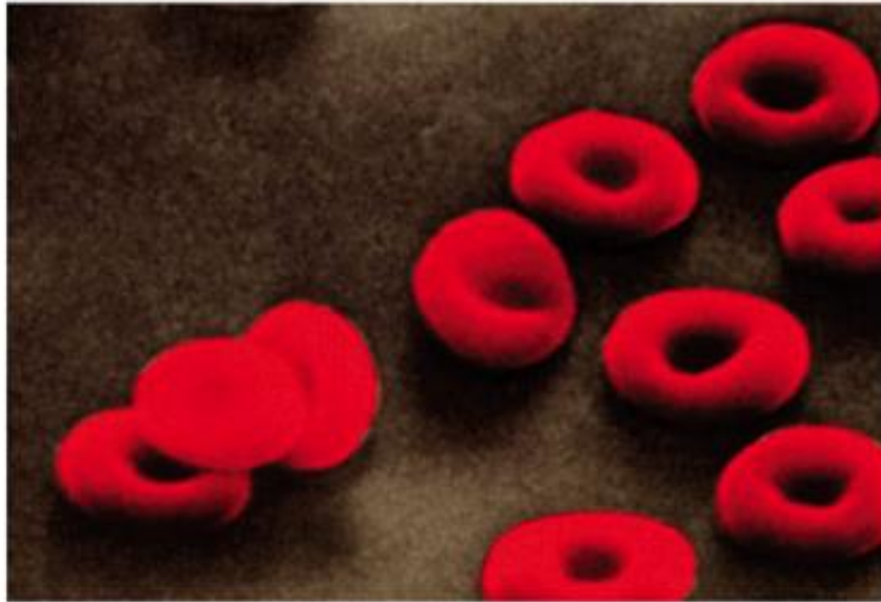
## Process and steps

- The DNA unzips
- The mRNA reads the code off the DNA; transcription
  - mRNA moves out of the nucleus into the cytoplasm and attaches to the ribosome
- tRNA brings amino acids to ribosomes according to the original DNA code
- Amino acids bind together and are released into cytoplasm as a protein

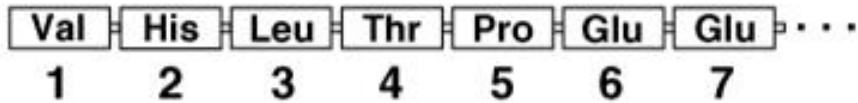




A single amino acid substitution in hemoglobin causes sickle-cell disease. How does an individual get this disorder?



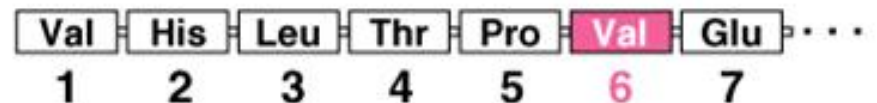
10  $\mu$ m



(a) Normal red blood cells and the primary structure of normal hemoglobin



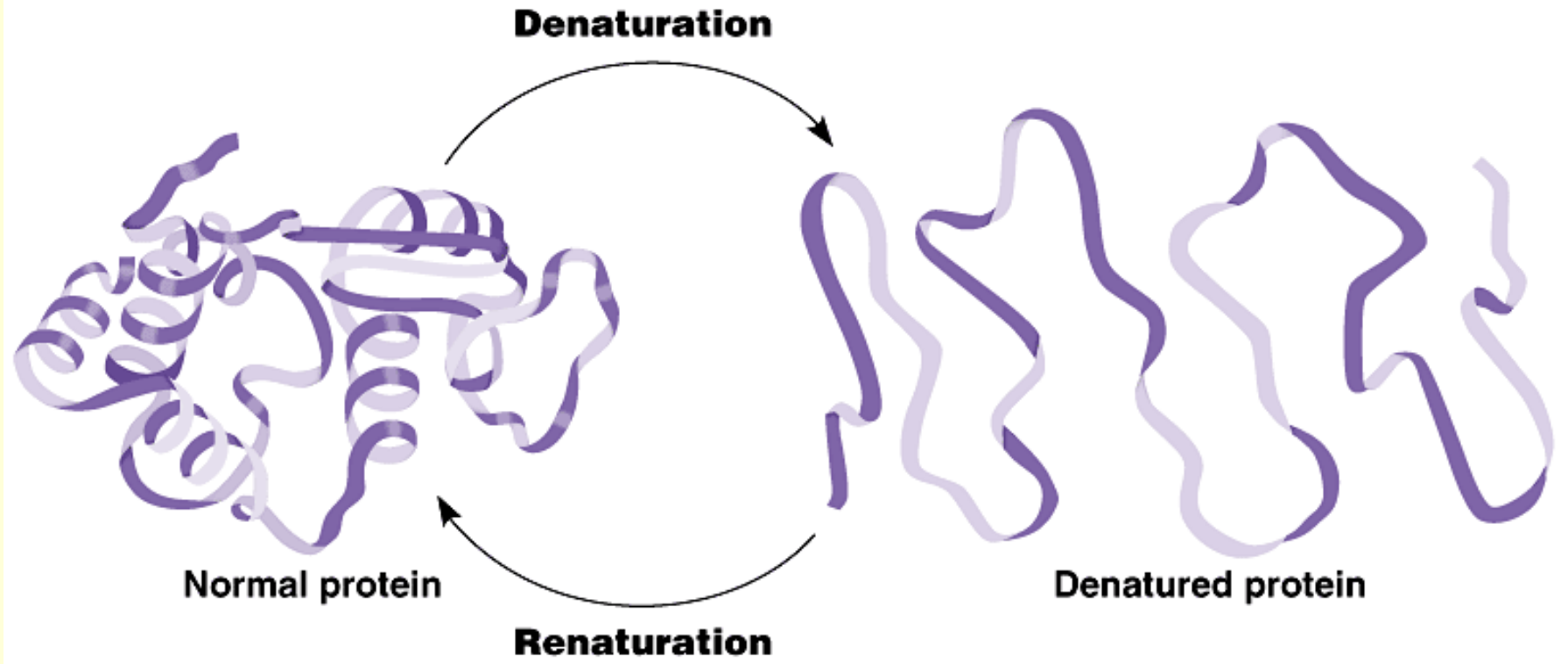
10  $\mu$ m



(b) Sickled red blood cells and the primary structure of sickle-cell hemoglobin

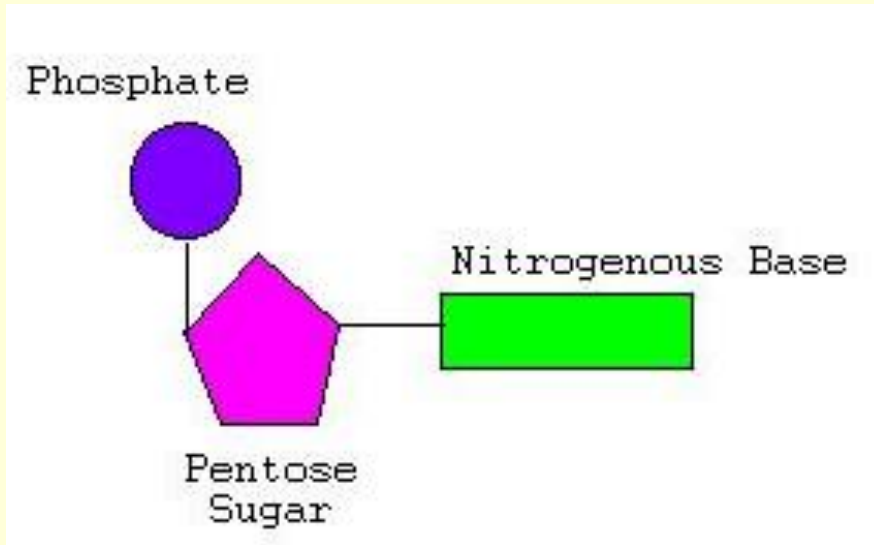


**Denaturation** occurs at high temperatures or various chemical treatments. Shape maybe permanently changed.



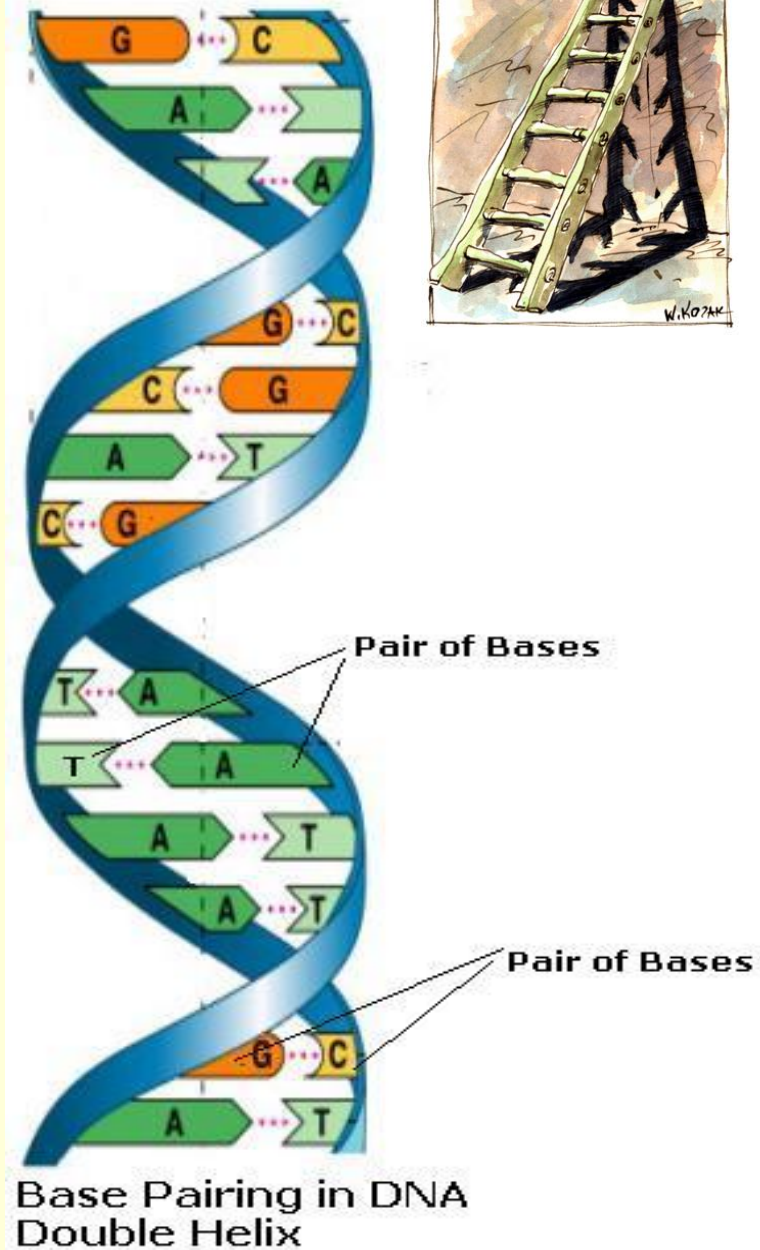
# Structure of DNA (Nucliec Acids)

Building Blocks are Nucleotides



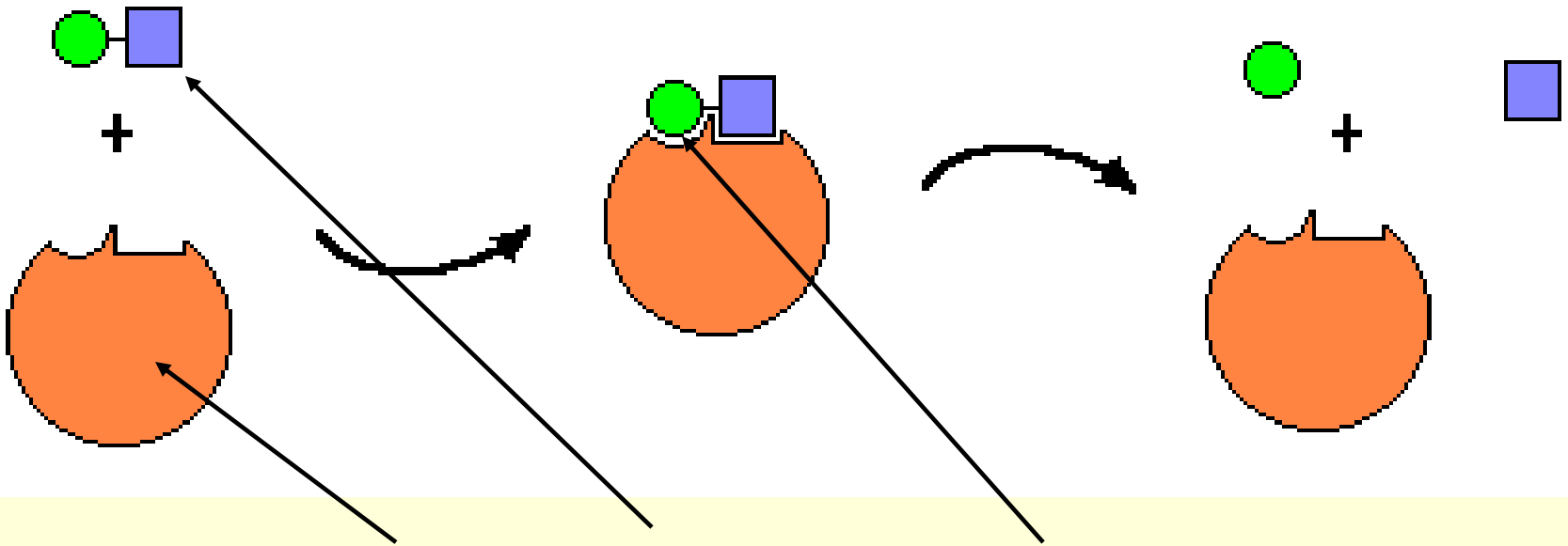
## Nitrogen Bases

- Adenine
- Thymine
- Guanine
- Cytosine



**Enzymes** specialized protein that catalyzes the chemical reactions of a cell

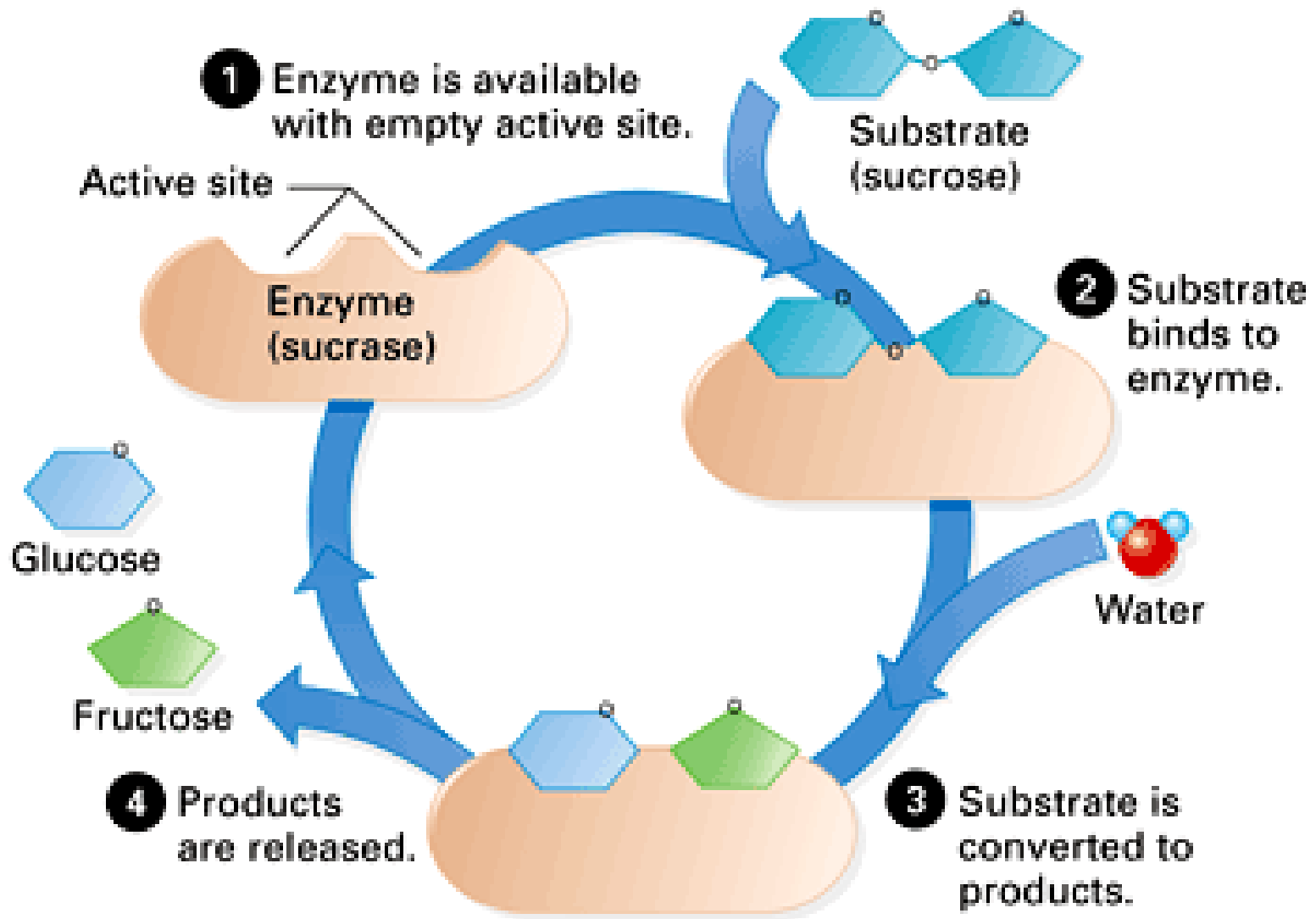
- Enzyme shape fits the shape of only particular reactant molecules called the substrate.
- Enzymes are specific to the substrate.
- The substrate fits the enzyme at the active site.



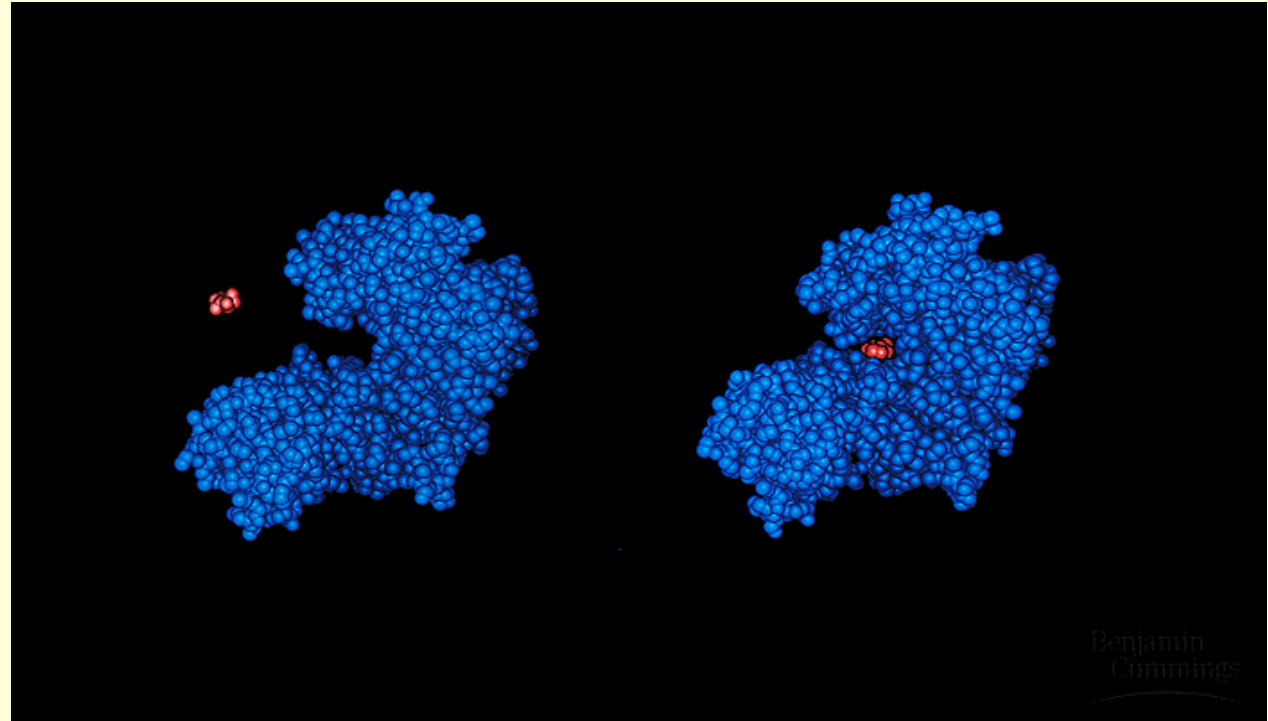
Identify the enzyme, substrate, and active site



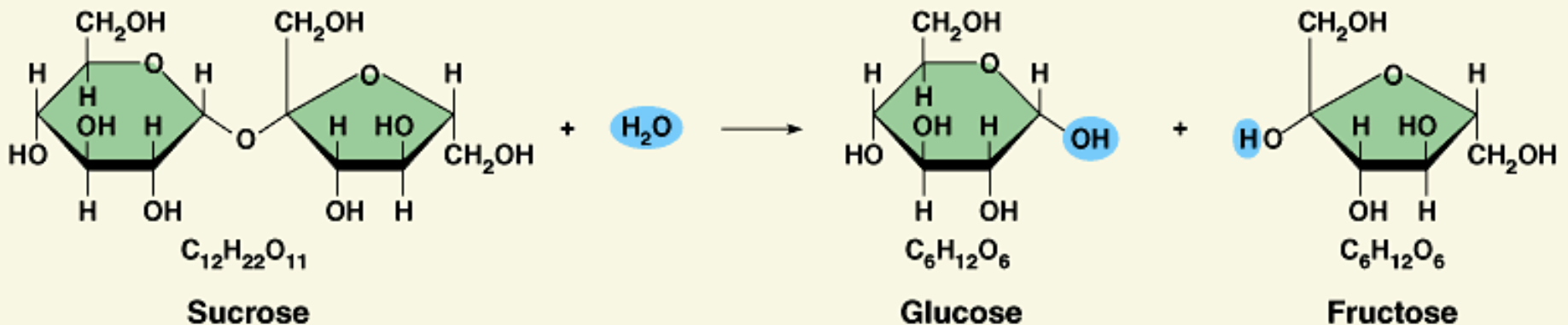
# Catalytic cycle of a enzyme



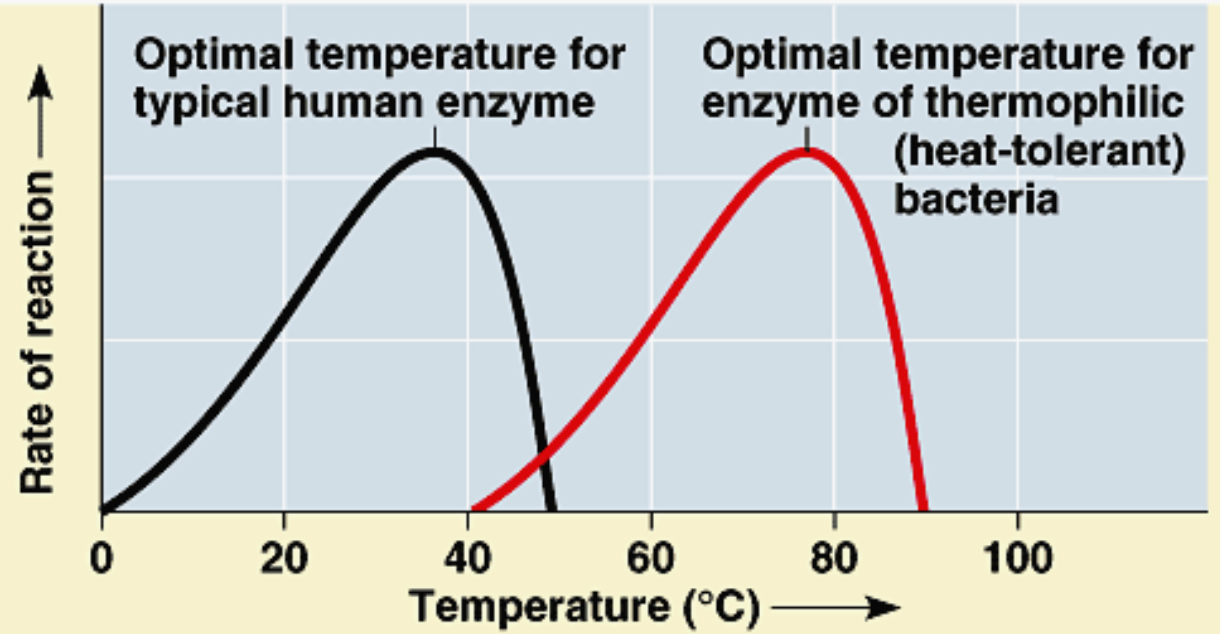
Enzymes are substrate specific due to the “fit” at the active site of the enzyme.



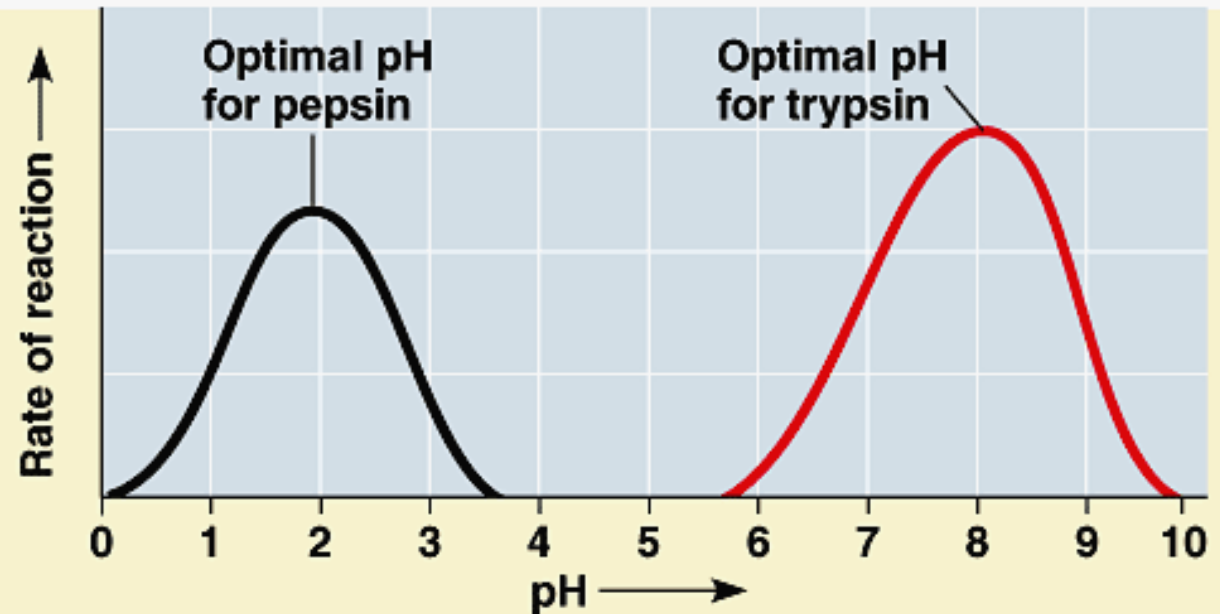
Enzyme sucrase will catalyze this reaction



# Factors influence rate of enzyme reactions



(a) Optimal temperature for two enzymes



(b) Optimal pH for two enzymes

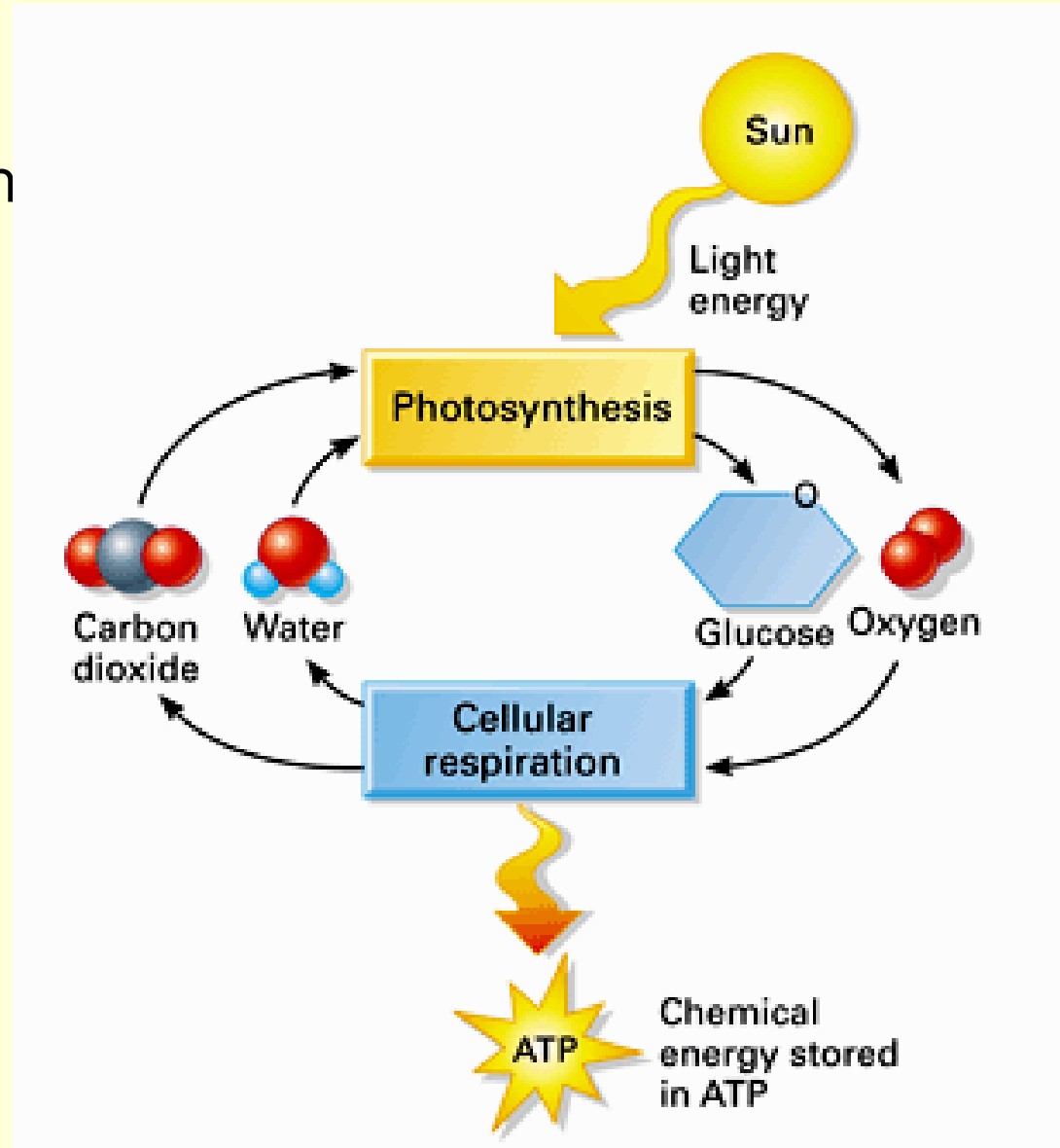


# Principles of Energy Harvest

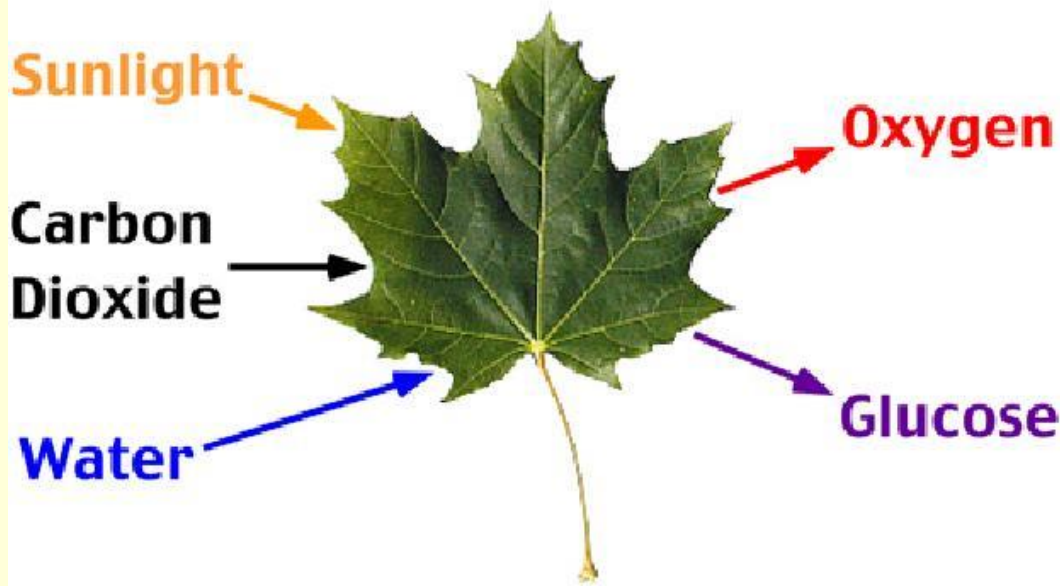
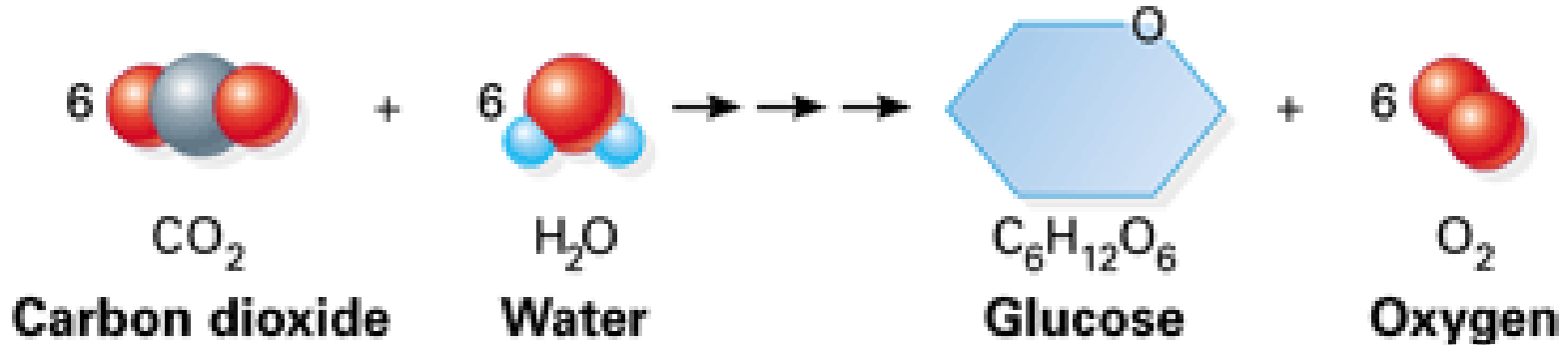
Energy flow occurs through the ecosystem

The products of photosynthesis are used in cellular respiration.

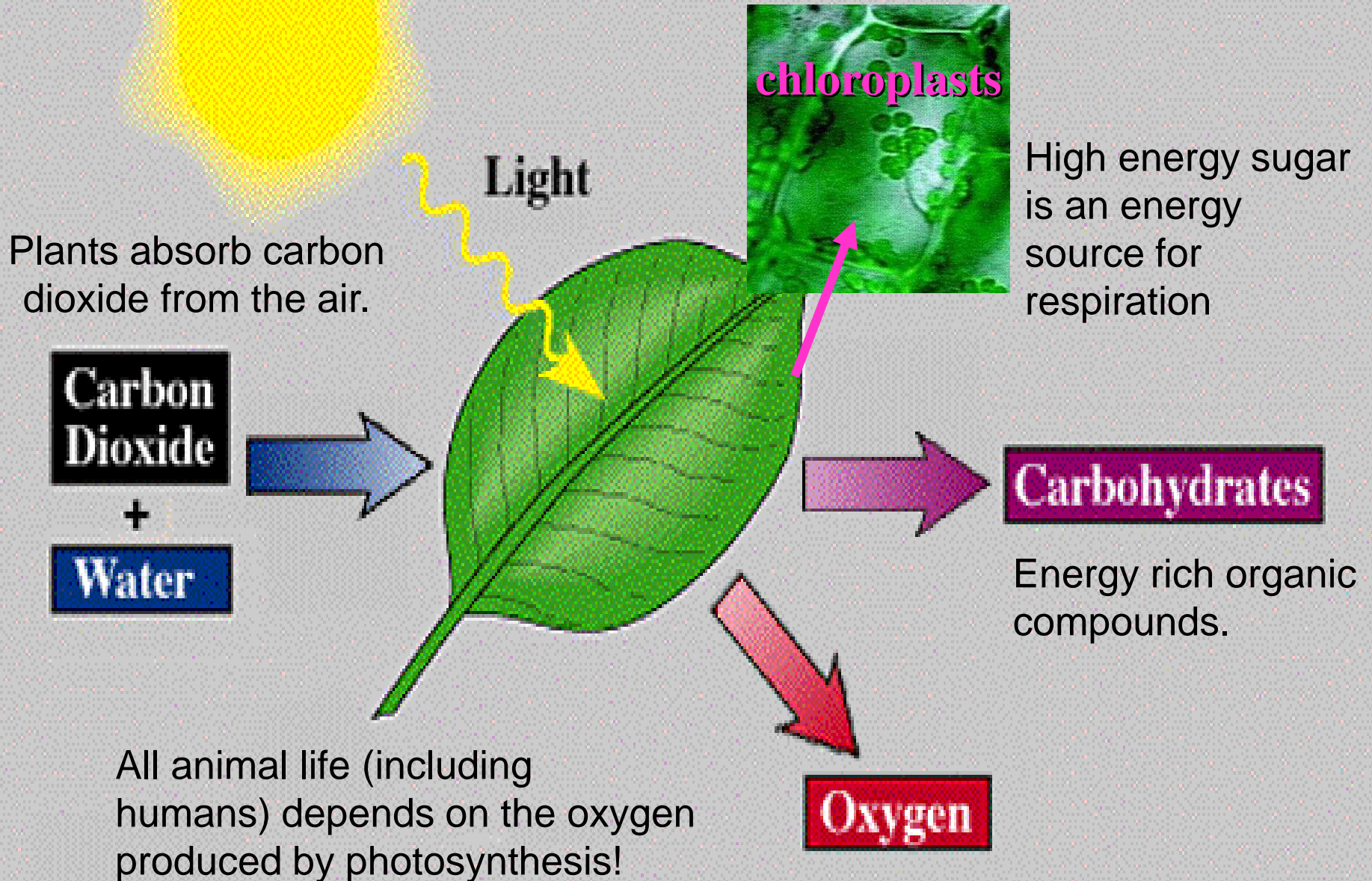
The products of cellular respiration are the ingredients for photosynthesis.



**Photosynthesis:** Use light energy from the sun to make sugar from carbon dioxide and water.



# Photosynthesis

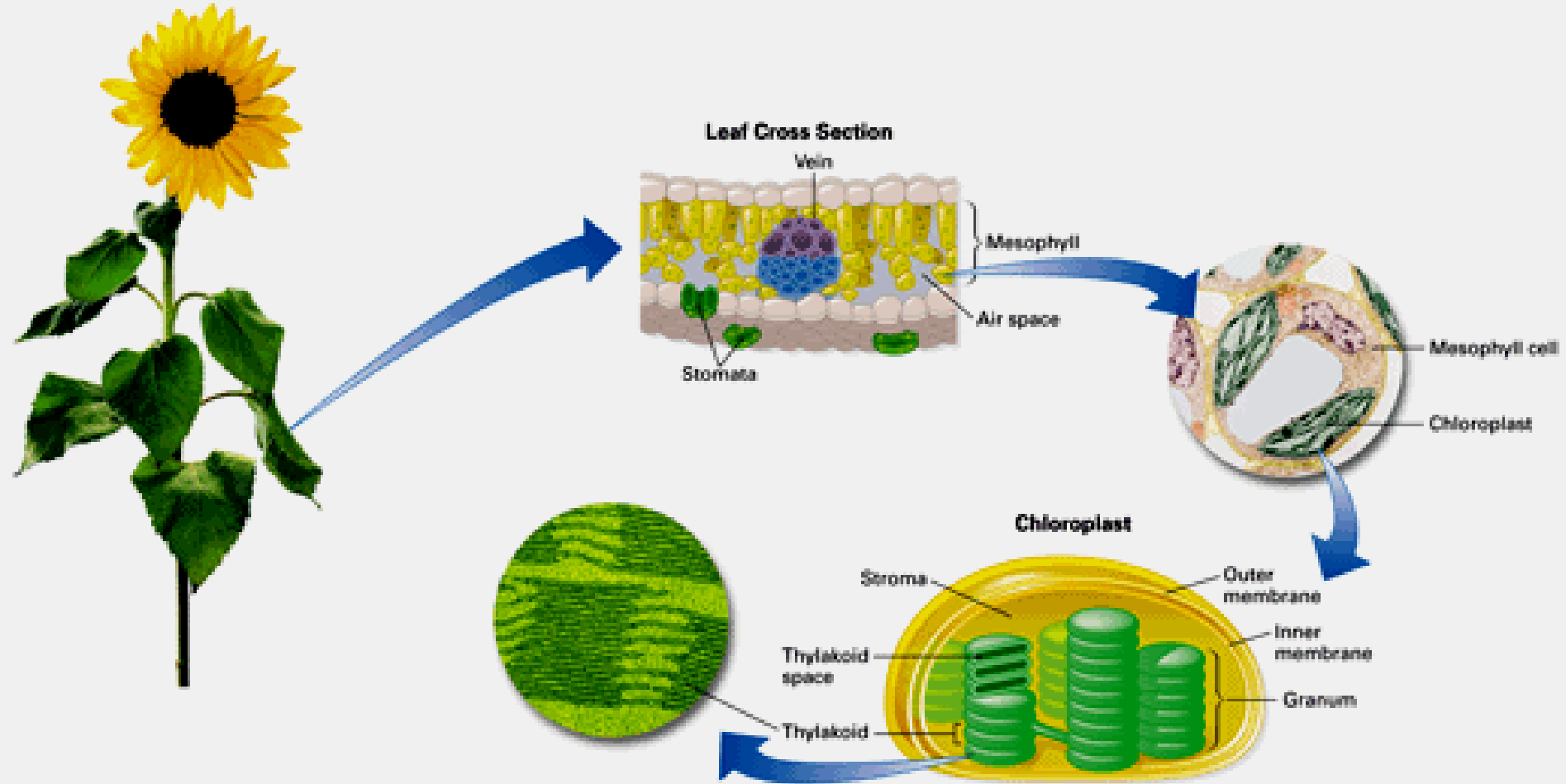




# Chloroplasts are the sites of photosynthesis in plants

The leaf is the organ of photosynthesis.

Photosynthesis takes place in cellular organelles called chloroplasts.



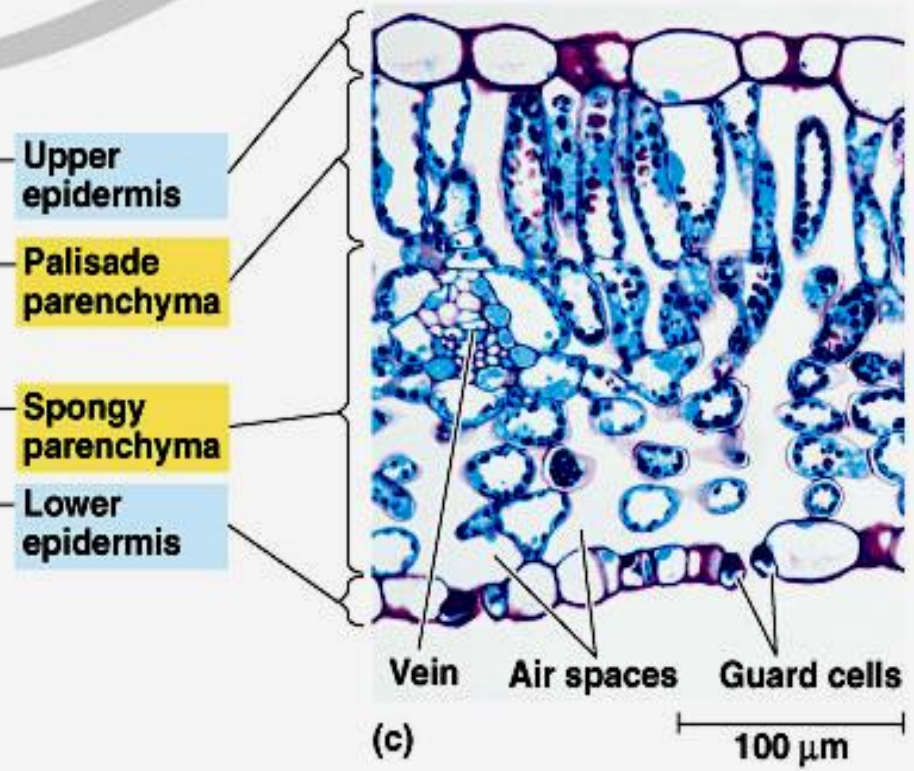
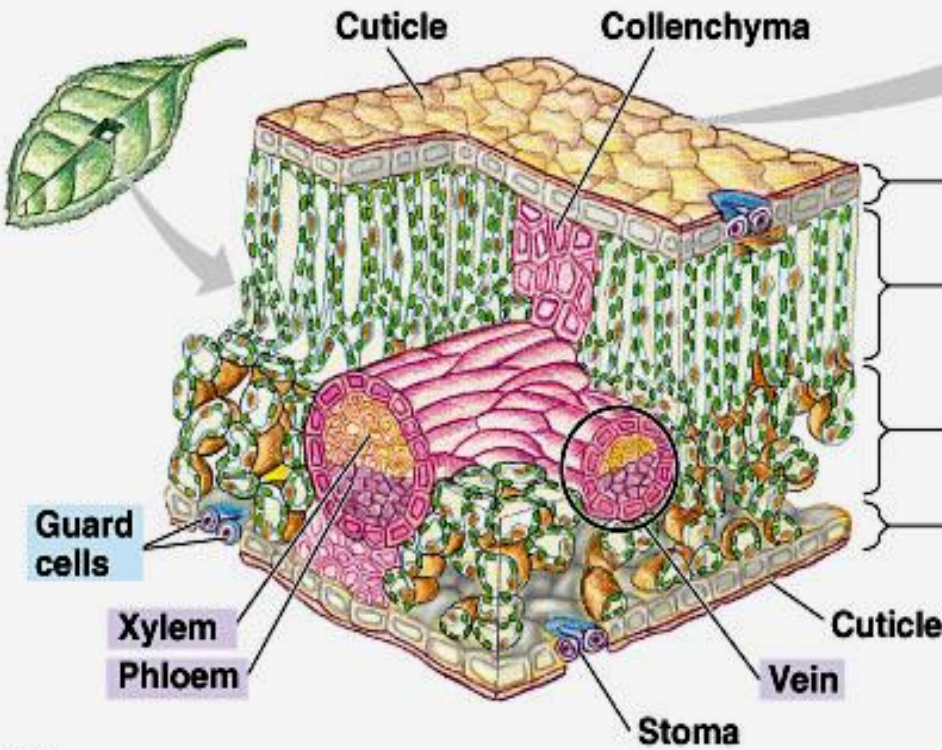
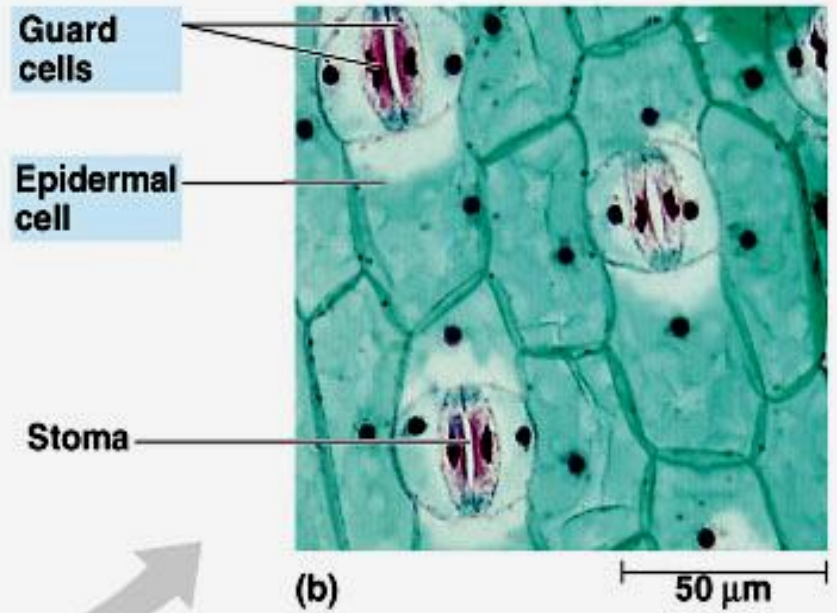
**Stomates** regulate the exchange gases with guard cells

Good water: Stomates Open

Dry Condition: Stomates Close

**Key**

- Dermal
- Ground
- Vascular



(a)

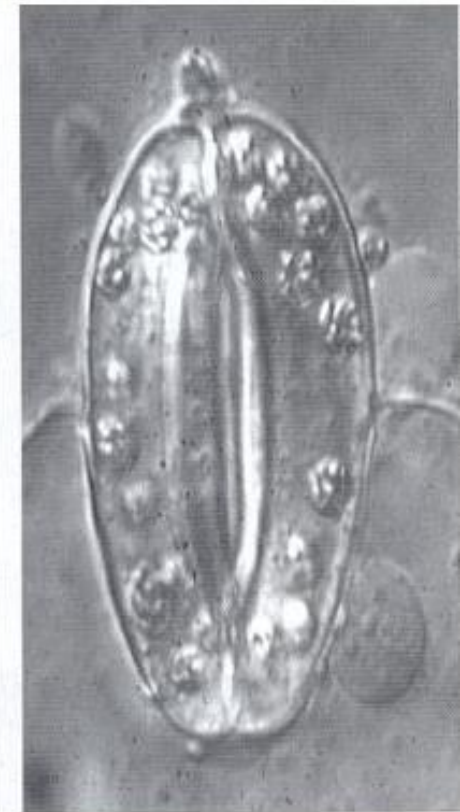
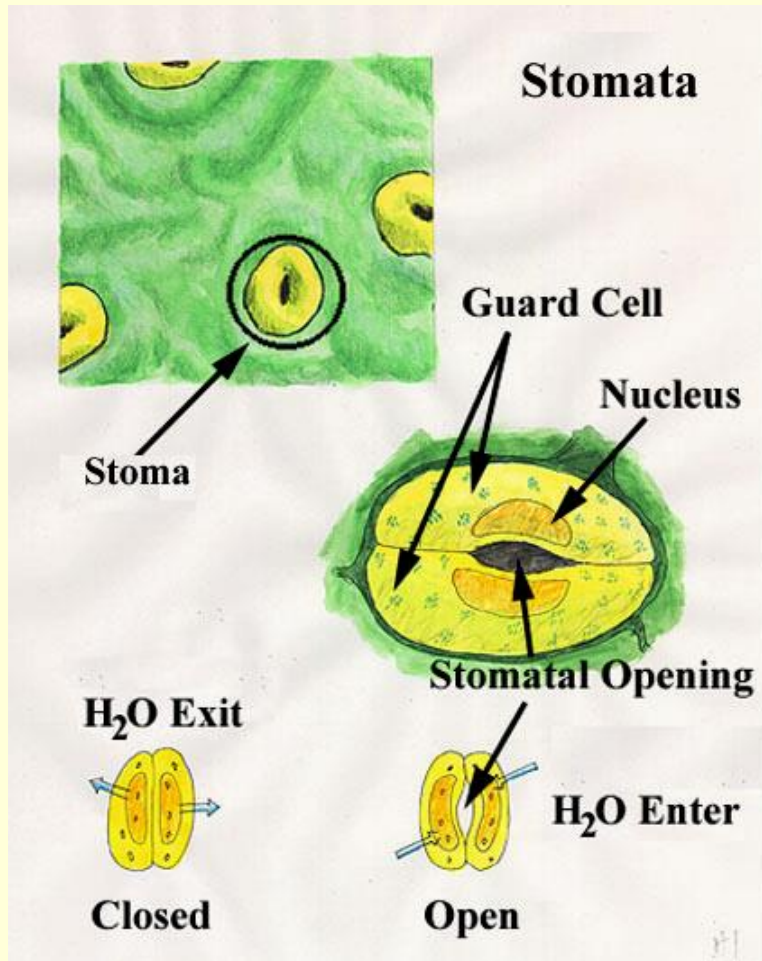
(b)

(c)

**Feedback:** Conditions regulate guard cells to open or close stomates

Open – water vapor exits & carbon dioxide enters

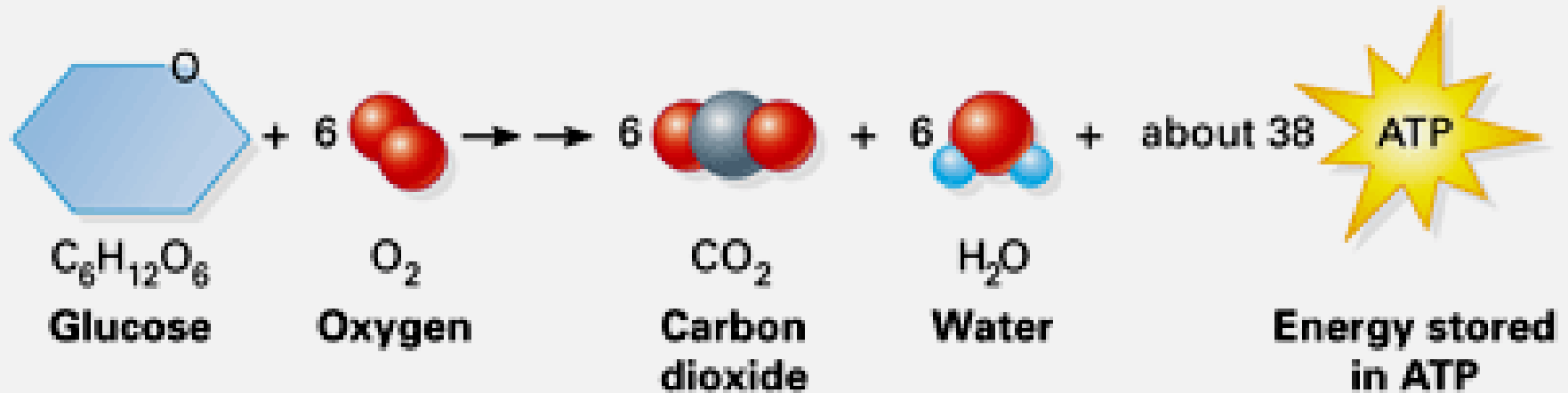
Closed – plant is conserving water



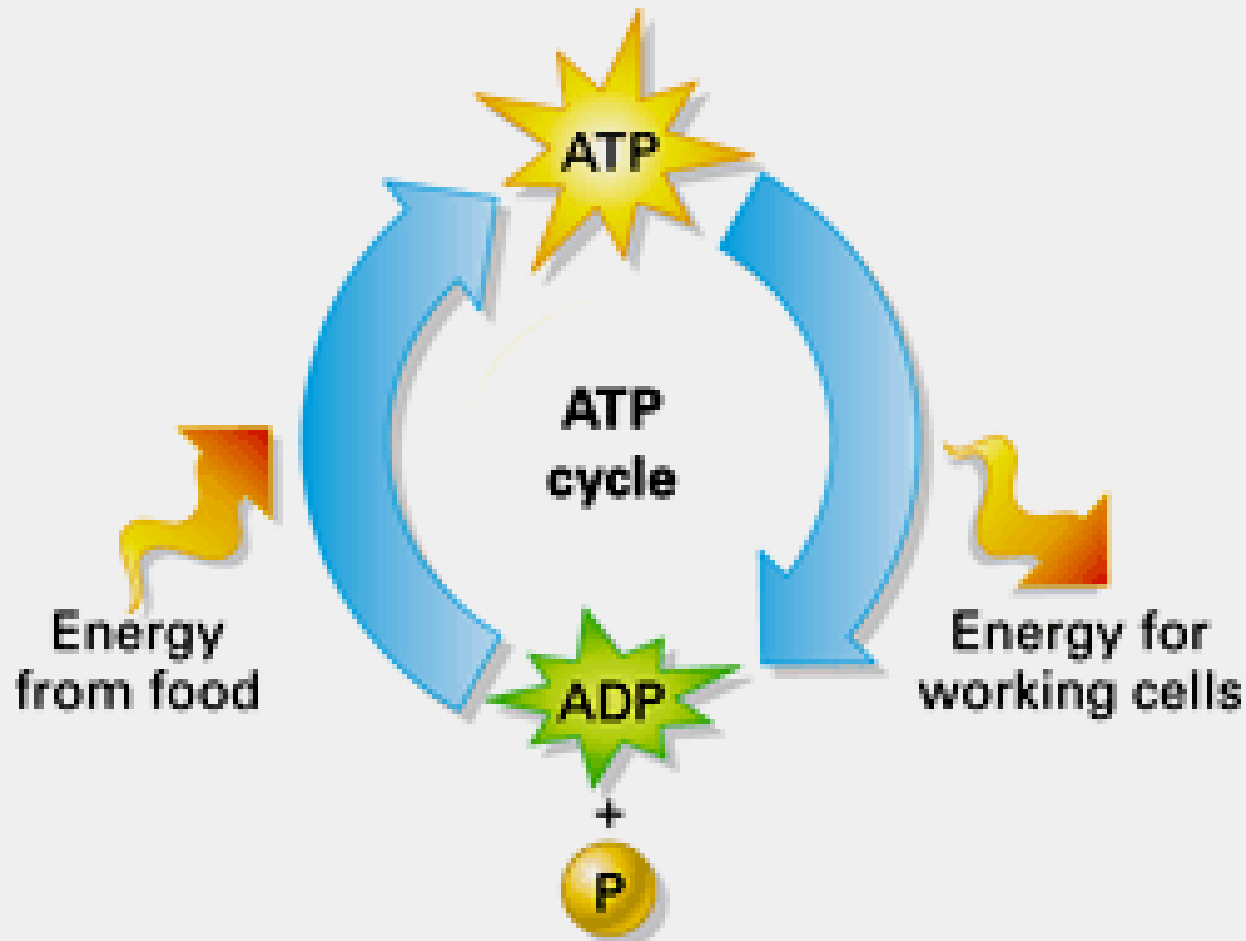


# Cell Respiration

Energy stored in organic molecules is released as and temporarily stored as ATP



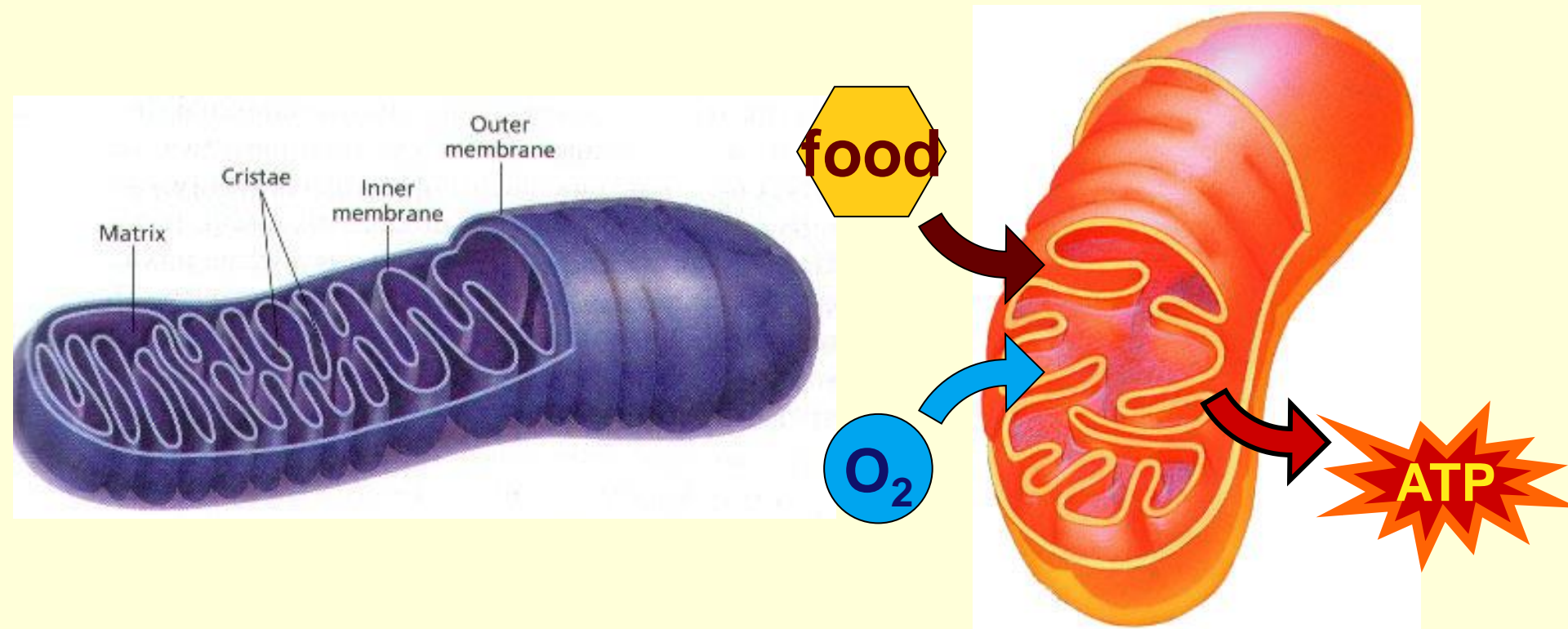
# The ATP Cycle



ATP is constantly recycled in your cells. A working muscle cell recycles all of its ATP molecules about once each minute. That's 10 million ATP molecules spent and regenerated per second!

**Cell Respiration** takes place in the mitochondria in eukaryotic cells (cell with organelles bound by membrane)

Plants and Animals perform cell respiration.

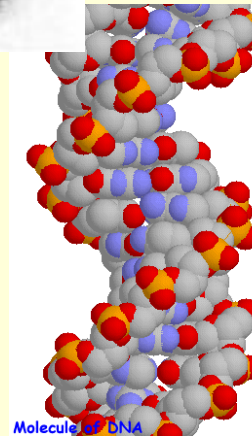
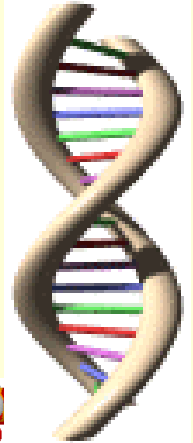
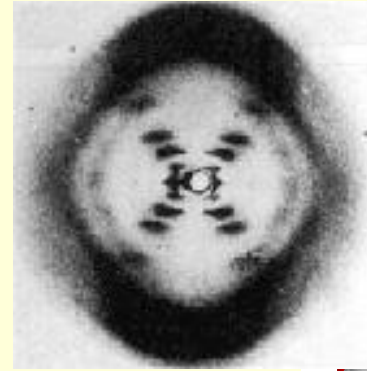
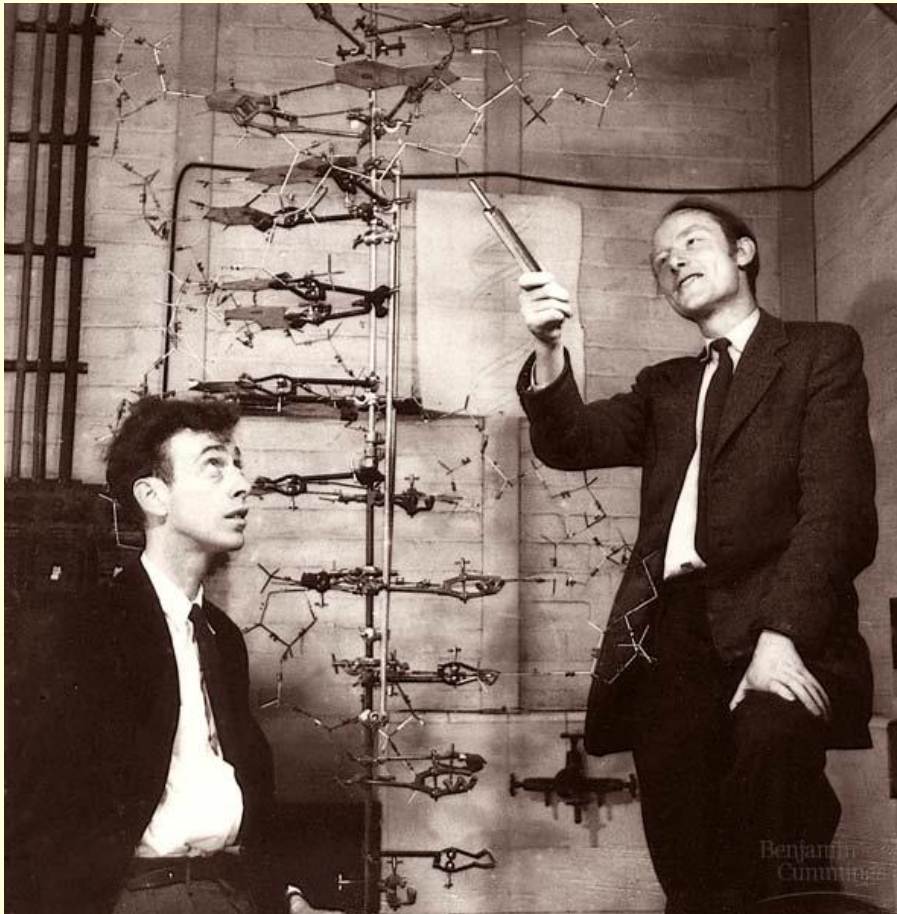




# Genetic Nature of Life

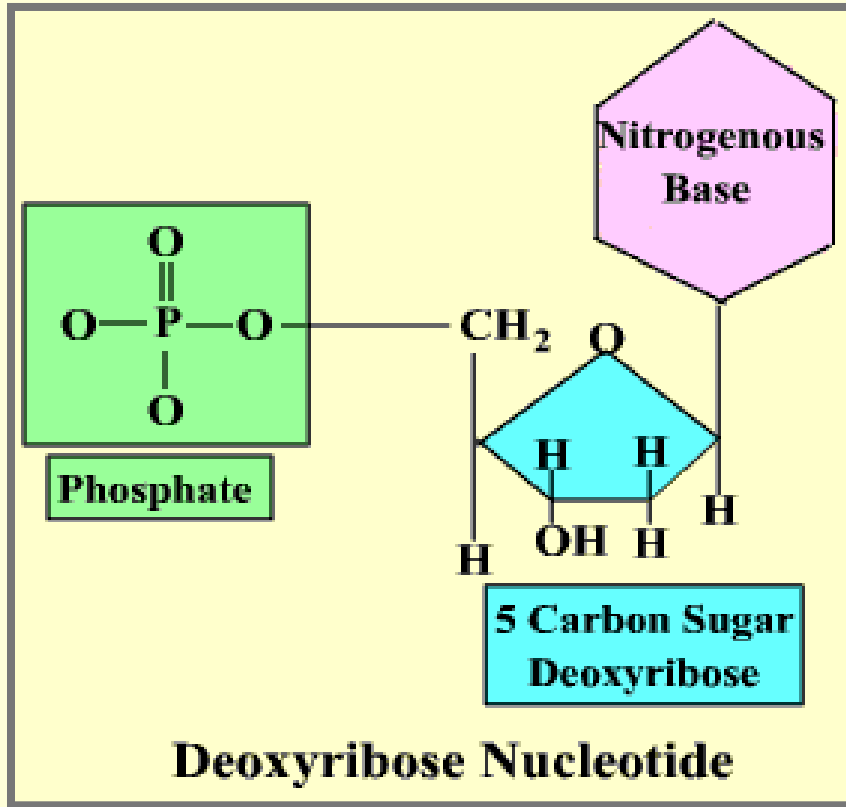
## Key Idea 2:

Organisms inherit genetic information in a variety of ways that result in continuity of structure and function between parents and offspring.

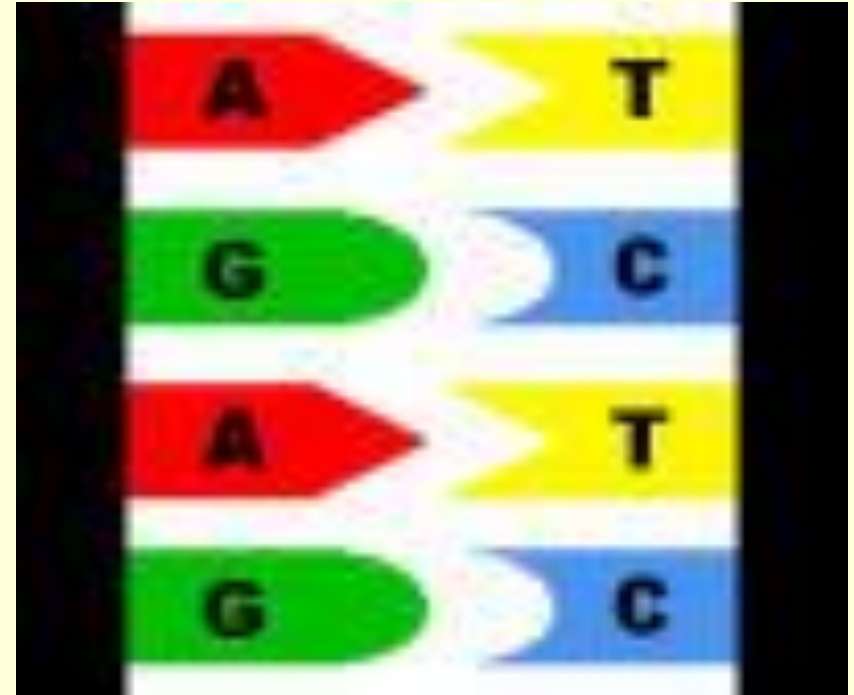


**DNA is the language of life**

# Nucleotides: The building blocks of DNA



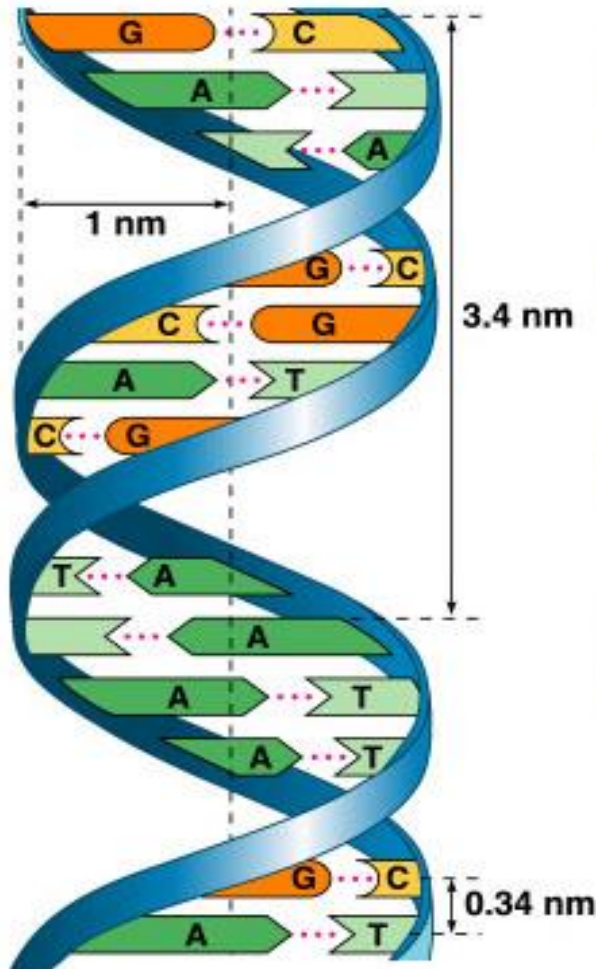
## Nitrogen Bases



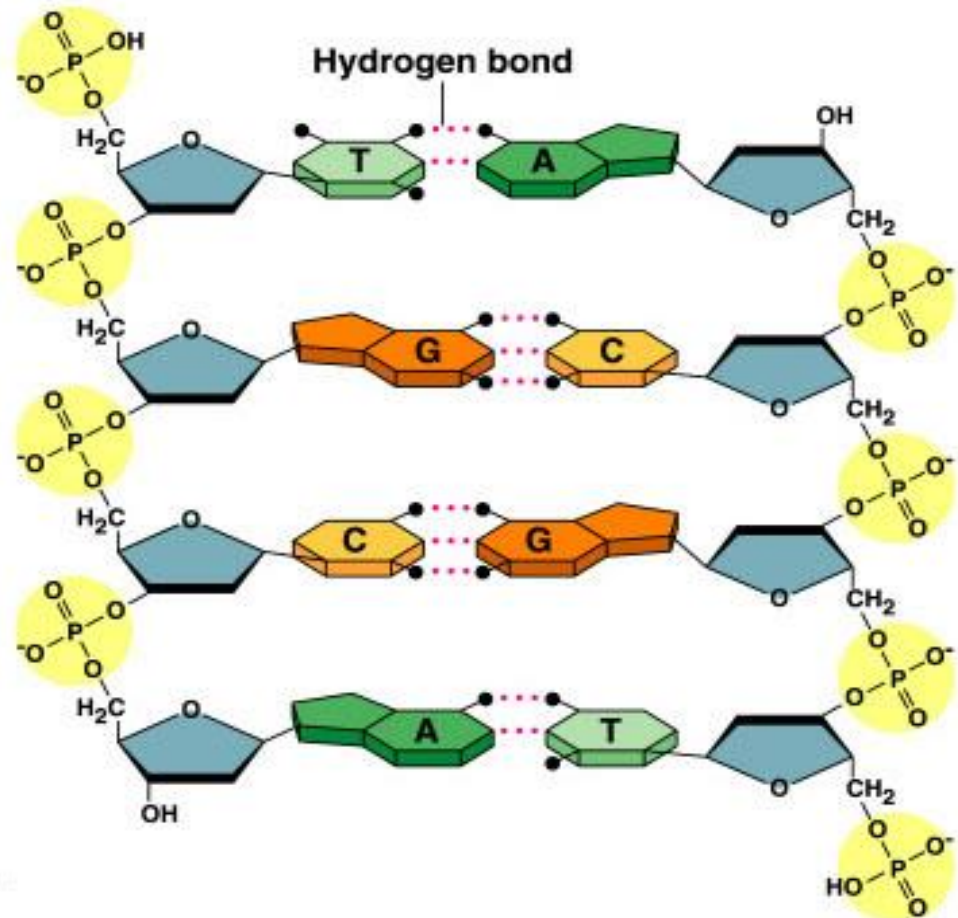
# Structure of DNA

Nucleotides of sugar, phosphate, nitrogen bases

The bases pair forming the a **double helix** A:T and G:C.



(a) Key features of DNA structure

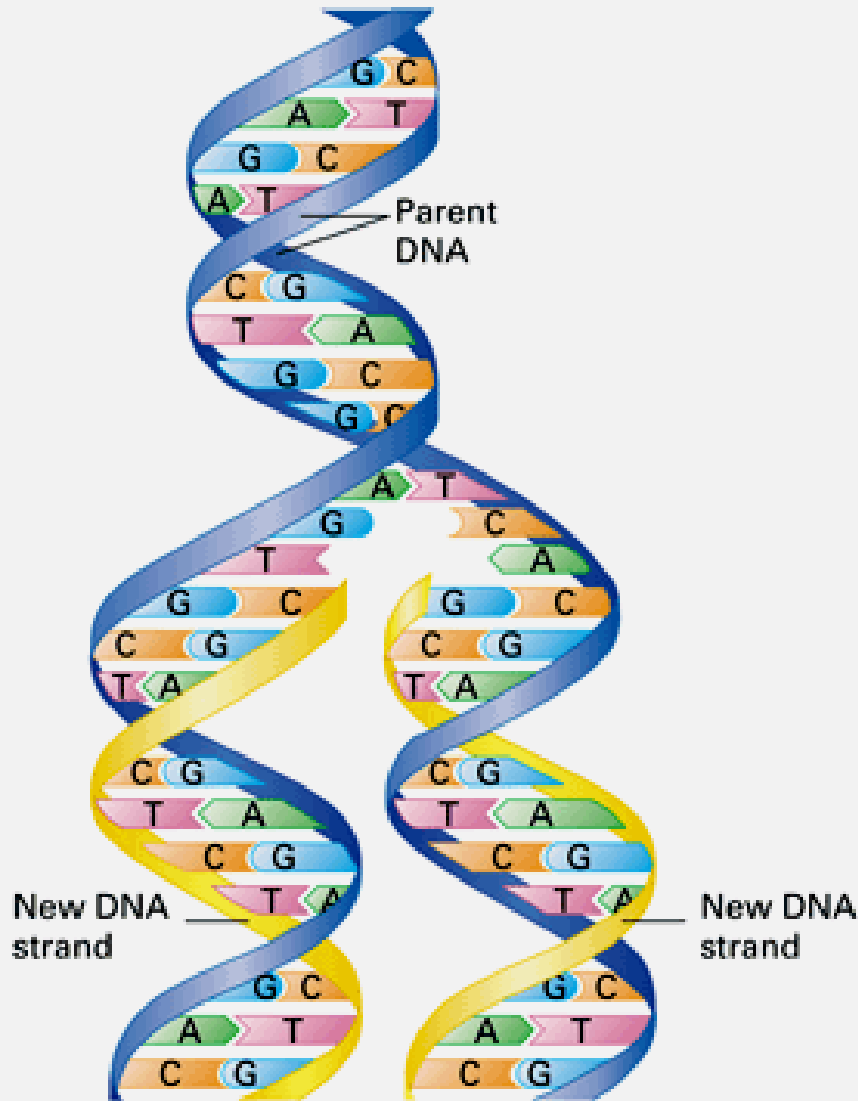


(b) Partial chemical structure



# DNA Replication occurs when cells divide

Occurs before cells divide in mitosis and meiosis



The original parent DNA molecule **serves as a template** for making a new strand.

Results in two daughter DNA molecules, each consisting of one original strand and one new strand.

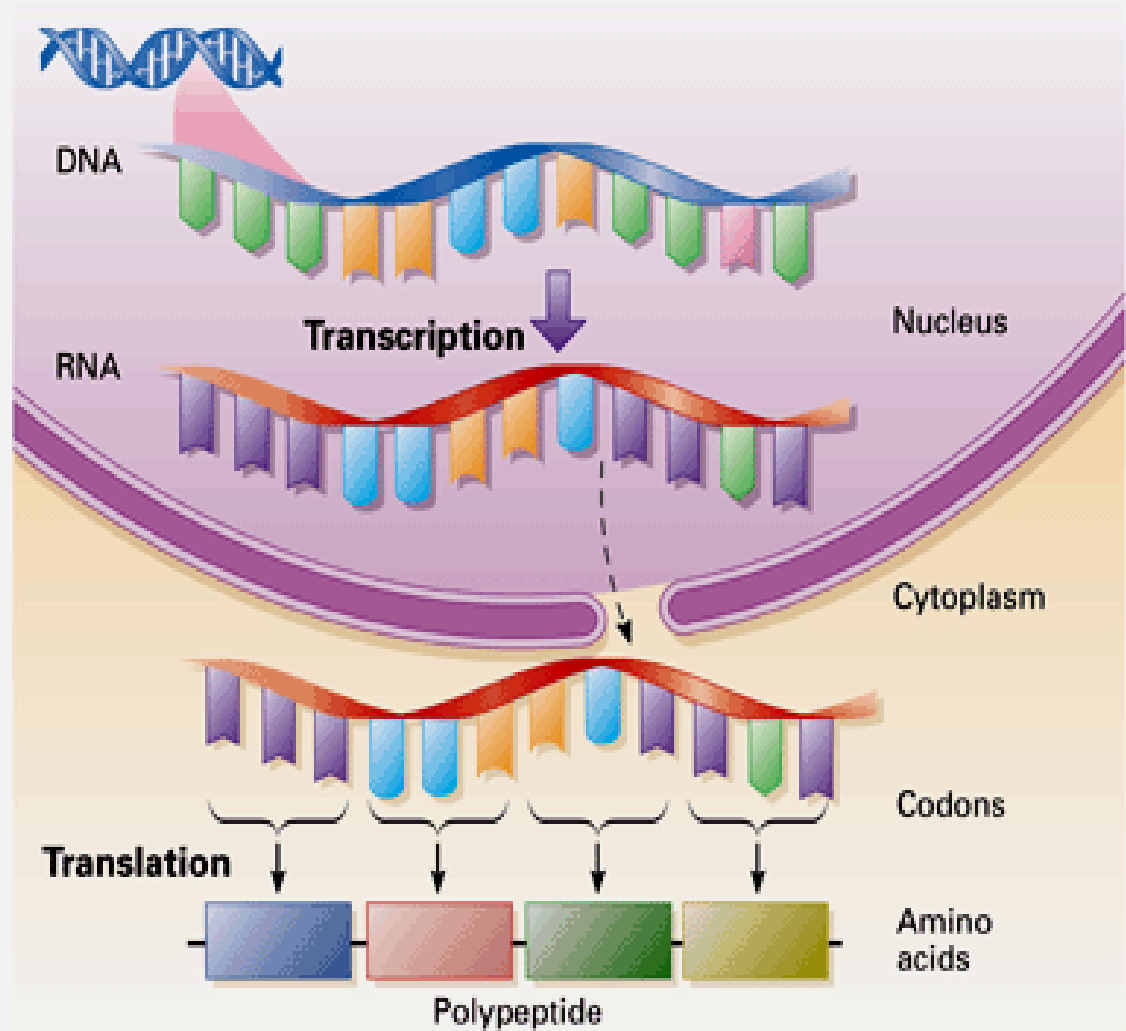
**DNA regulates cell processes with its specific code to synthesize proteins.**

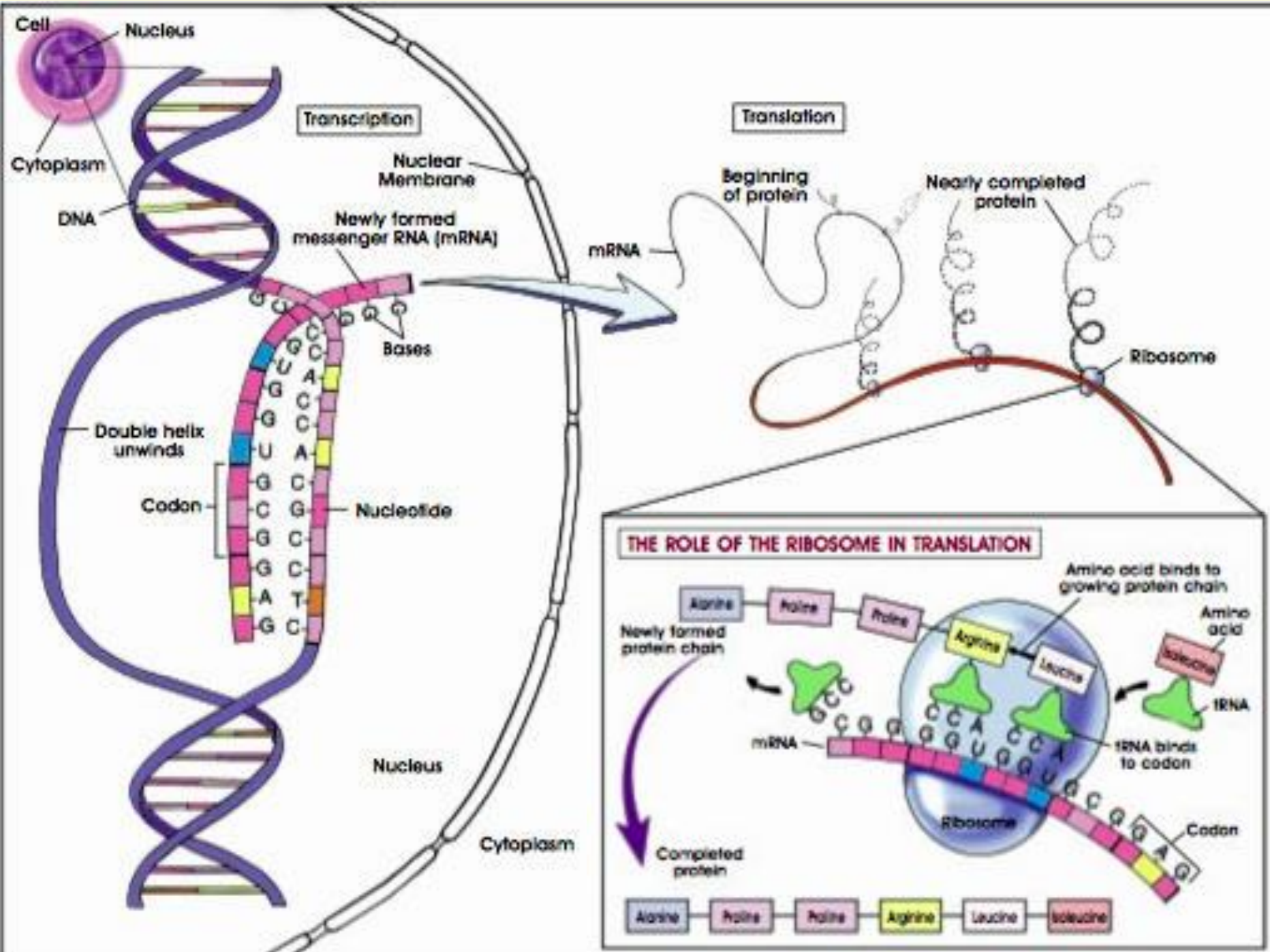
## **DNA to RNA to Protein**

**Information flows from gene to protein.**

DNA (a gene) is copied to make RNA in the cell's nucleus.

The RNA travels to the ribosome where it is **translated** into the specific amino acid sequence of a protein.





Cell Nucleus

Cytoplasm

DNA

Transcription

Nuclear Membrane

Newly formed messenger RNA (mRNA)

Bases

Double helix unwinds

Codon

Nucleotide

Nucleus

Cytoplasm

Translation

Beginning of protein

Nearly completed protein

Ribosome

mRNA

THE ROLE OF THE RIBOSOME IN TRANSLATION

Newly formed protein chain

Amino acid binds to growing protein chain

Amino acid

tRNA

tRNA binds to codon

mRNA

Ribosome

Codon

Completed protein

Arginine Proline Proline Arginine Leucine Isoleucine



# The Triplet Code

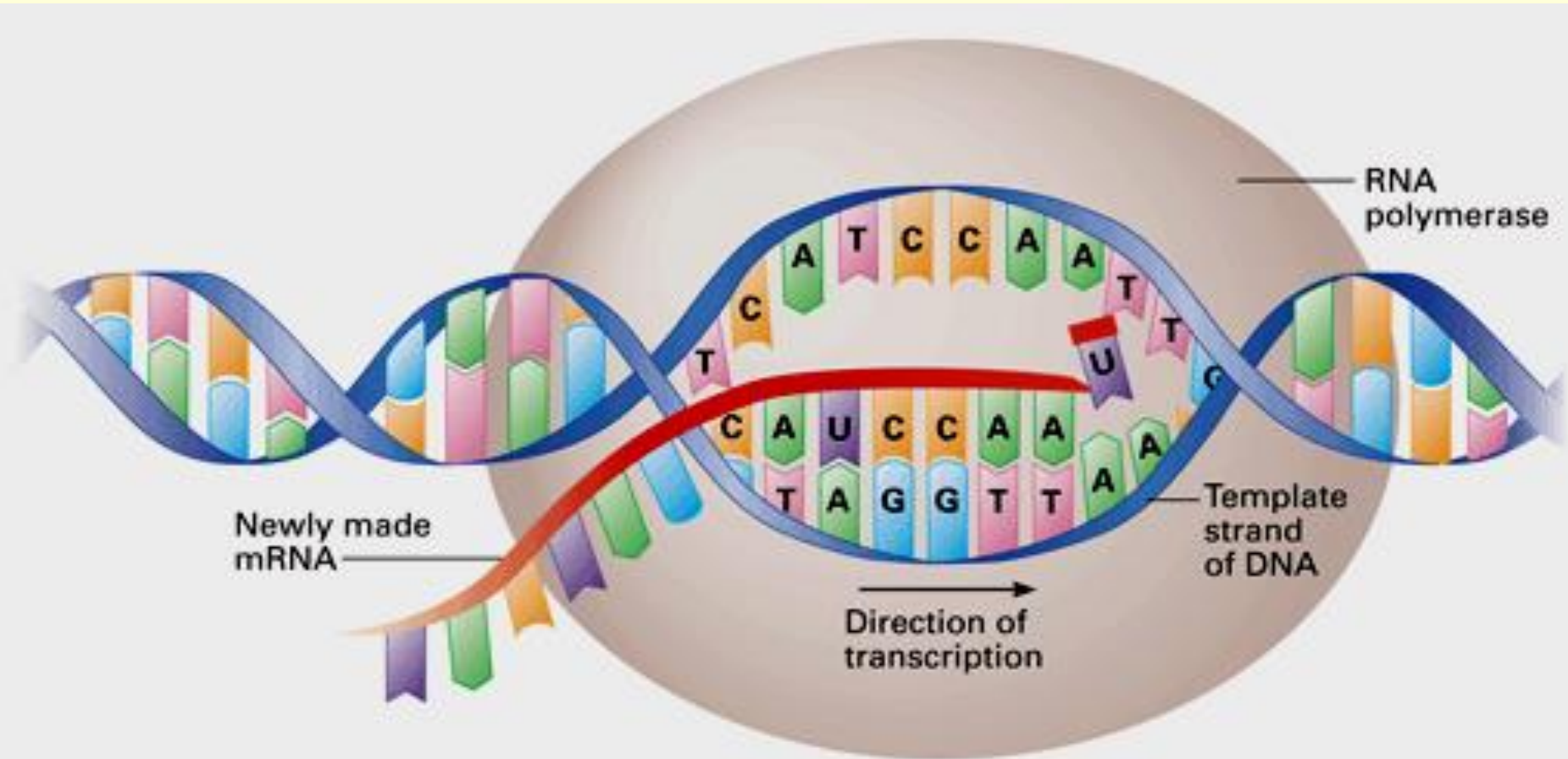
Each RNA codon codes for a particular amino acid.

The genetic code is a universal dictionary for the synthesis of proteins from the DNA nucleotides.

		Second base in codon				
		U	C	A	G	
U	UUU } Phe	UCU } Ser	UAU } Tyr	UGU } Cys	U	
	UUC } Phe		UAC } Tyr	UGC } Cys	C	
	UUA } Leu		UCA } Ser	UAA Stop	UGA Stop	A
	UUG } Leu		UCG } Ser	UAG Stop	UGG Trp	G
C	CUU } Leu	CCU } Pro	CAU } His	CGU } Arg	U	
	CUC } Leu		CCC } Pro	CAC } His	CGC } Arg	C
	CUA } Leu		CCA } Pro	CAA } Gln	CGA } Arg	A
	CUG } Leu		CCG } Pro	CAG } Gln	CGG } Arg	G
A	AUU } Ile	ACU } Thr	AAU } Asn	AGU } Ser	U	
	AUC } Ile		ACC } Thr	AAC } Asn	AGC } Ser	C
	AUA } Ile		ACA } Thr	AAA } Lys	AGA } Arg	A
	AUG Met or start		ACG } Thr	AAG } Lys	AGG } Arg	G
G	GUU } Val	GCU } Ala	GAU } Asp	GGU } Gly	U	
	GUC } Val		GCC } Ala	GAC } Asp	GGC } Gly	C
	GUA } Val		GCA } Ala	GAA } Glu	GGA } Gly	A
	GUG } Val		GCG } Ala	GAG } Glu	GGG } Gly	G

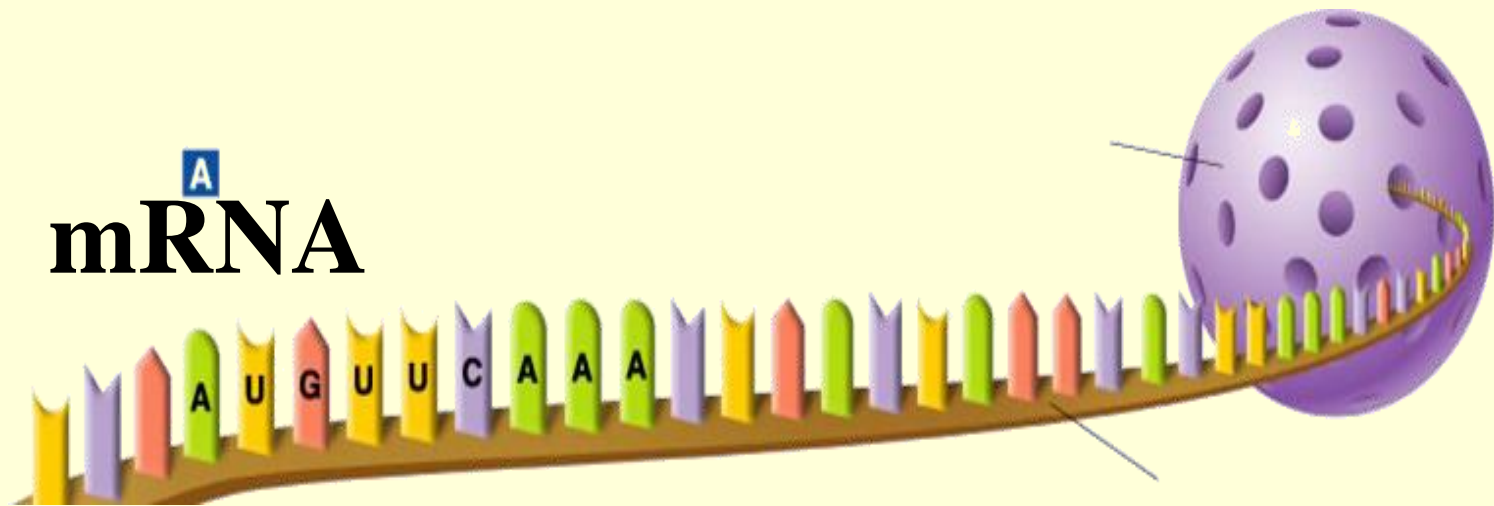
## Step 1: DNA to RNA

The DNA template is used to make a single stranded RNA.

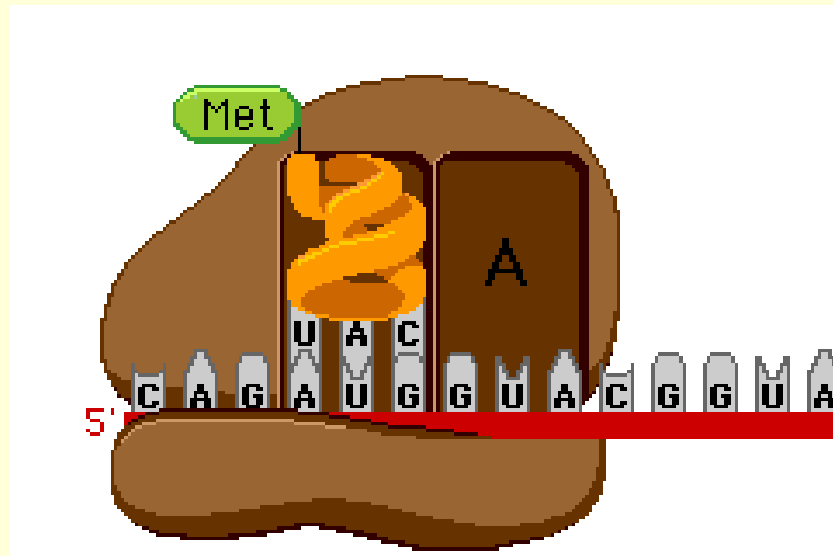


RNA nucleotides base-pair with DNA nucleotides on the template strand. RNA has the base U which pairs with A in DNA.

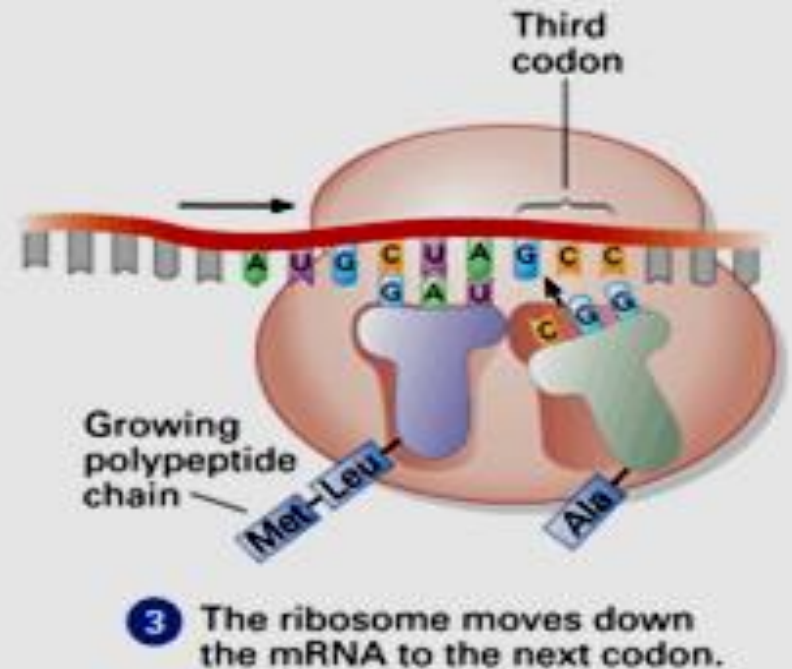
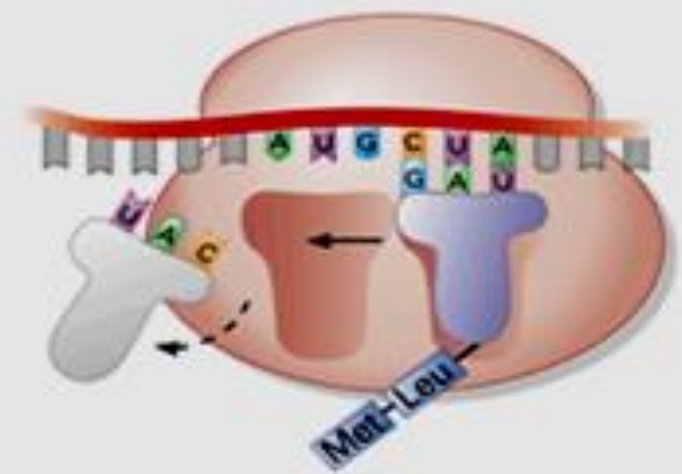
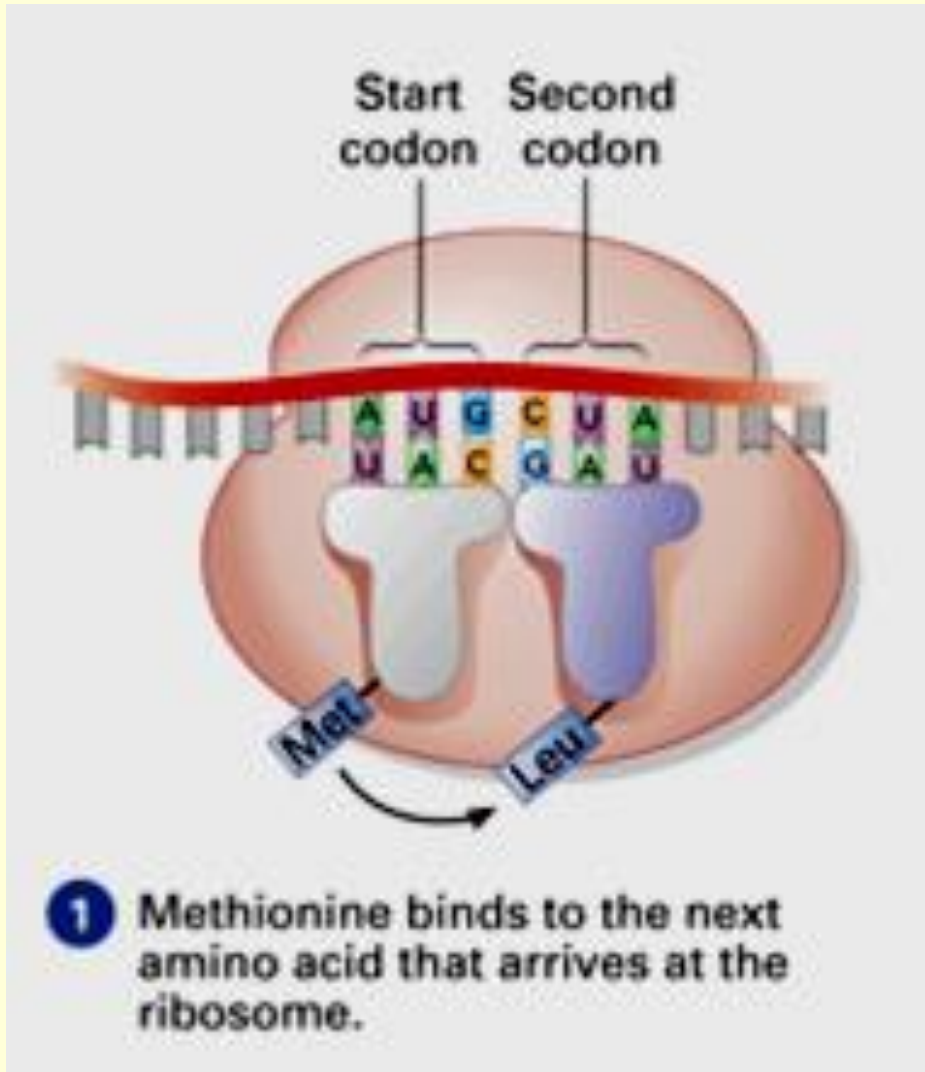
## Step 2: mRNA leaves the nucleus



## Step 3: mRNA and Ribosome join in cytoplasm

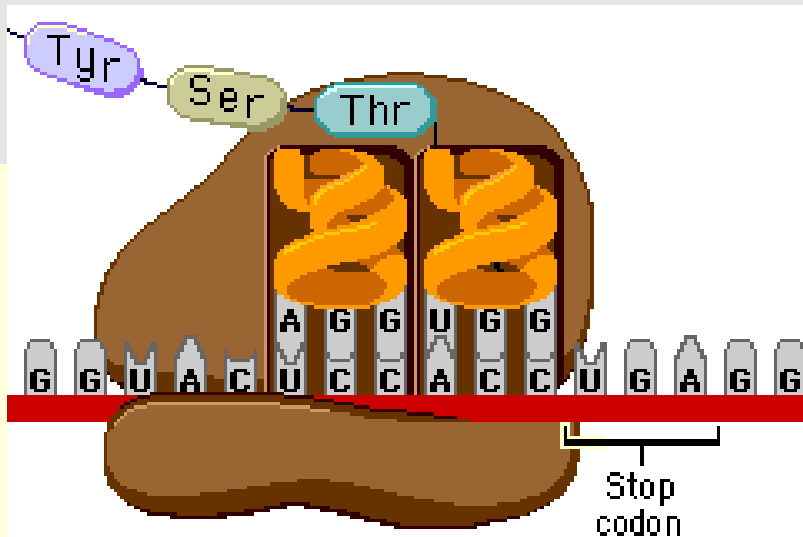
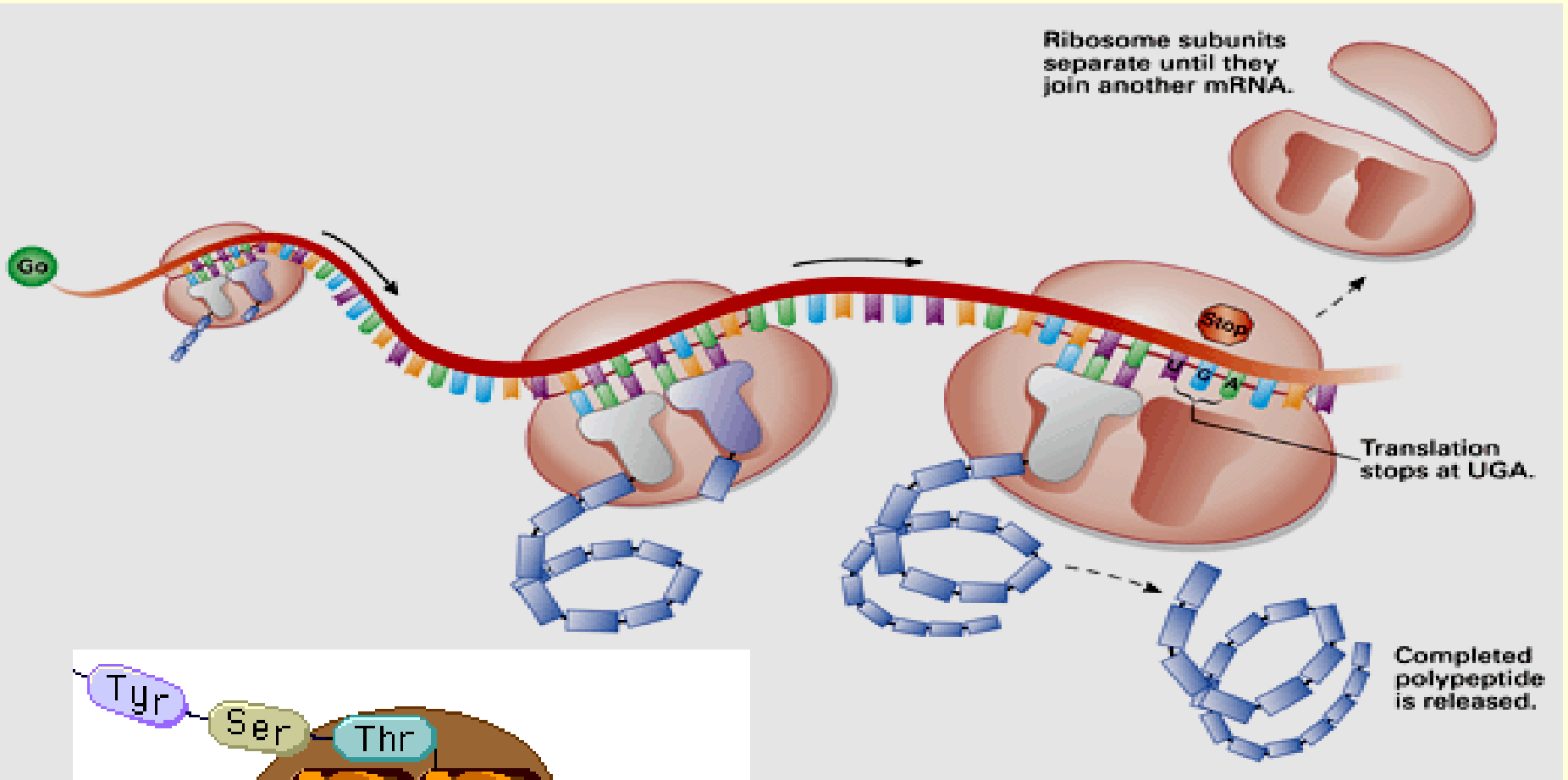


# Step 4: Amino Acids are carried to ribosome and joins according to the triplet code



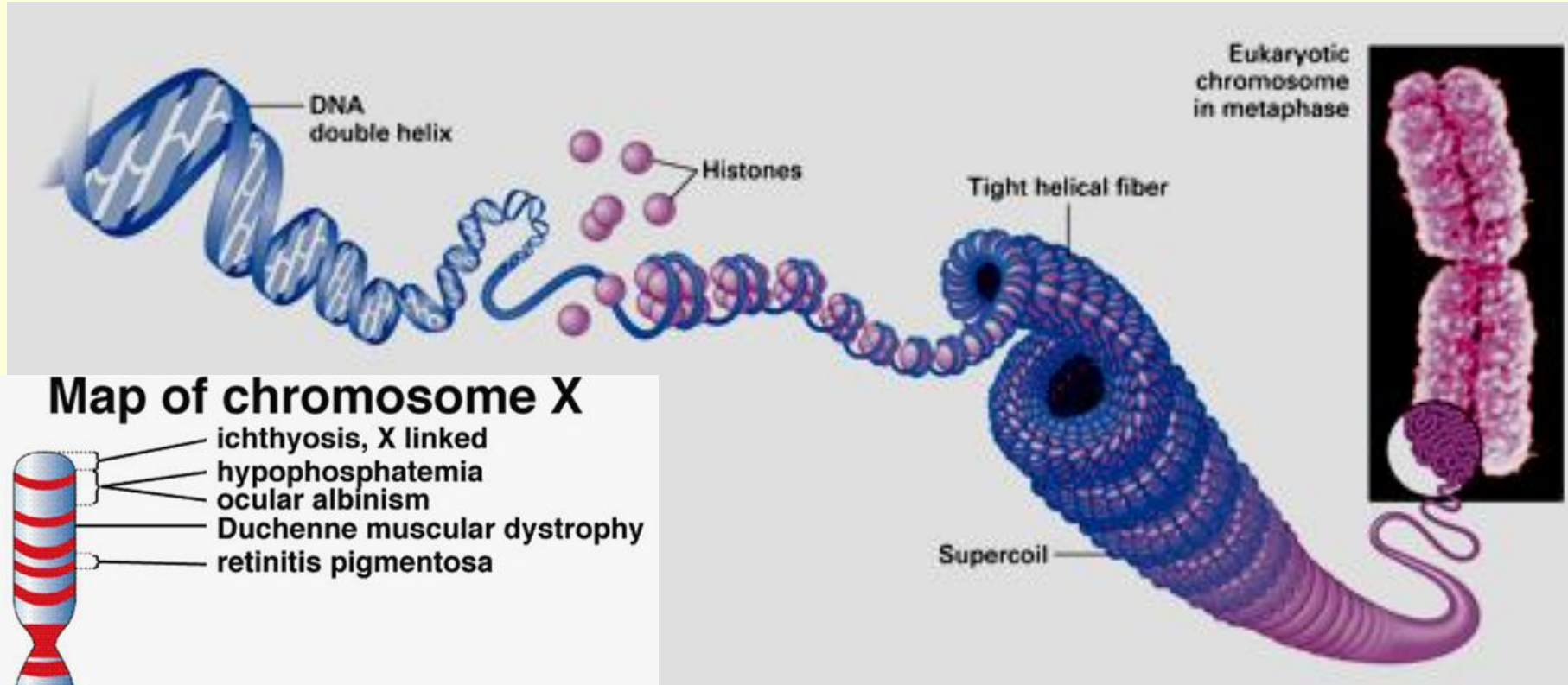


# Step 5: The protein chain is created

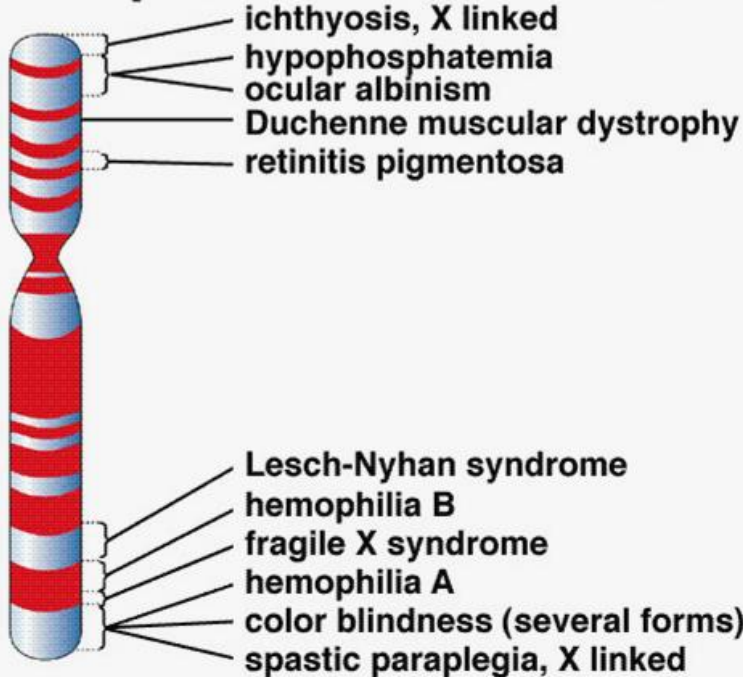


The DNA is wrapped around proteins to form Chromosomes

The Gene is a unit of information within a chromosome



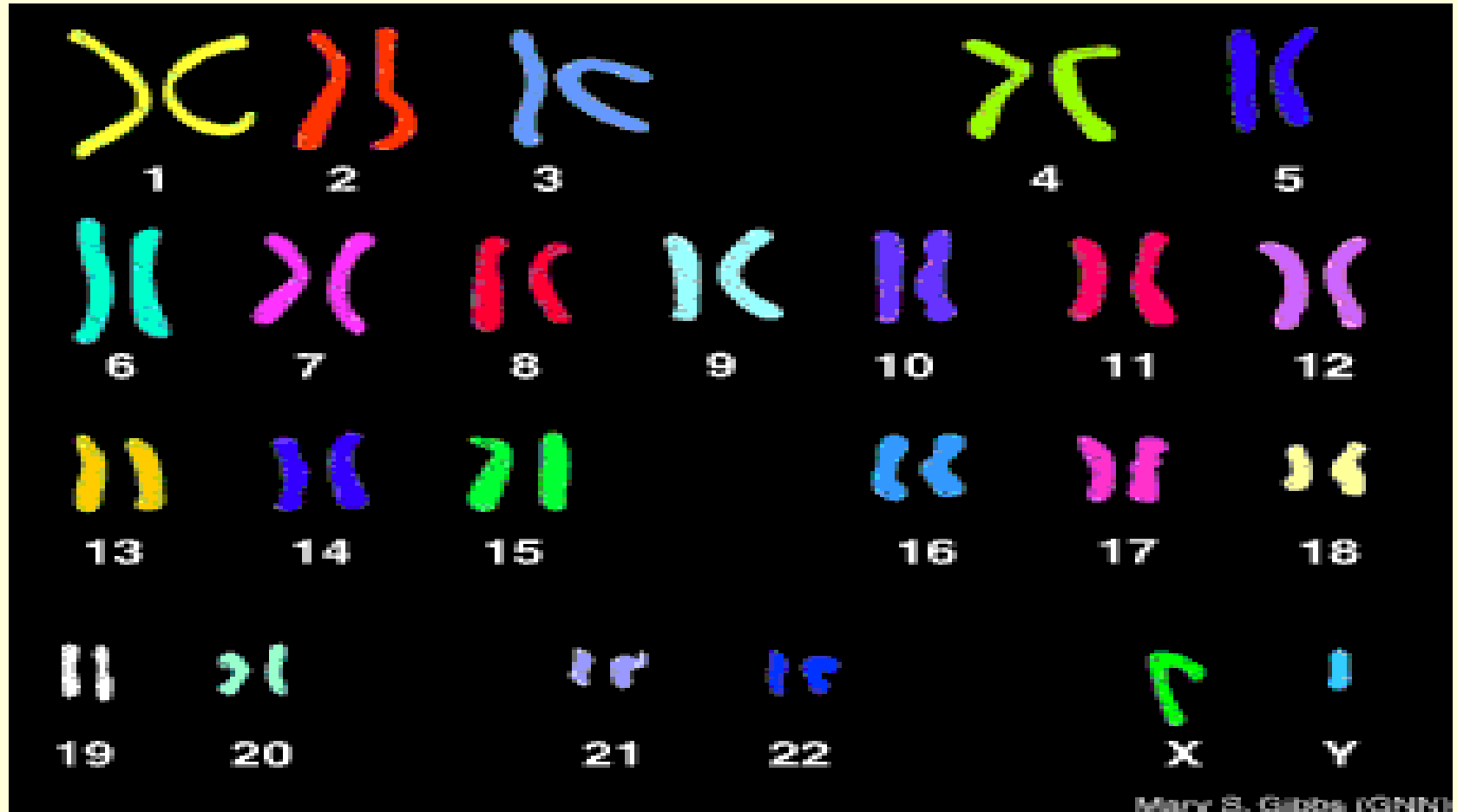
### Map of chromosome X



Many genes or on a chromosome

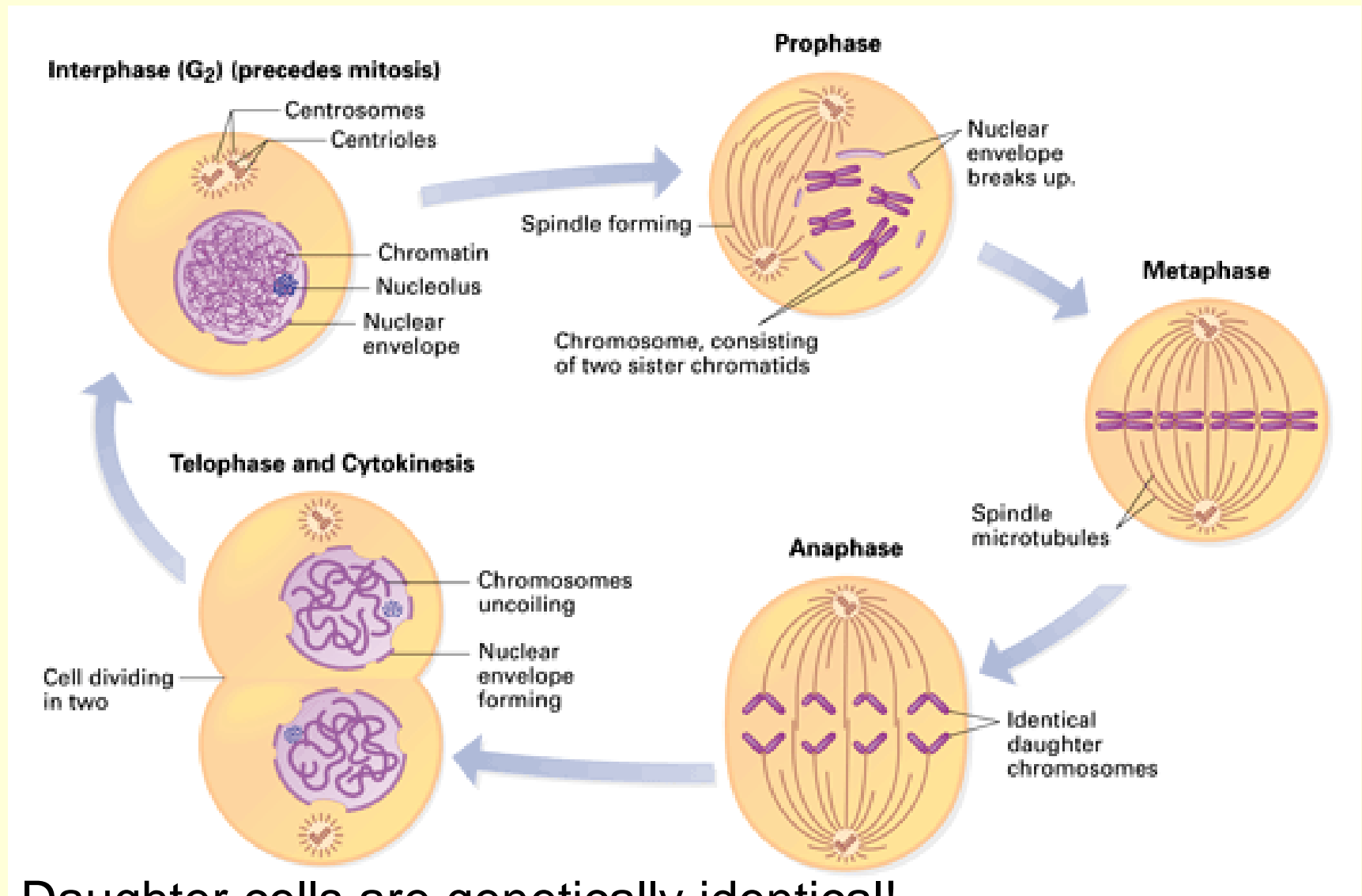
Humans have 46 chromosomes in a “normal” body cell.

Chromosomes in a body cell are paired, so we have two of each one.



Sex chromosomes: Males are XY and Females are XX

Chromosomes replicate and separate so body cells have the same chromosomes

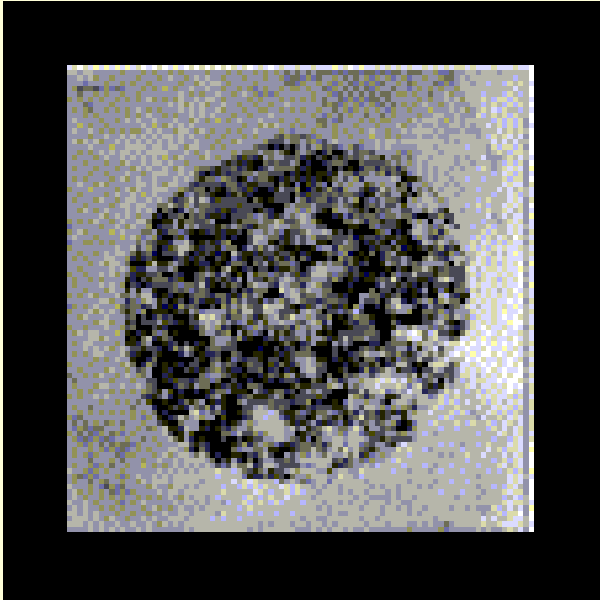


Daughter cells are genetically identical!

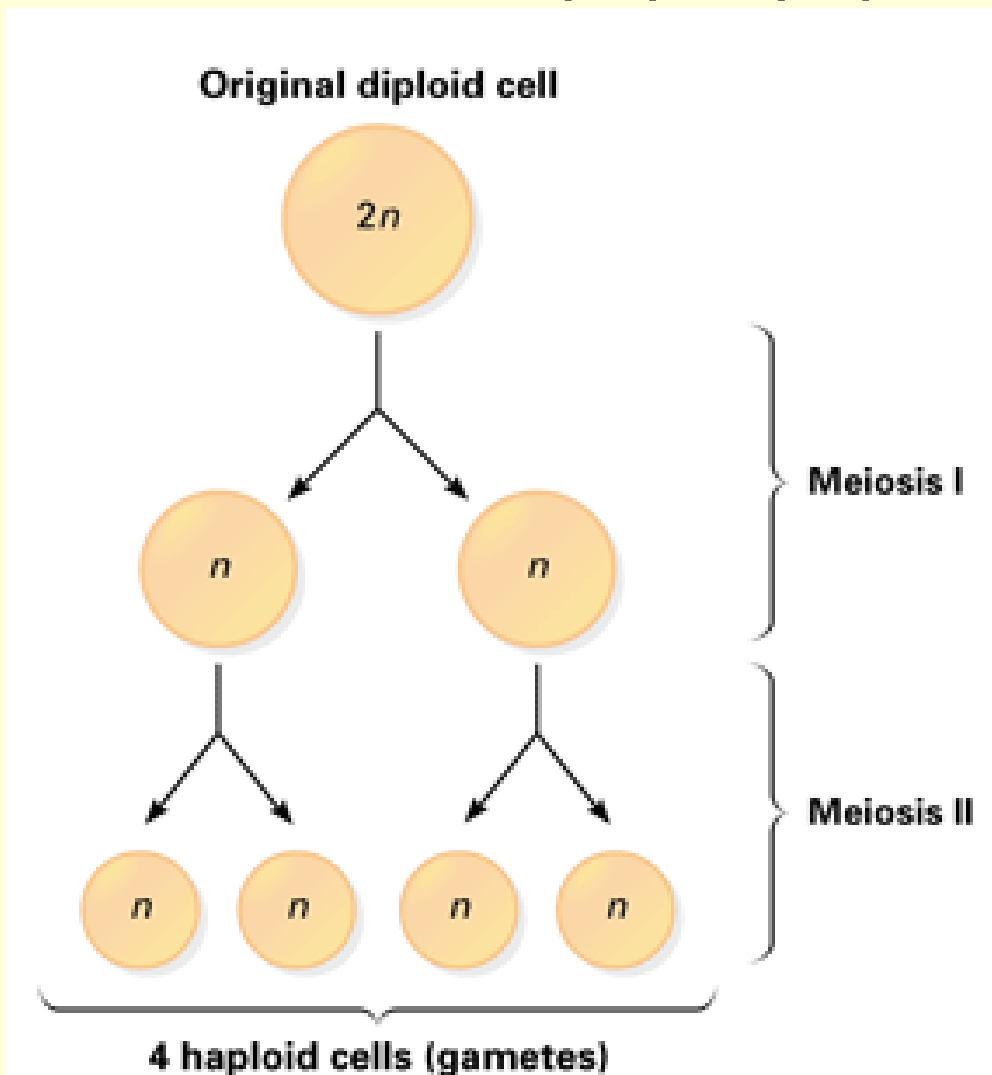


# Meiosis makes Sex Cells (gametes)

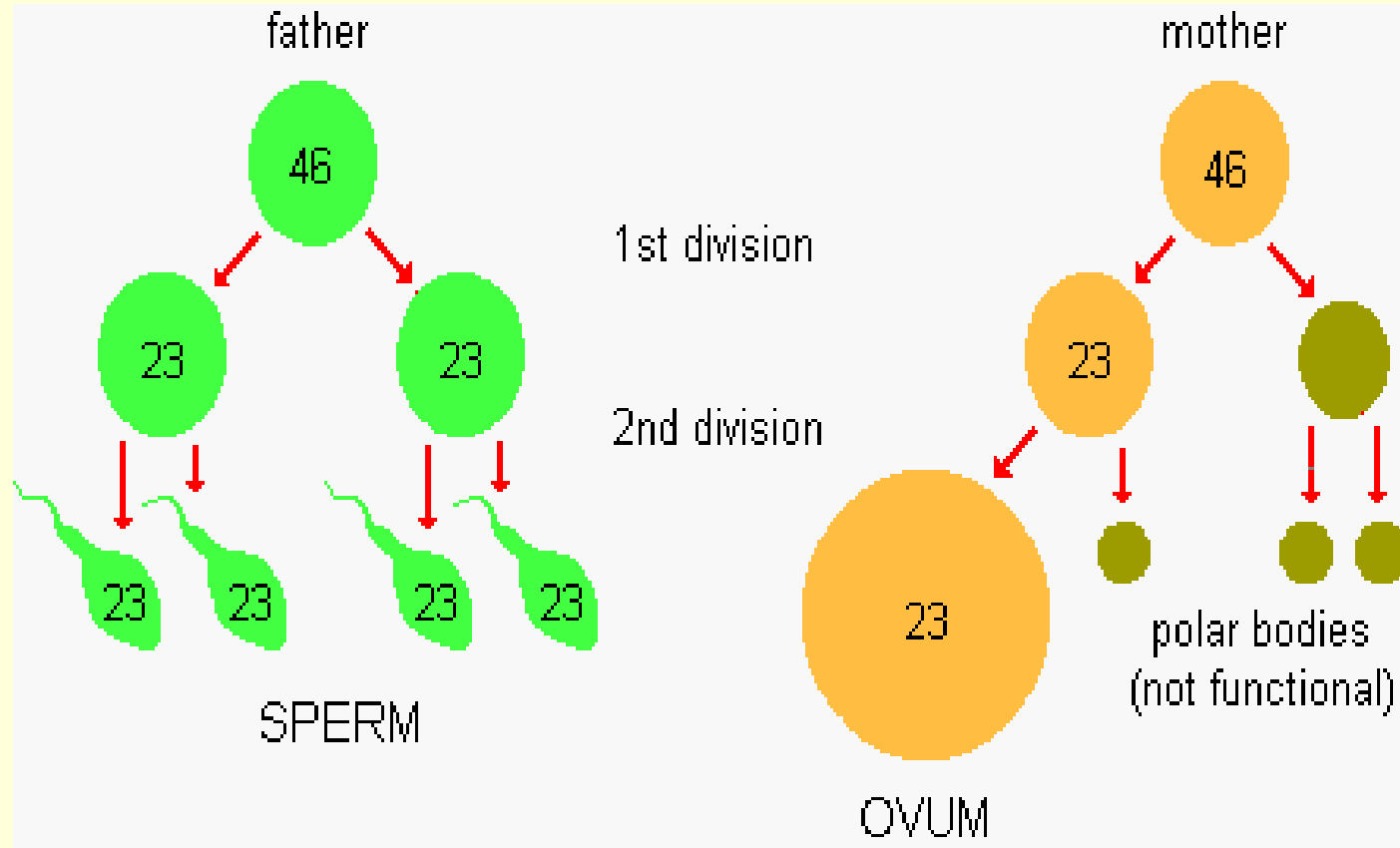
Meiosis reduces chromosome number from ( $2n$ ) to ( $1n$ )



Chromosomes replicate and there is a double division in meiosis.



**Gametes have one of each pair of chromosomes**

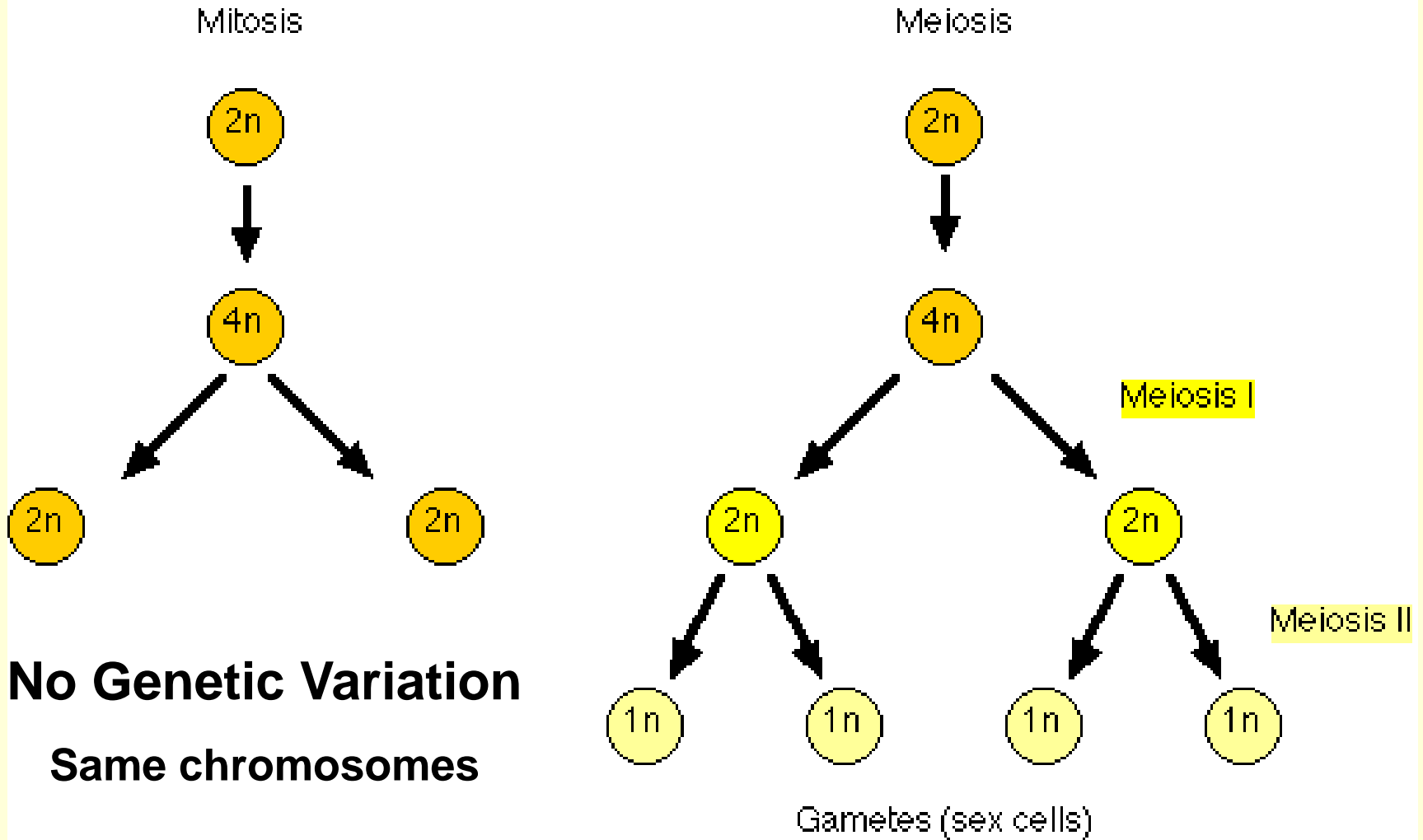


Gametes carry  $\frac{1}{2}$  the chromosomes of body cells and are genetically different.

Recombinations occur when gametes form and at fertilization.

# How does Mitosis and Meiosis compare?

## Comparison of mitosis and meiosis



**Genetic Variations**

$\frac{1}{2}$  set of chromosomes

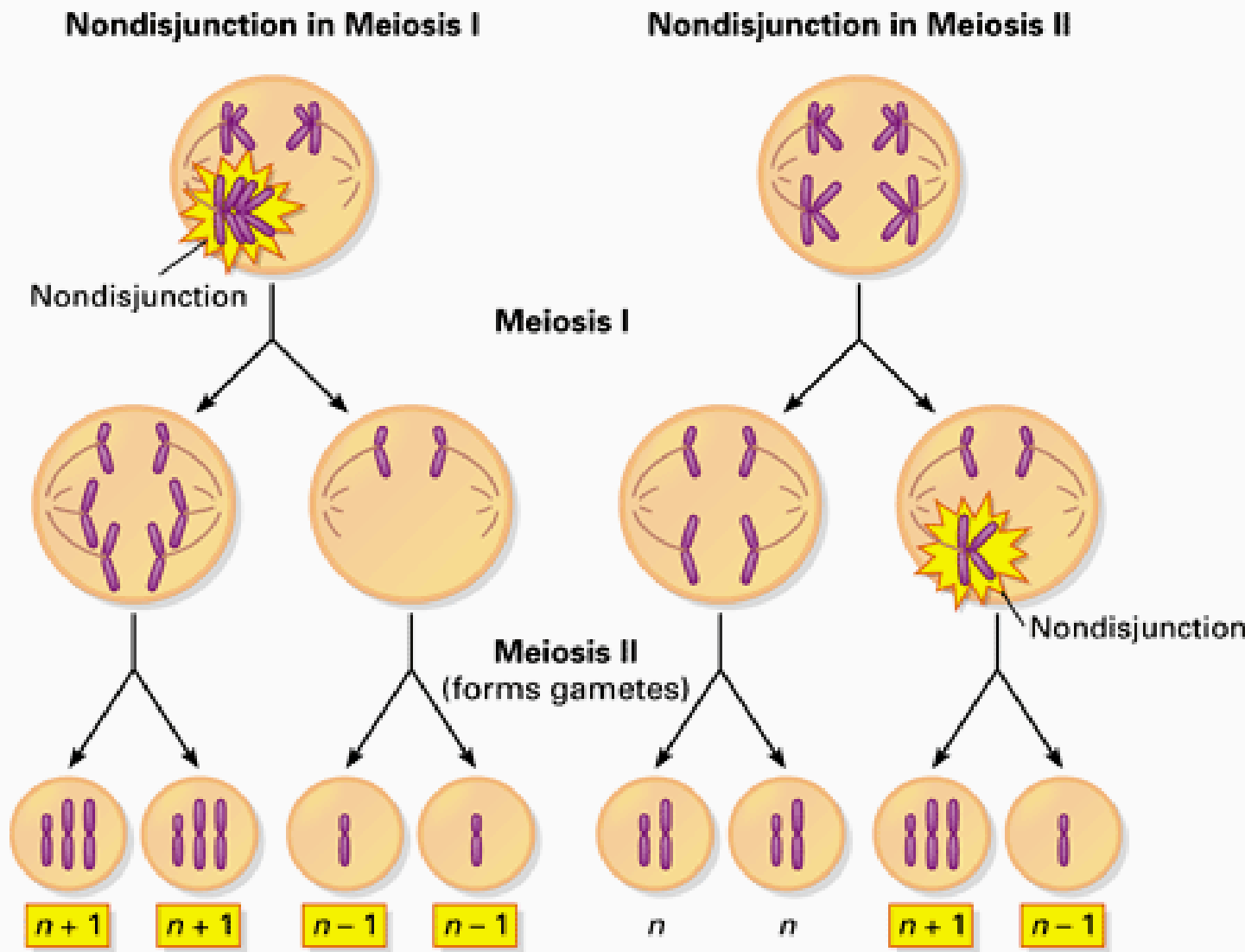
# Mitosis vs. Meiosis

Points of Comparison	Mitosis	Meiosis
# of cell divisions	<b>1</b>	<b>2</b>
# of functioning cells produced from the original	<b>2</b>	<b>4</b>
Compare Genetic makeup of final cells produced	<b>identical</b>	<b>different</b>
Function of cells produced in multicellular organisms	<b>Body cells</b>	<b>Gametes or sex cells</b>



# Mutations that result in an abnormal number of chromosomes

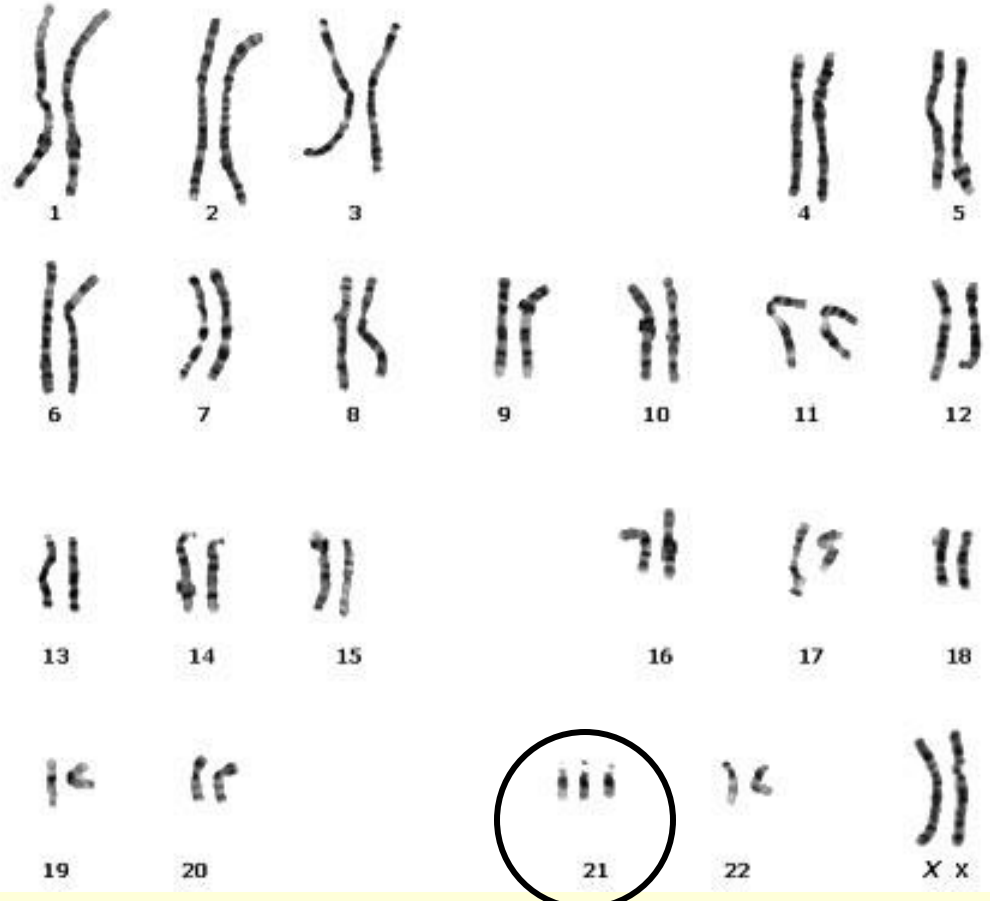
**Nondisjunction** occurs when chromosome fail to separate during meiosis.



# Human Disorders Due to Chromosomal Alterations

One condition, Down syndrome, affects approximately one out of every 700 children born in the United States

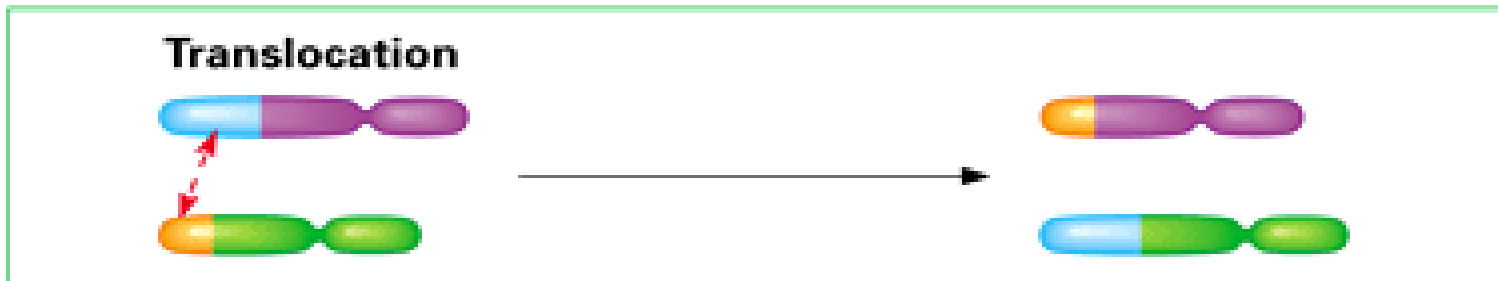
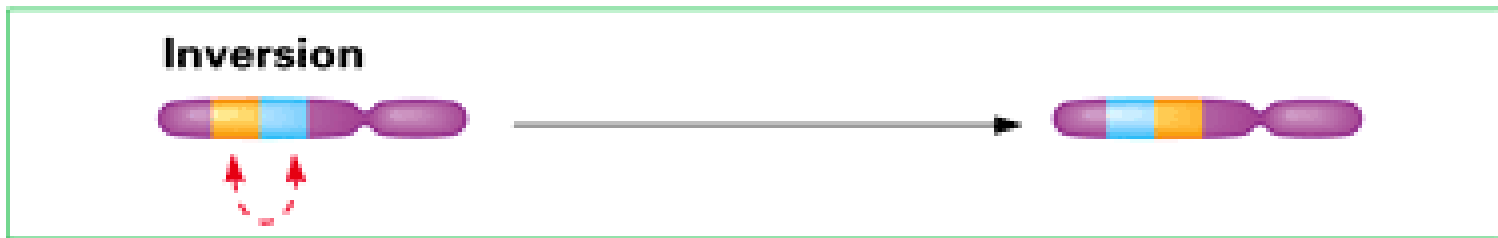
Trisomy 21



Extra chromosome 21

# Damaged Chromosomes

Changes in chromosome structure may also cause disorders. For example, a chromosome may break, leading to a variety of new arrangements that affect its genes.



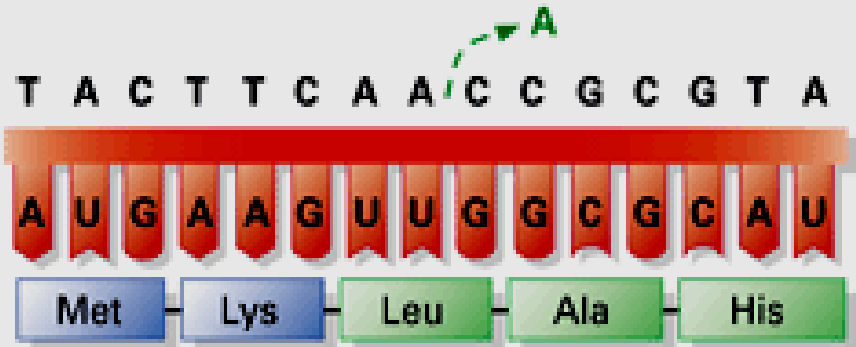
# Mutations of a gene

A gene mutation is a change in the nucleotide sequence of DNA.



(a) Base substitution

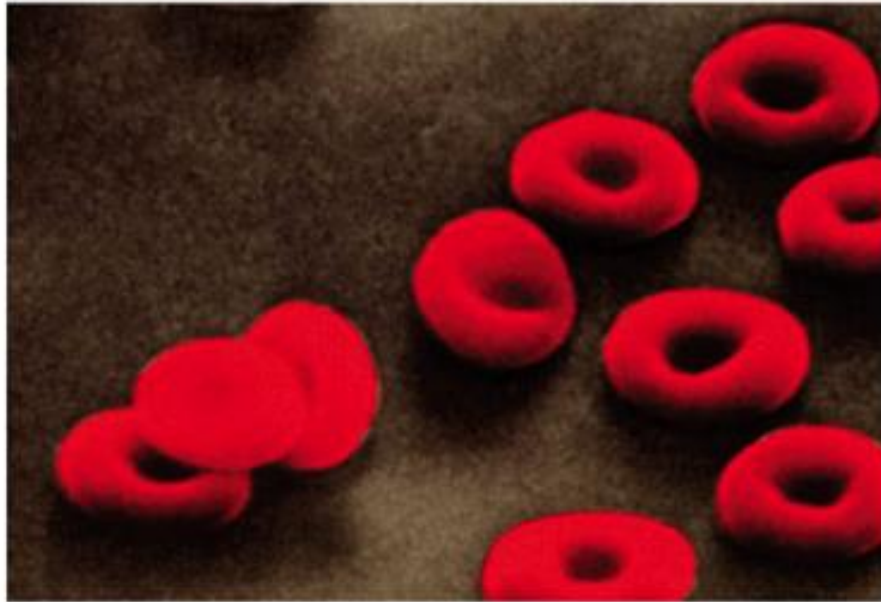
(b) Base deletion



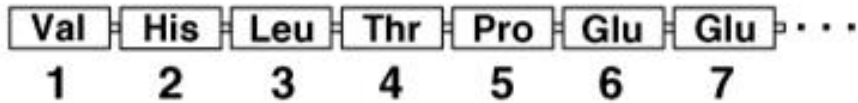
Alters the gene product: Altered Protein produced



A single amino acid substitution in hemoglobin causes sickle-cell disease. How does an individual get this disorder?



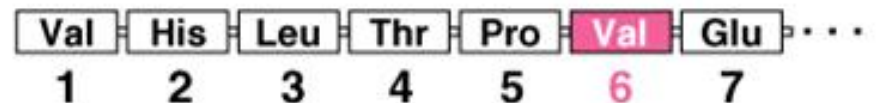
10  $\mu$ m



(a) Normal red blood cells and the primary structure of normal hemoglobin



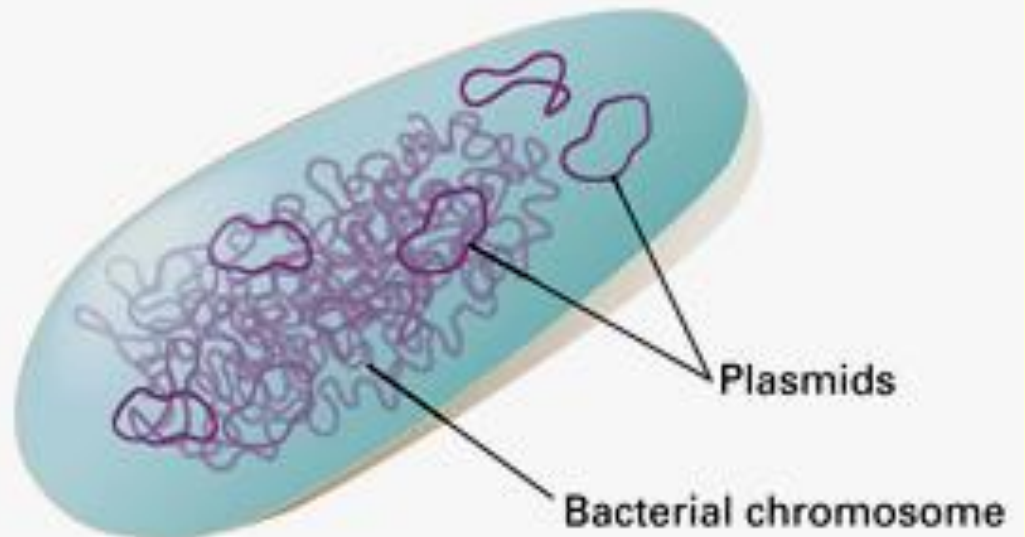
10  $\mu$ m



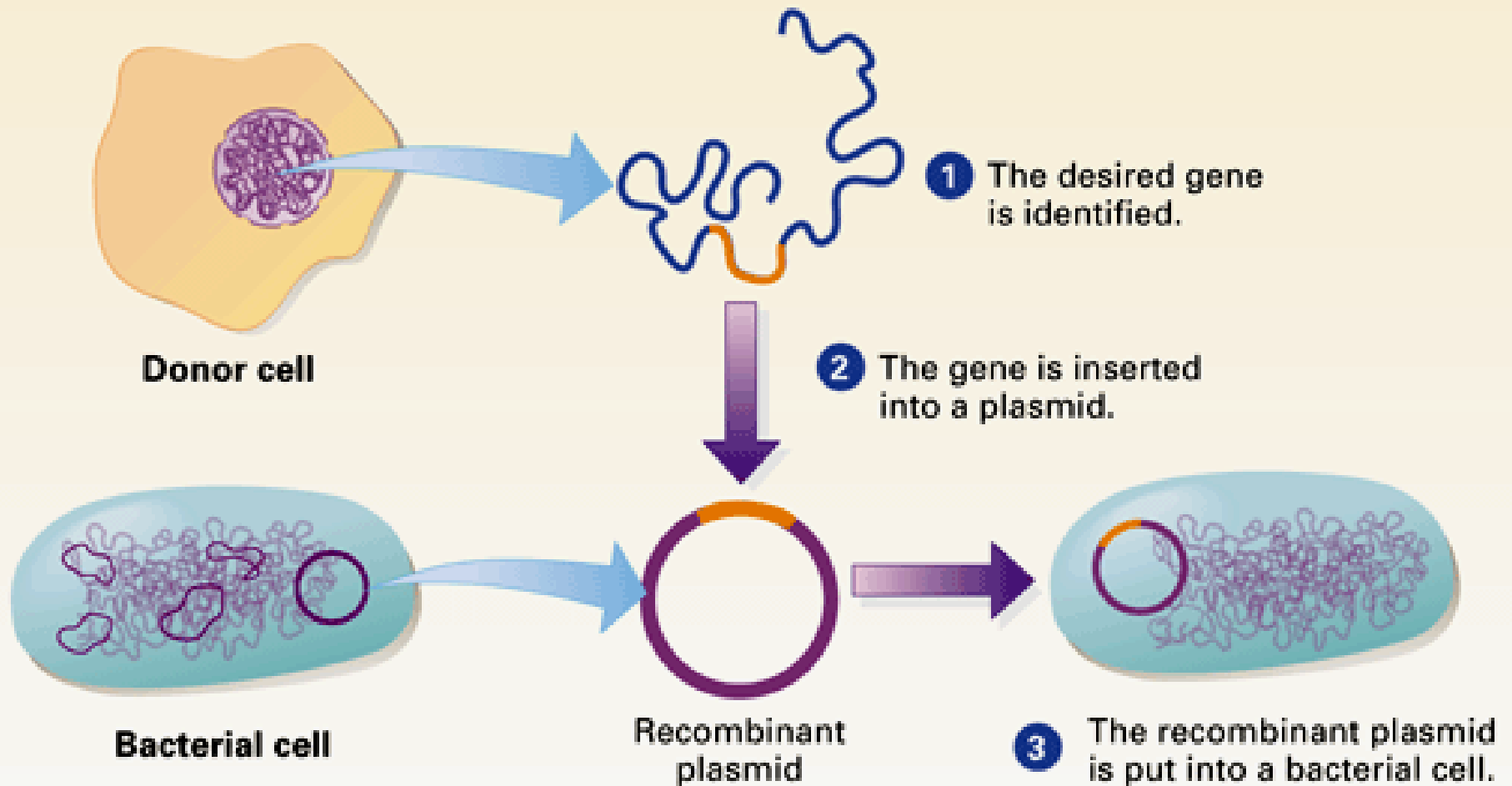
(b) Sickled red blood cells and the primary structure of sickle-cell hemoglobin

**Biotechnology** is the use of organisms to perform practical tasks for humans.

Scientists manipulate DNA with both breeding and biochemistry.



# Recombinant DNA Technology

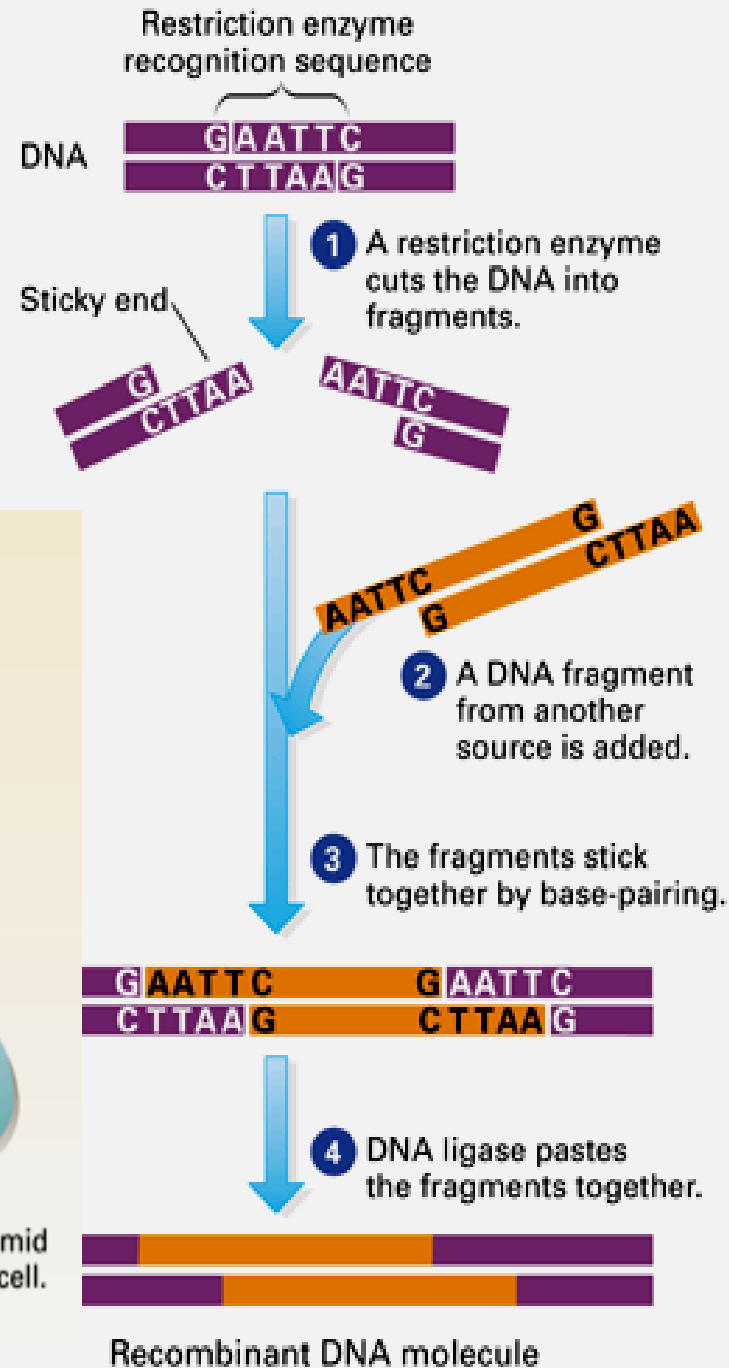
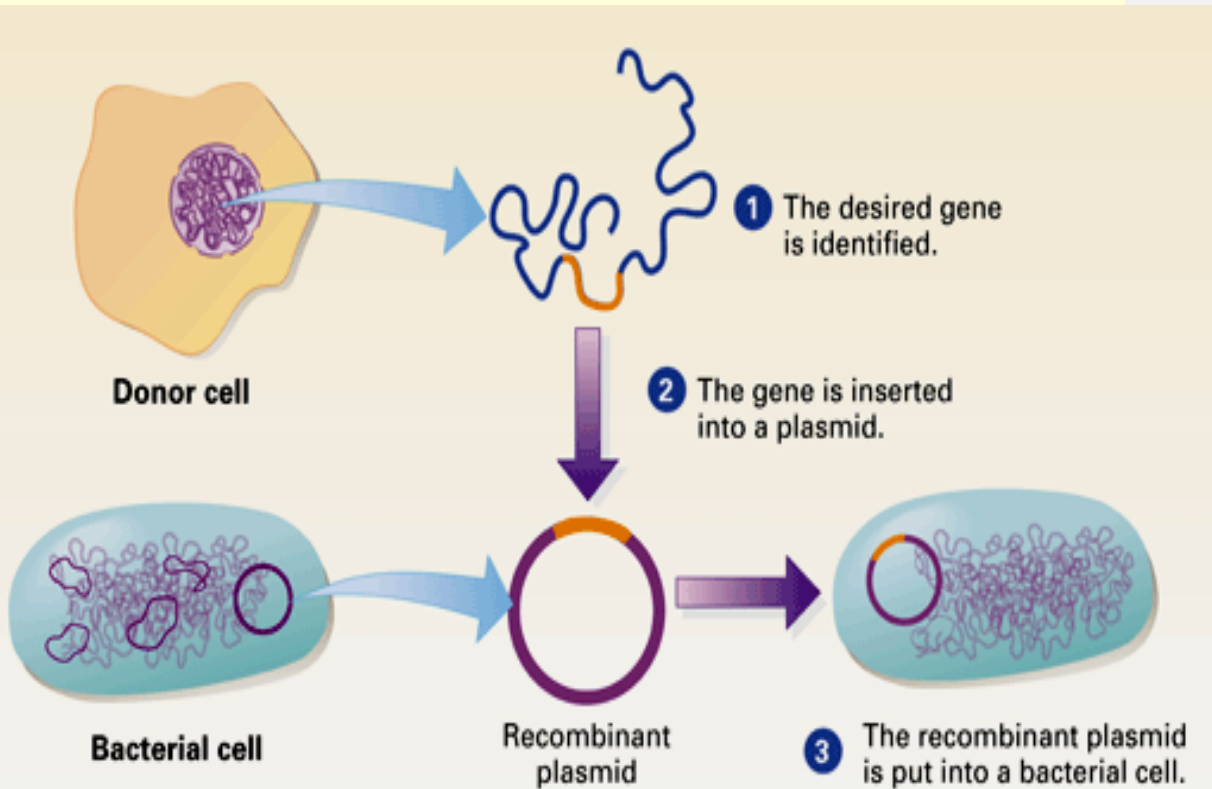


Bacteria are genetically engineered by inserting DNA from another source.

# How is Recombinant DNA made?

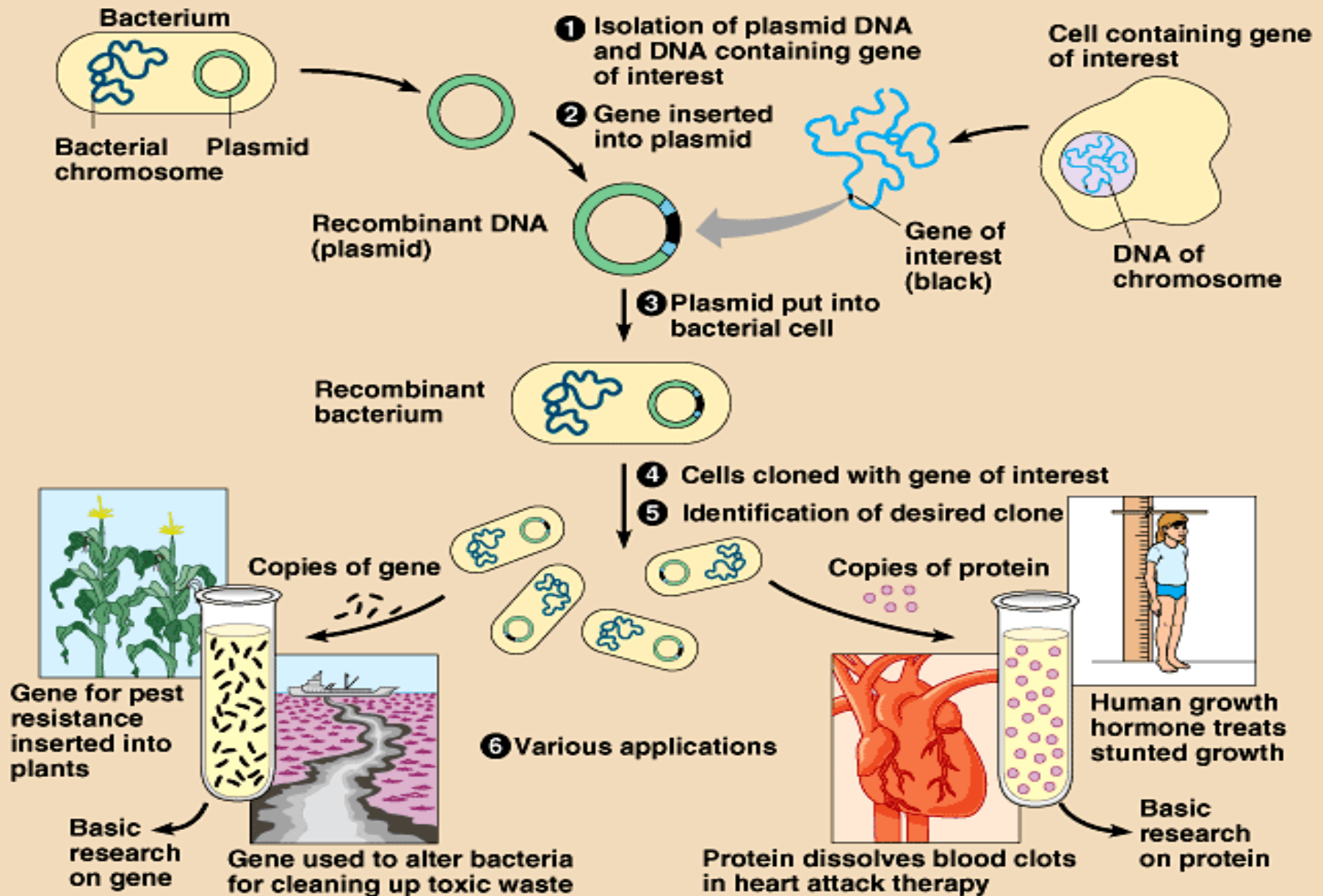
DNA containing the desired gene must be "cut" out of a much longer DNA molecule.

DNA is cut with **restriction enzymes**.



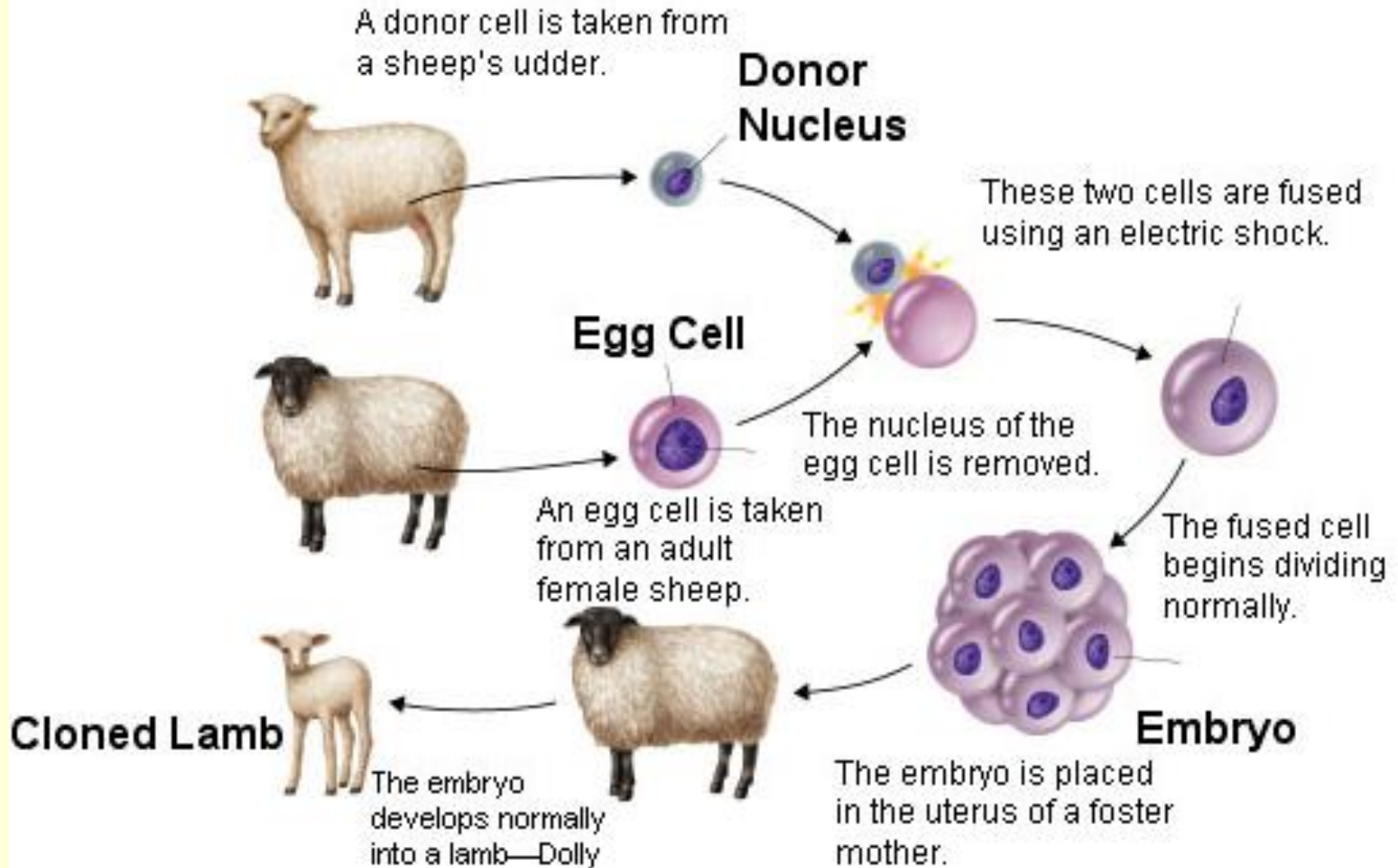


Recombinant DNA is used to make chemicals humans may be missing: (insulin, growth hormone)



# Cloning makes identical genetic copies

## Nuclear Transplant Technology



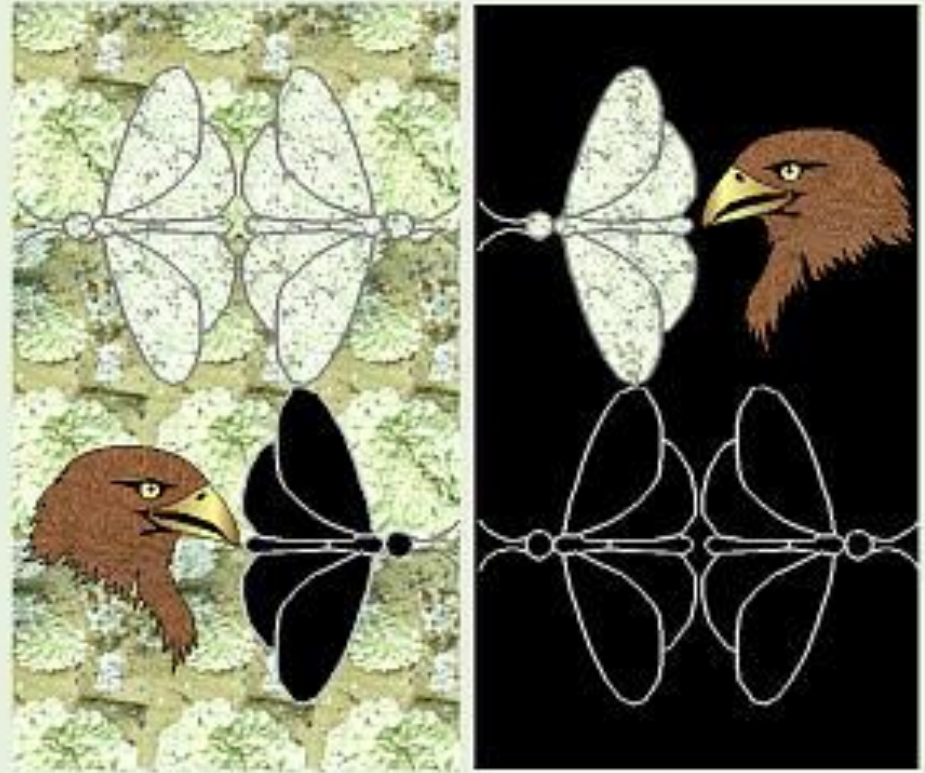
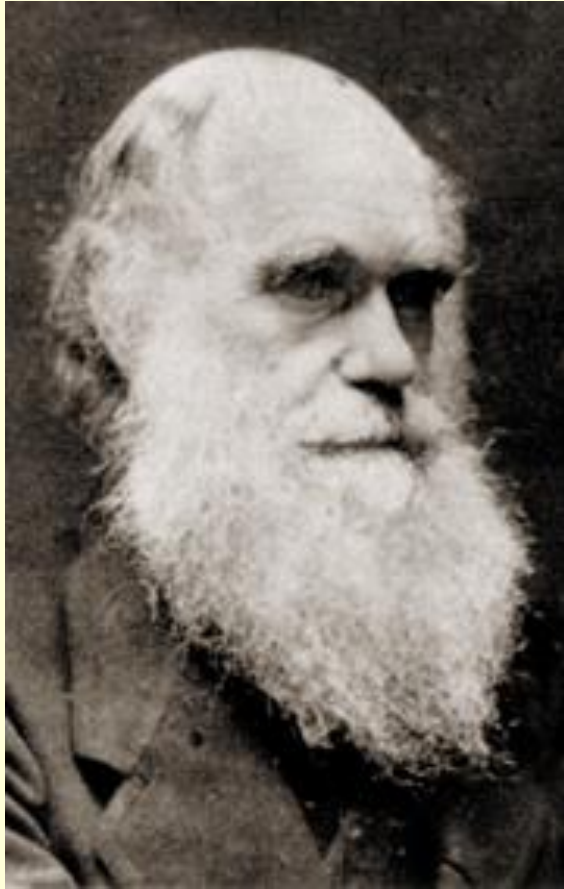
# Evolution: The change in species over time

## Key Idea 3:

Individual organisms and species change over time.

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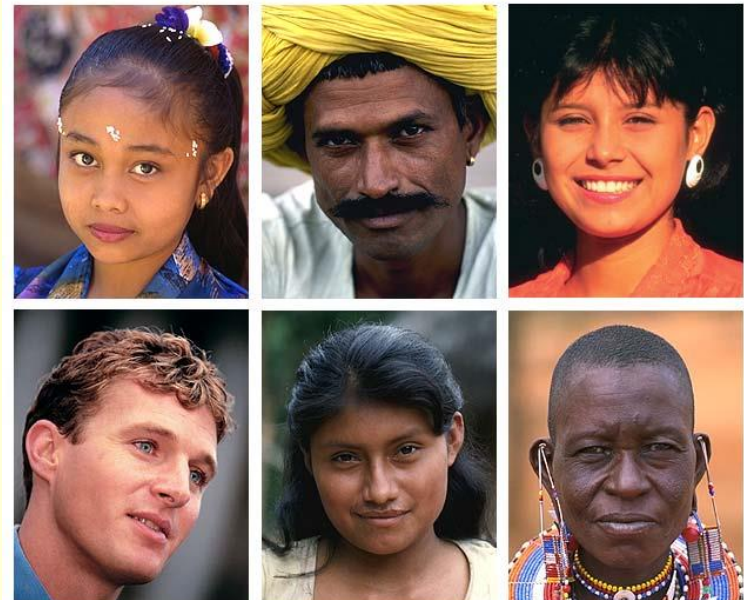
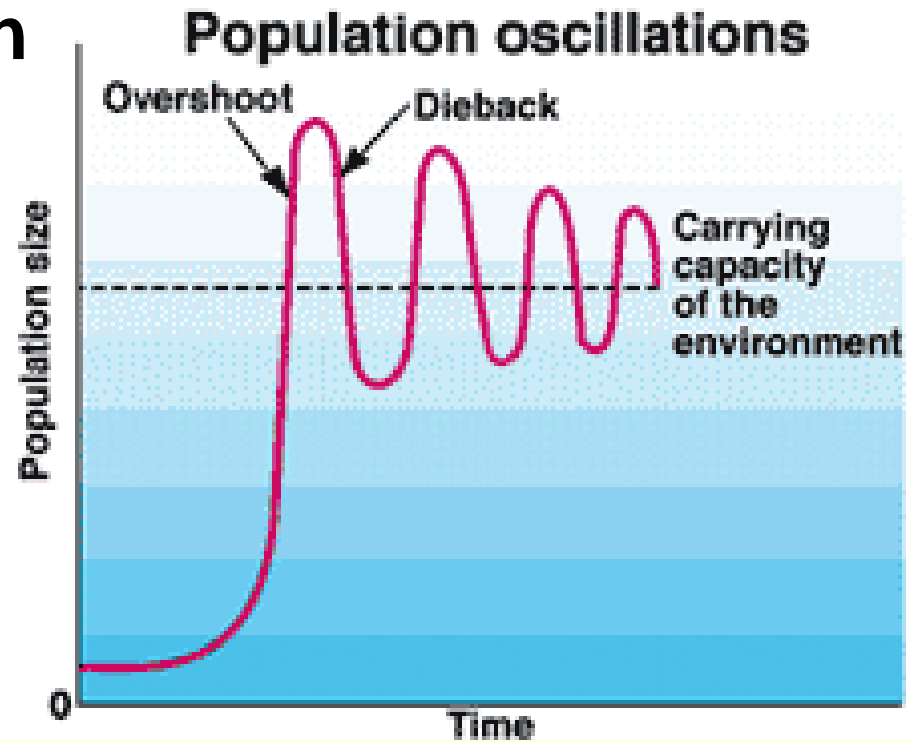


**Charles Darwin: Theory of Natural Selection**



# Theory of Natural Selection

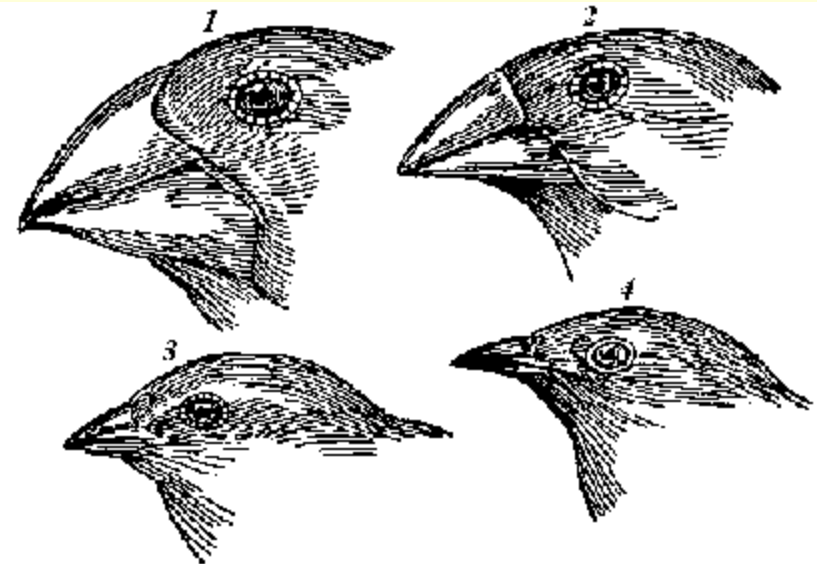
- **Overproduction of offspring:** species produce far more offspring than are needed.
- **Competition:** space and food are limited so competition occurs for resources. Only fraction can survive
- **Variation among offspring:** individuals in a species vary and these are inheritable





# Theory of Natural Selection

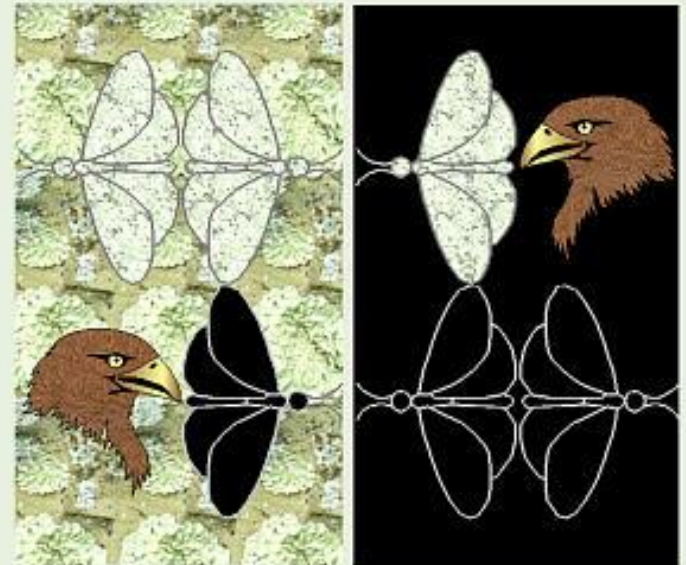
- **Struggle for survival:** result of competition
- **Adaptations** due to variations, some individuals are better adapted to survive and reproduce.
- **Natural Selection:** environmental factors will select the optimal traits. The “best fit” will survive and reproduce.
- **Speciation:** Over many generations, favorable adaptations accumulate and many changes lead to new species.



1. *Geospiza magnirostris*.  
3. *Geospiza parvula*.

2. *Geospiza fortis*.  
4. *Certhidea olivacea*.

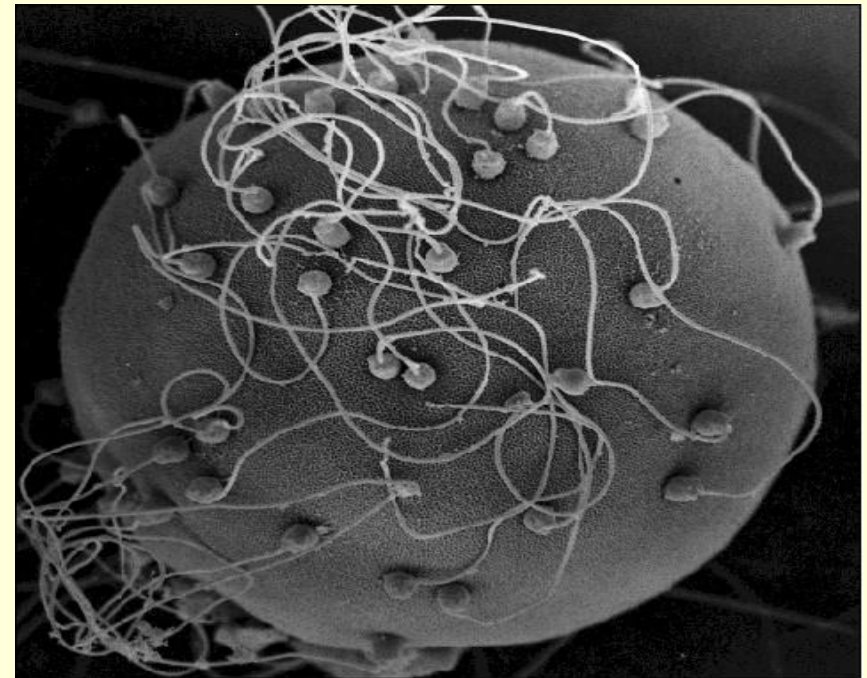
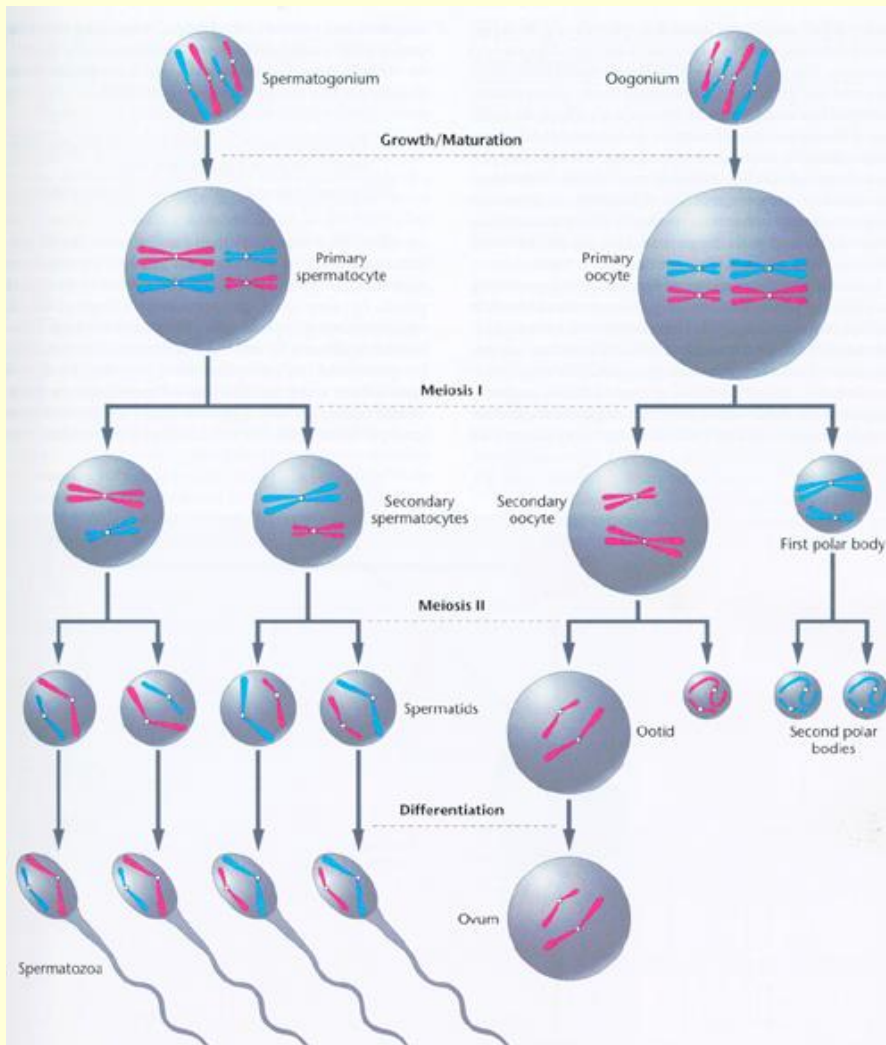
**Gradation in Beak Size in *Geospiza* Species**



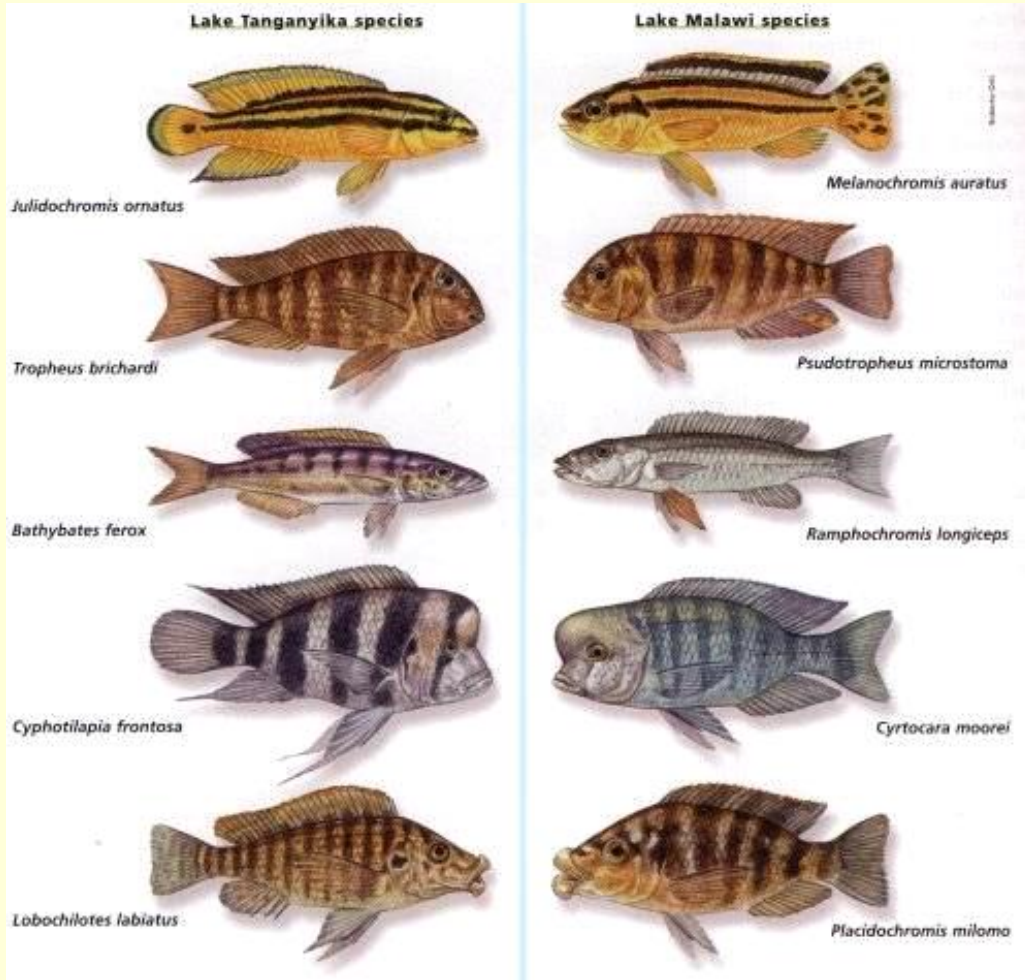
# What is the source of Variation?

Mutations: Changes in the DNA

Sexual Reproduction: Recombination of chromosomes



# Why is variation important to evolution?

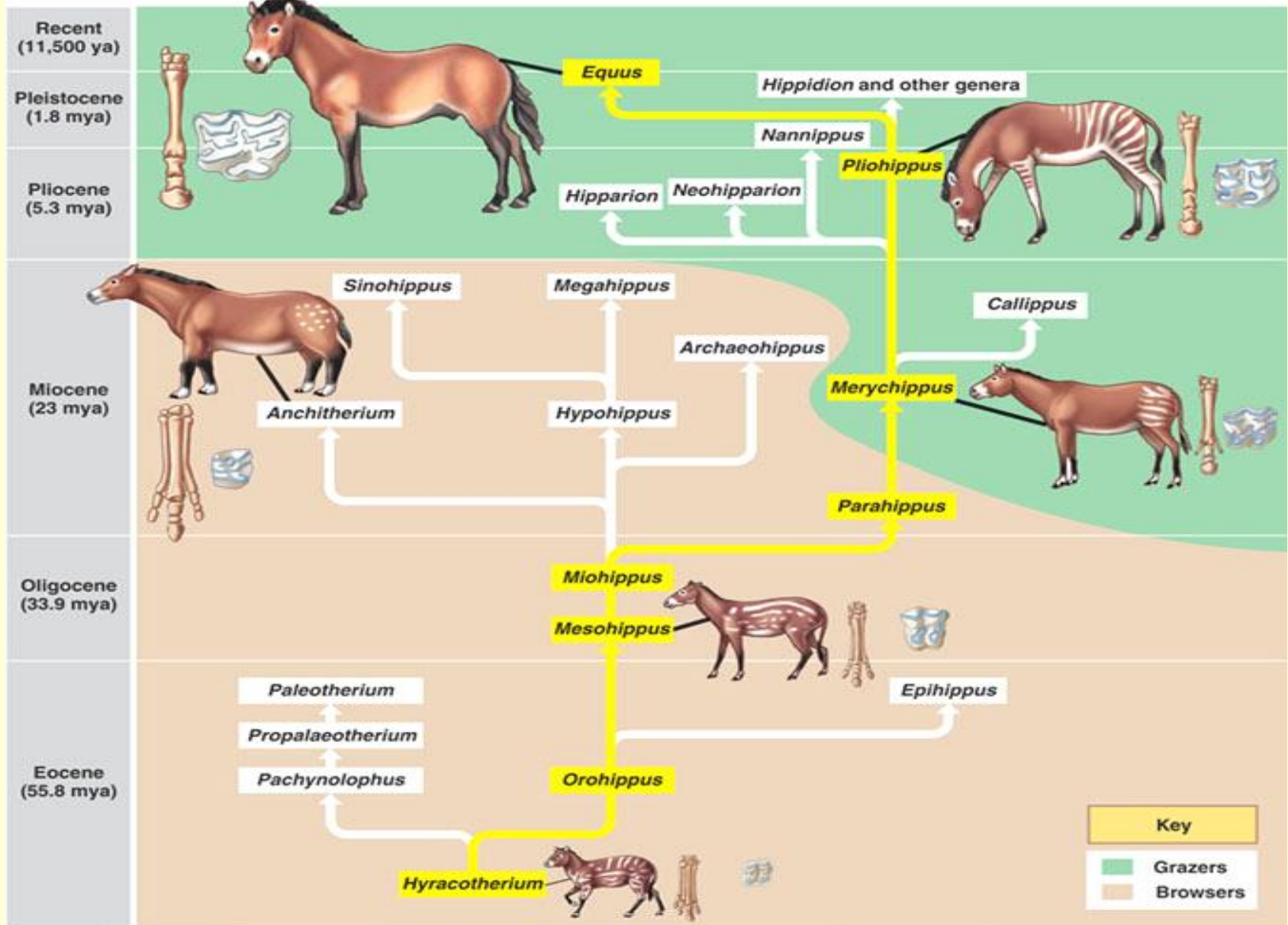


## cichlid fish

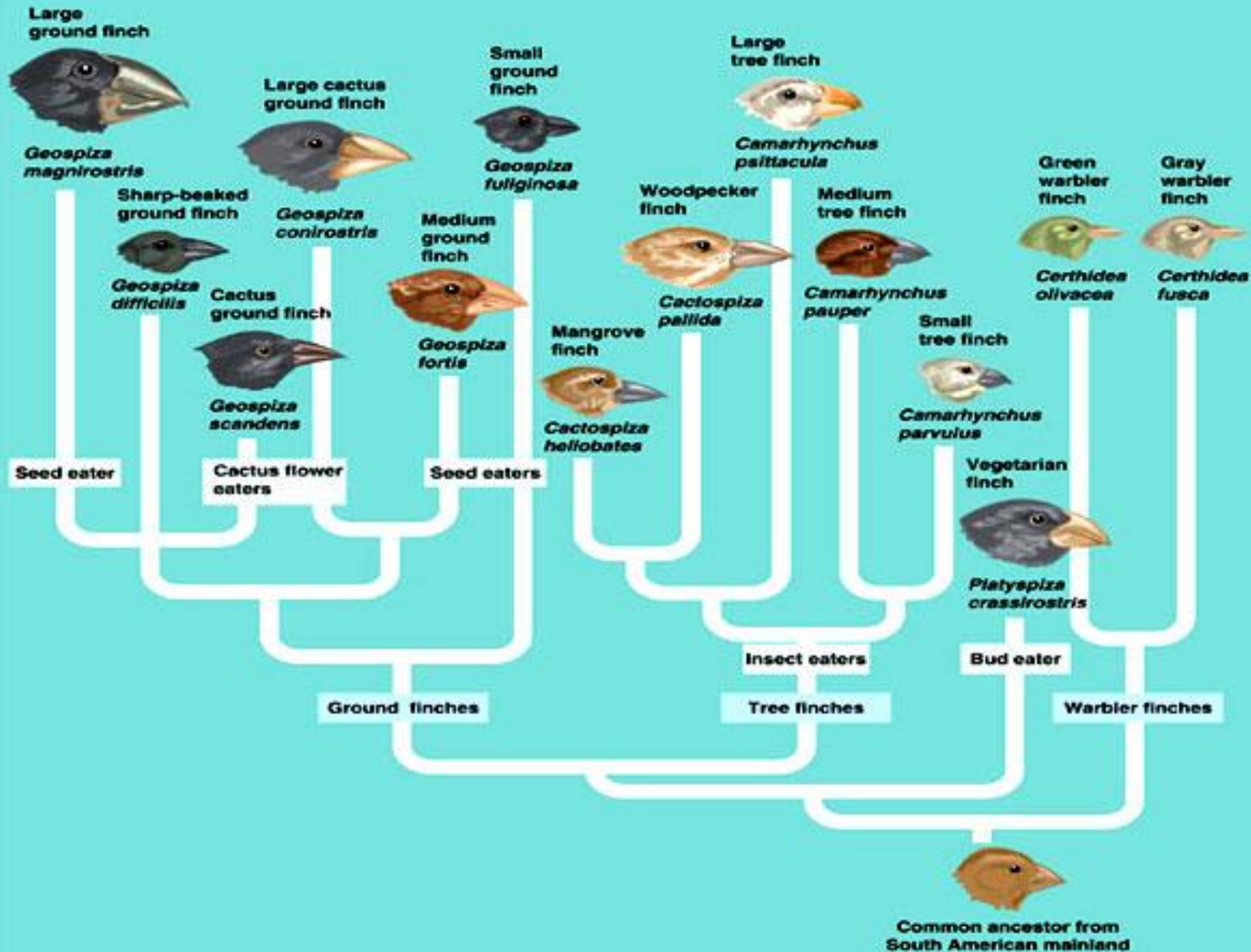
Variations within a species increases the chance of survival when conditions change.



# Fossil Evidence shows Evolutions progress without set direction.

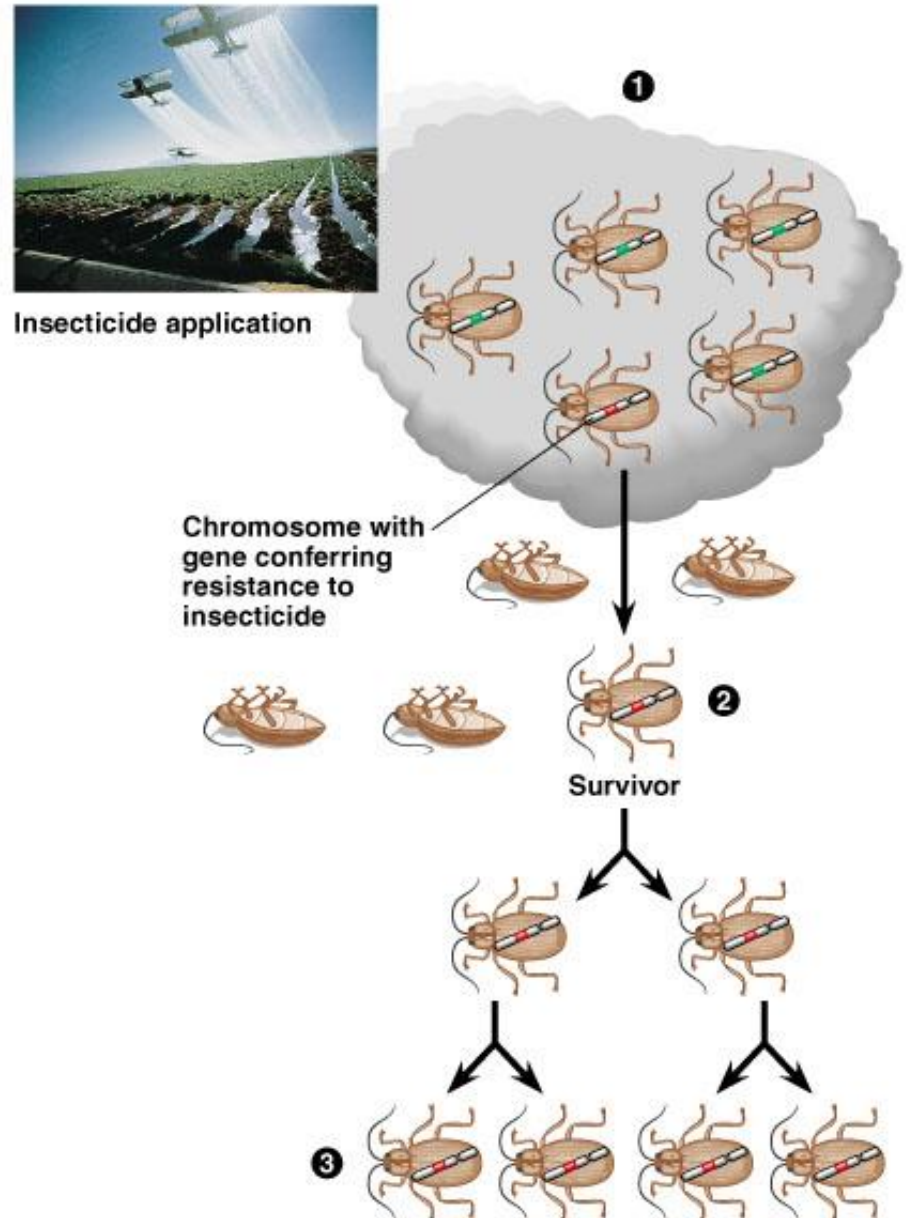






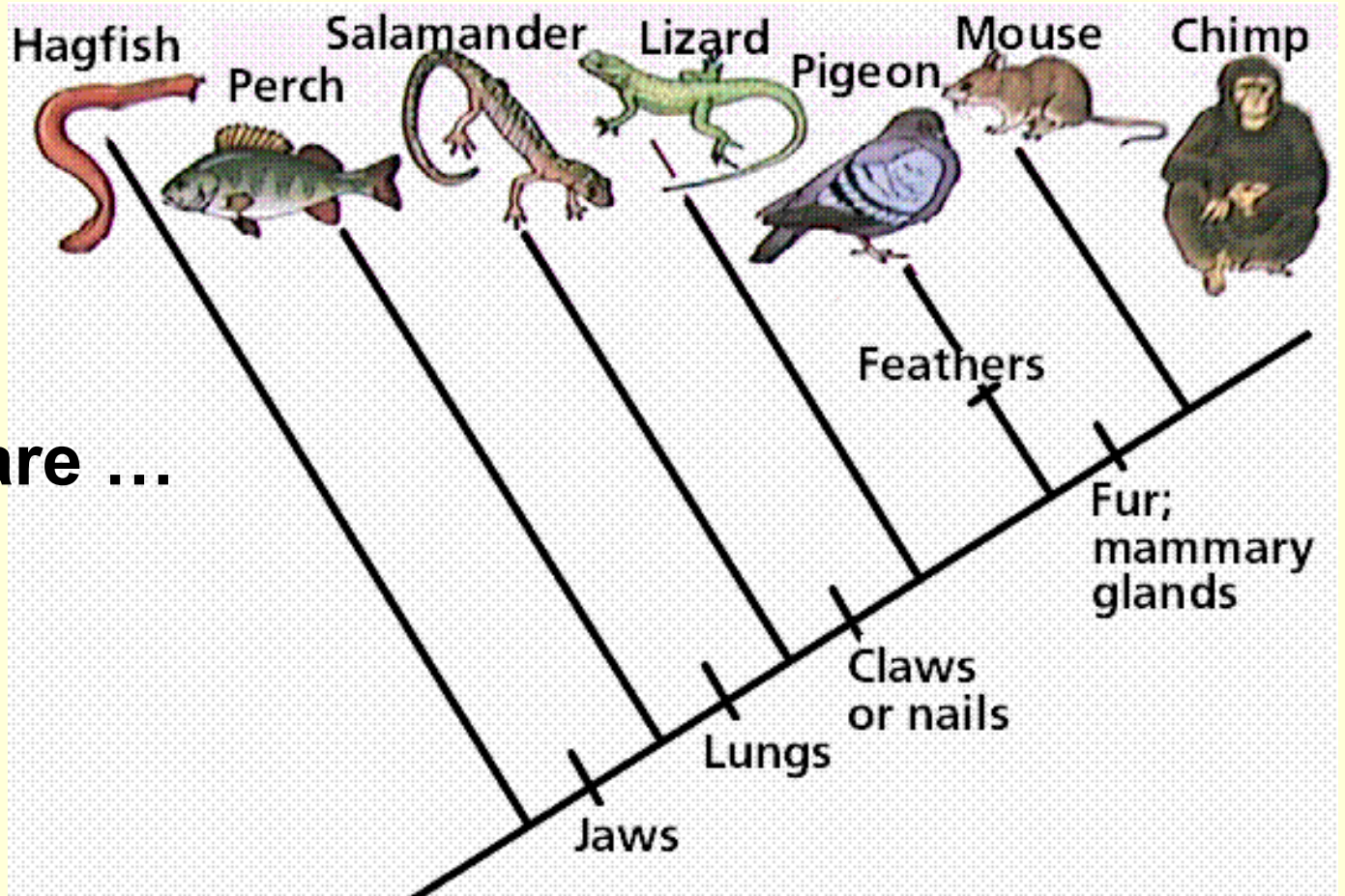
# Observed Natural Selection

- Insect resistance to insecticides
- Bacterial resistance to antibiotics



# How do we determine which organisms are more closely related?

We compare ...



- anatomy
- development
- biochemistry
- cells

**Similarity implies relationship!**

**Homologous structures** are a clues to determine evolutionary relationships.



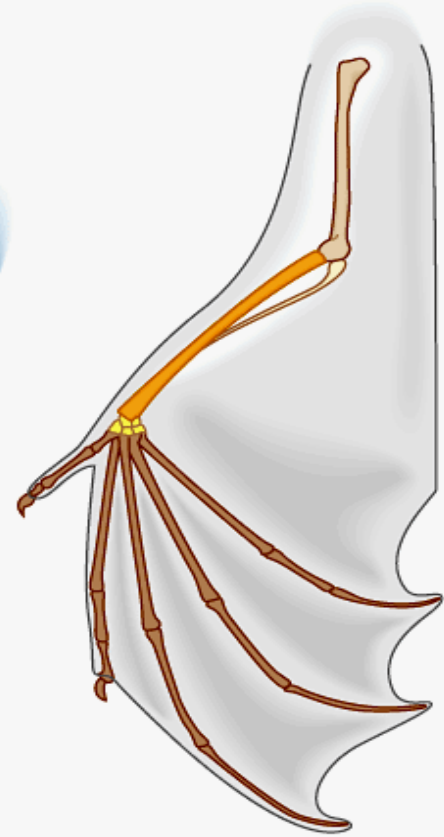
**Human**



**Cat**



**Whale**



**Bat**



# Molecular data is the best way to compare organisms to relatedness.

## Hemoglobin Comparisons Between Humans and Other Vertebrates

Species

Human

Gorilla

Rhesus  
monkey

Mouse

Chicken

Frog



Number of Amino  
Acids That Differ  
From a Human  
Hemoglobin Chain\*

0

1

8

27

45

67

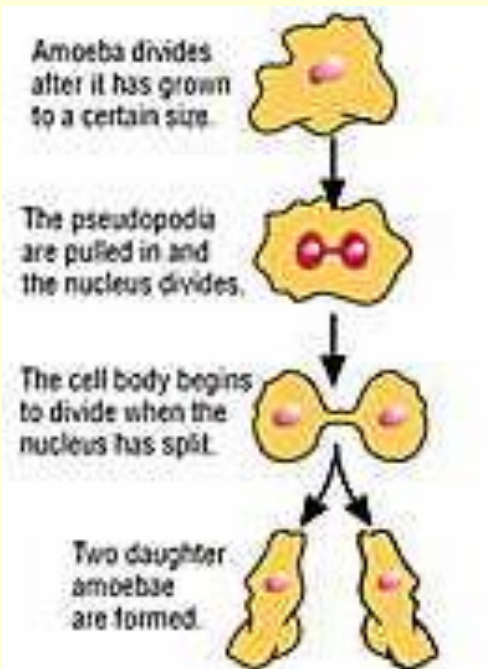
\* Total chain length = 146 amino acids

# Reproduction and Development

Reproduction is necessary for the continuation of a species.

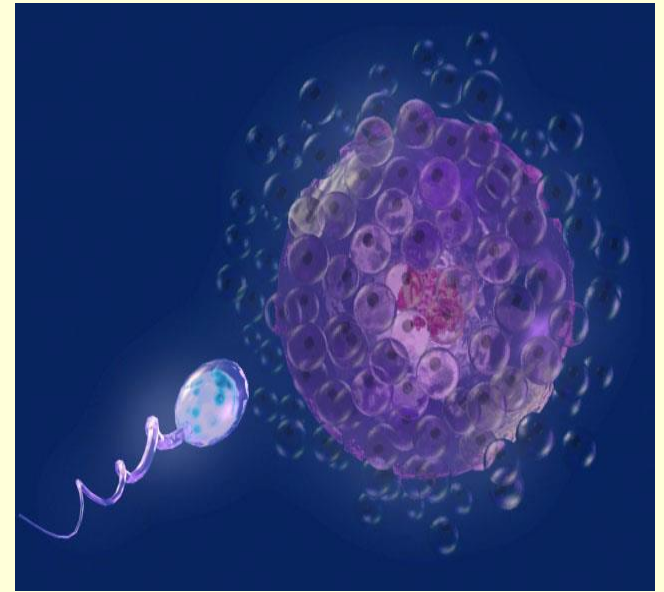
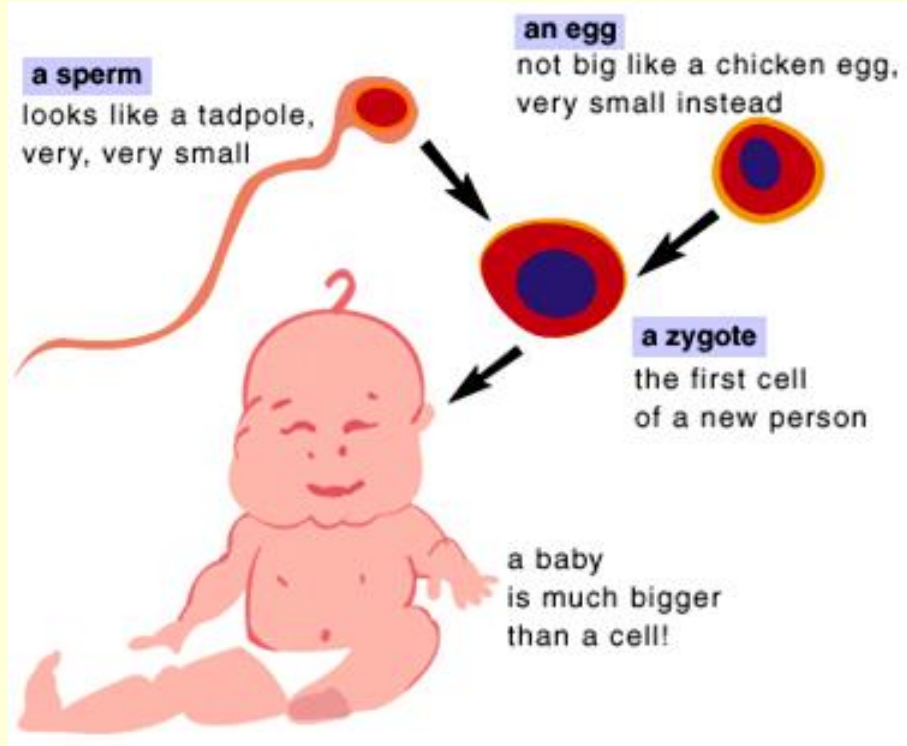
**Asexual Reproduction** is the production of offspring with genes all from one individual, without the fusion of gametes.

Offspring are genetically identical. No variation



**Cloning** produces identical copies

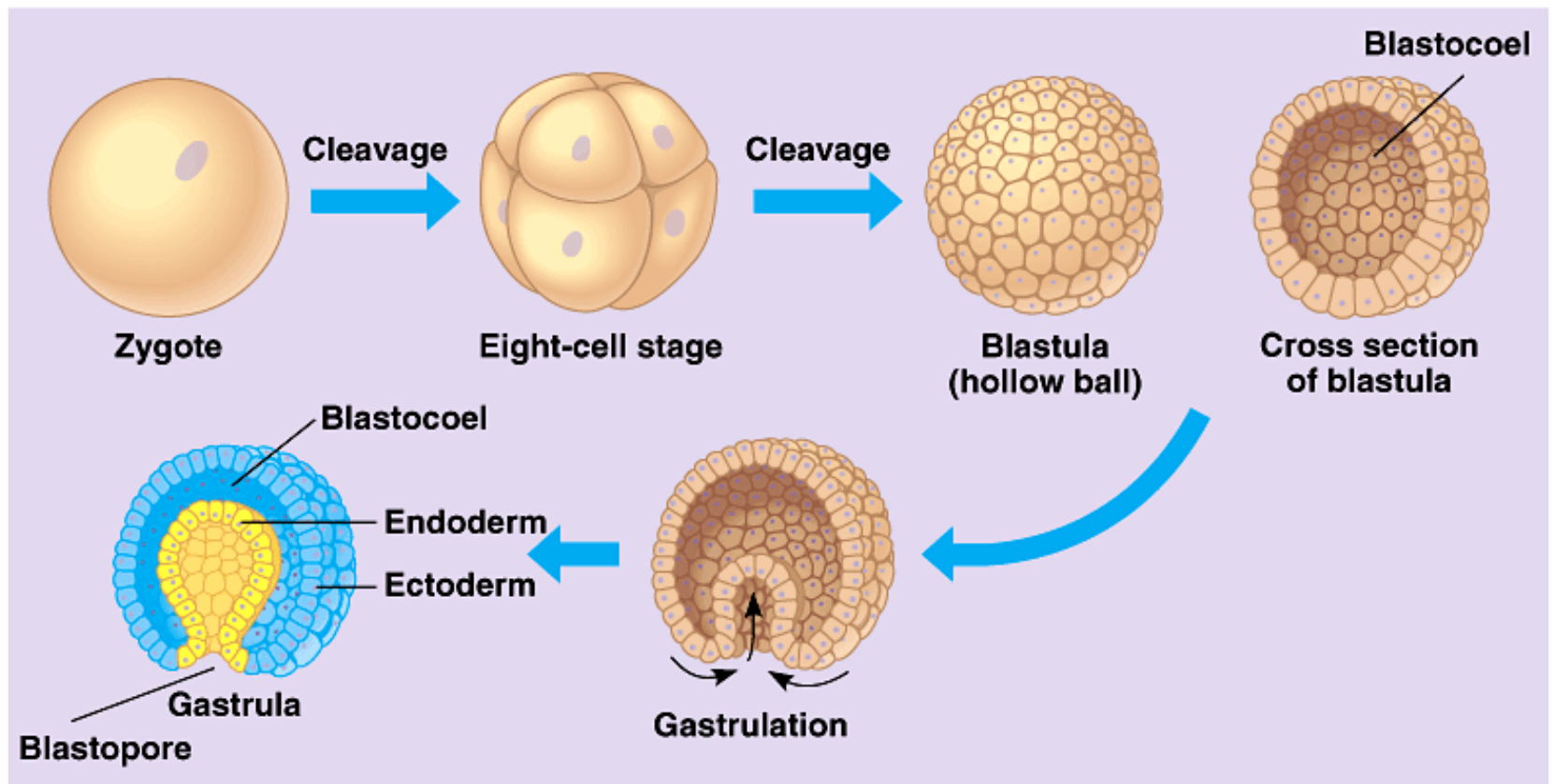
# Sexual Reproduction involves the combining of gametes



Variation due to recombination of chromosomes and gametes



**Development:** Changes that occur as the zygote through steps to form an embryo and fetus.



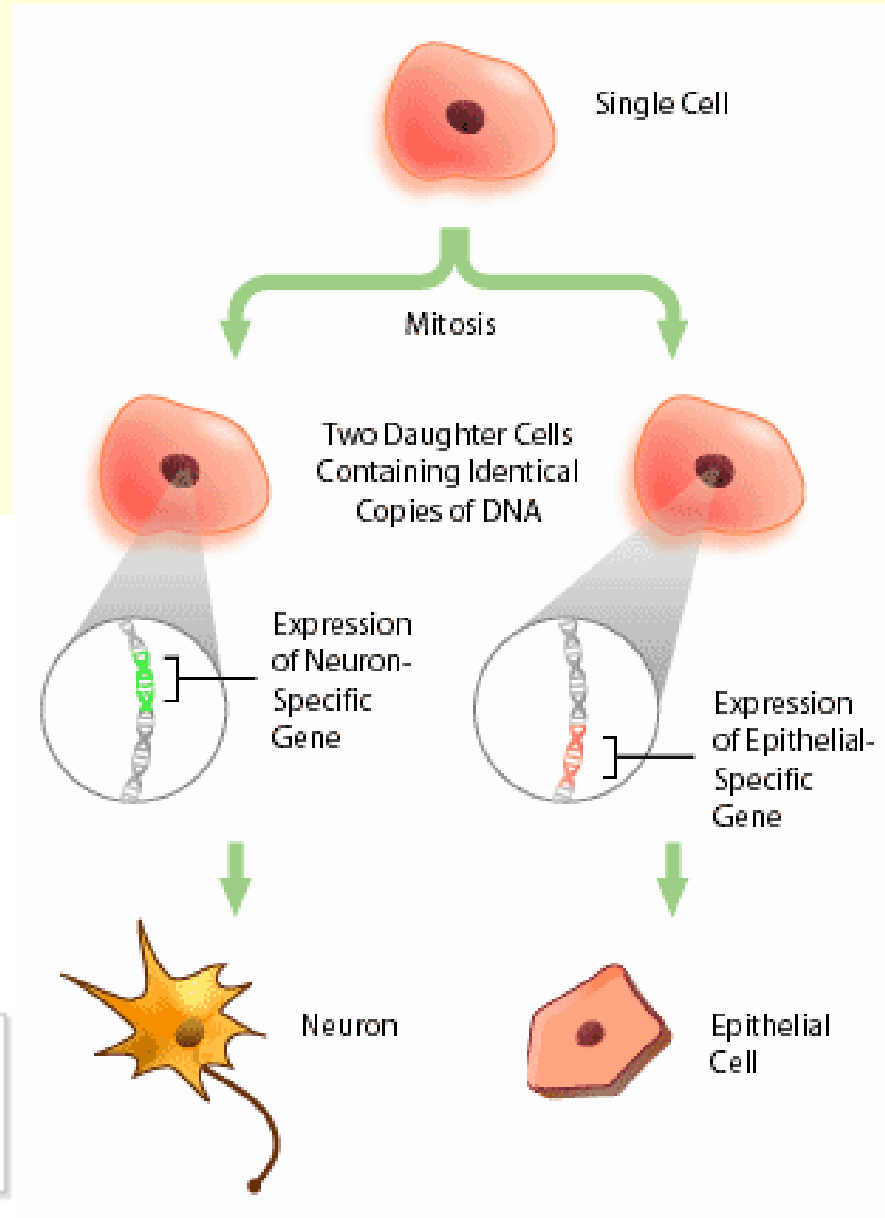
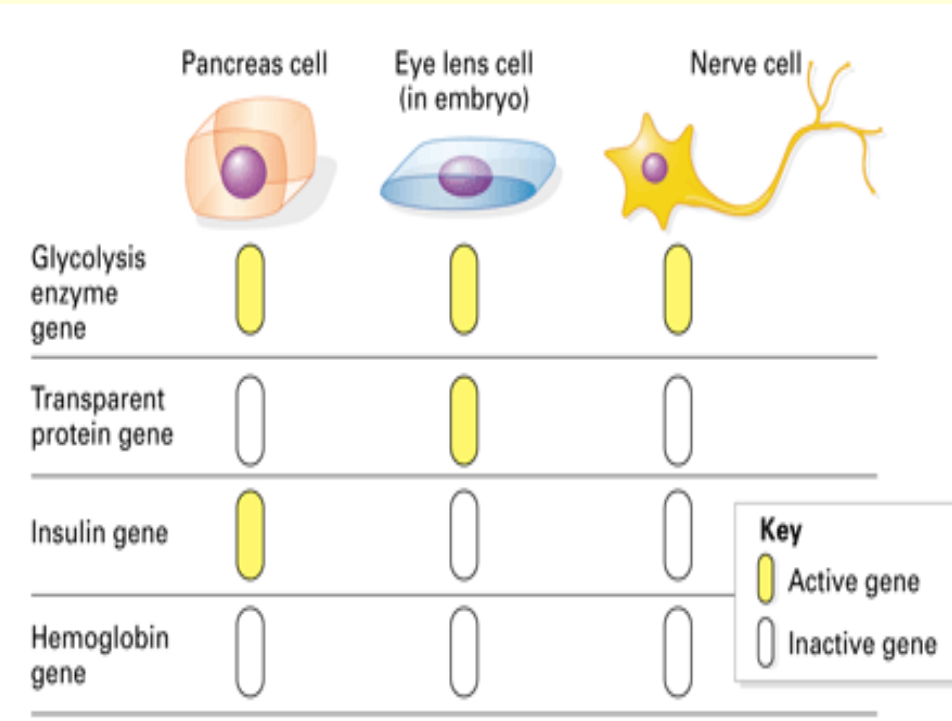
Zygote divides many times by mitosis and differentiates to form specialized cells, tissues and organs.



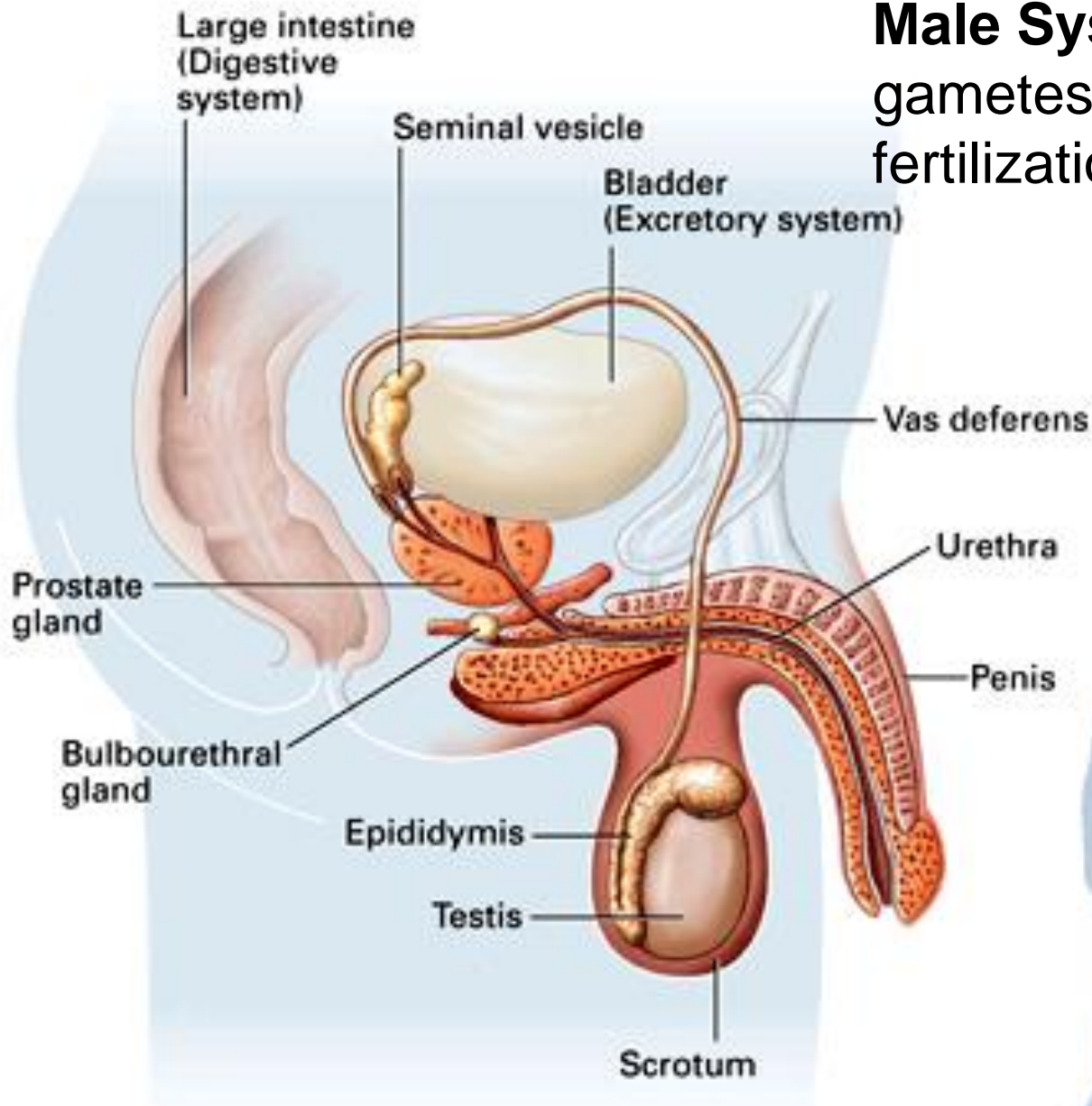
# Differentiation causes cells to specialize.

All genes of the genome are present in every type of cell.

Only a specific fraction of these genes are actually expressed in each type of cell.



**Male System:** produces gametes and deliver sperm for fertilization.



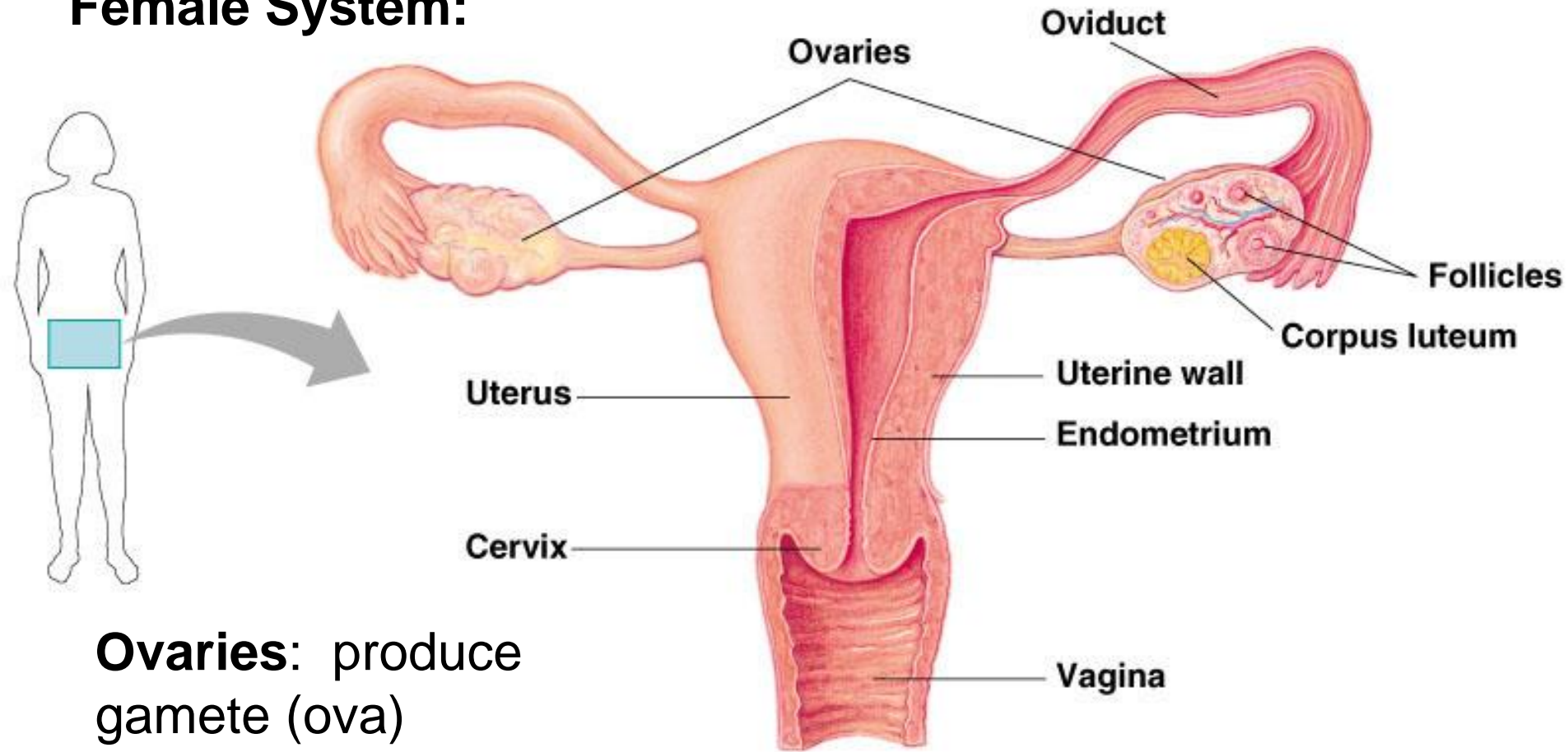
**Hormone  
testosterone**



**Side View**

**Front View**

# Female System:



**Ovaries:** produce gamete (ova)

Internal Fertilization in **Oviduct**

Internal Development in **Uterus**

Hormones:  
Estrogen  
Progesterone

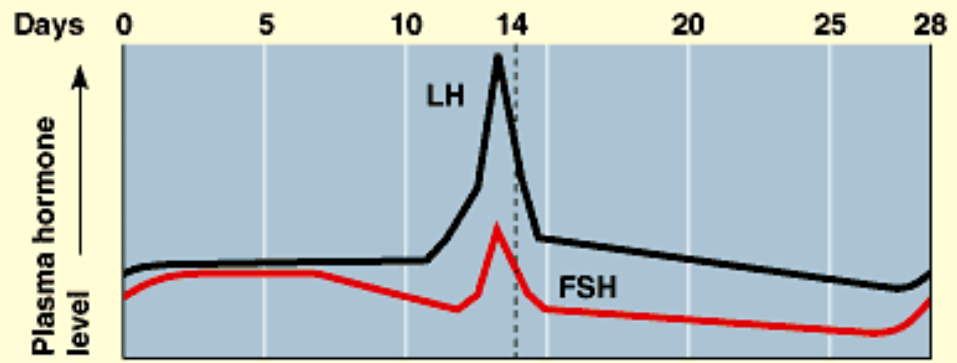
# Menstrual Cycle

Regulated by hormones

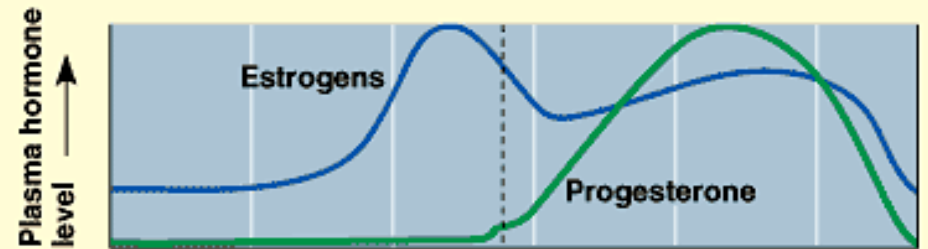
Estrogen

Progesterone

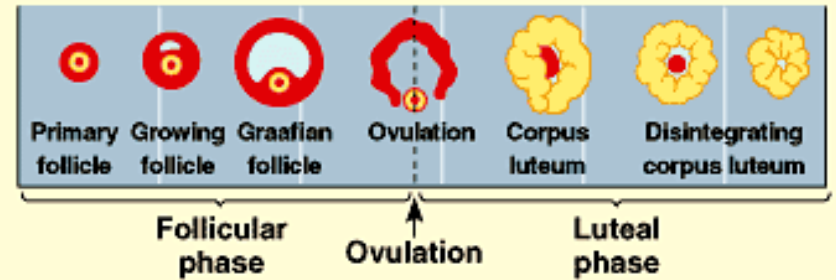
(a) Fluctuation of gonadotropin levels



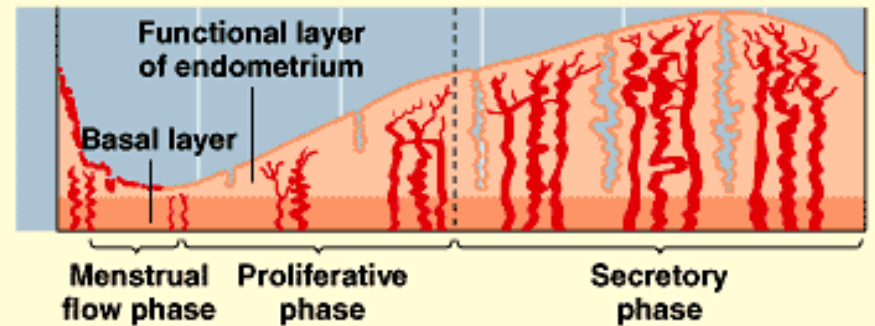
(b) Fluctuation of ovarian hormone levels



(c) Ovarian cycle



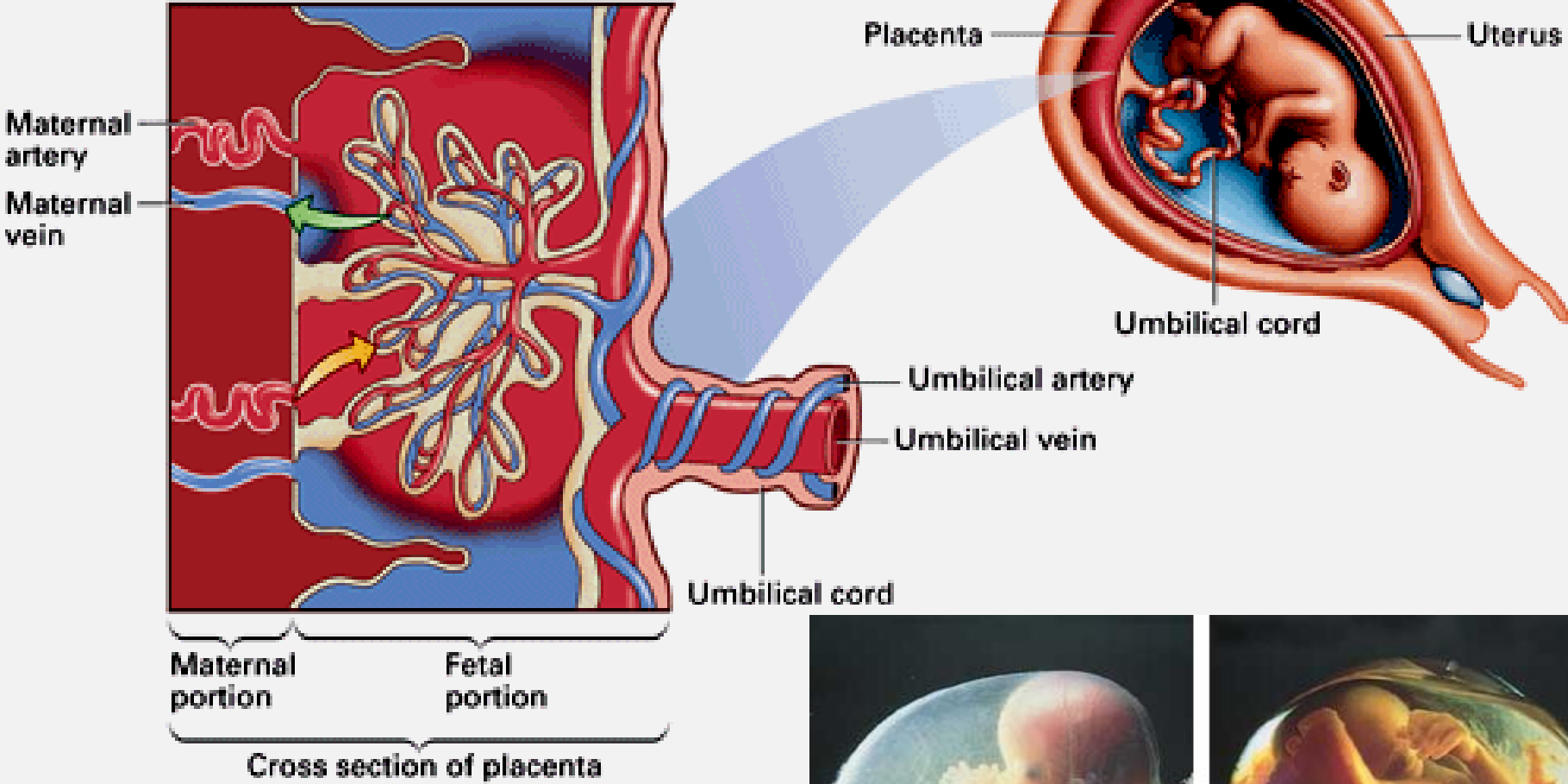
(d) Menstrual cycle (uterine cycle)



Days 0 5 10 14 20 25 28



Internal Development occurs in the uterus with nourishment through the placenta.

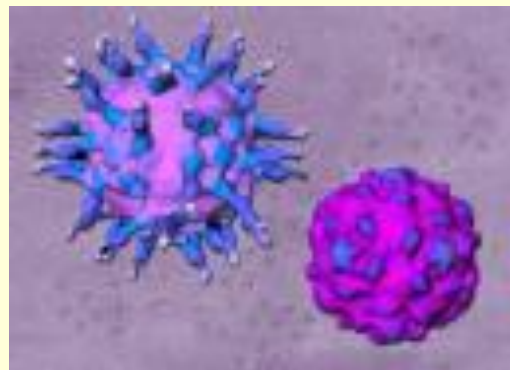
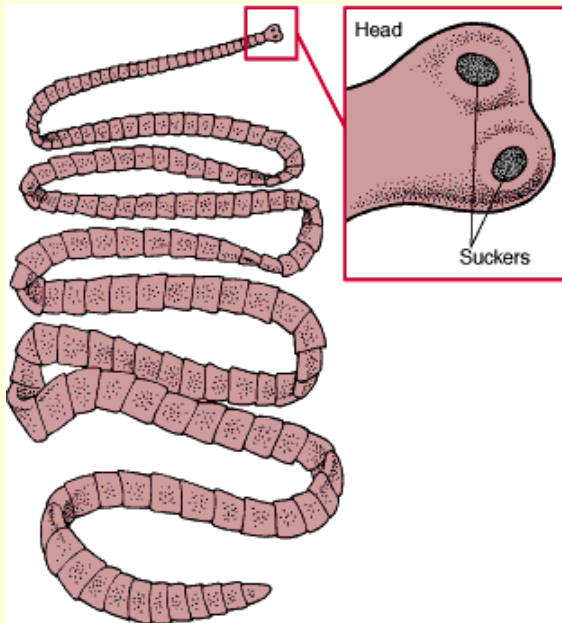
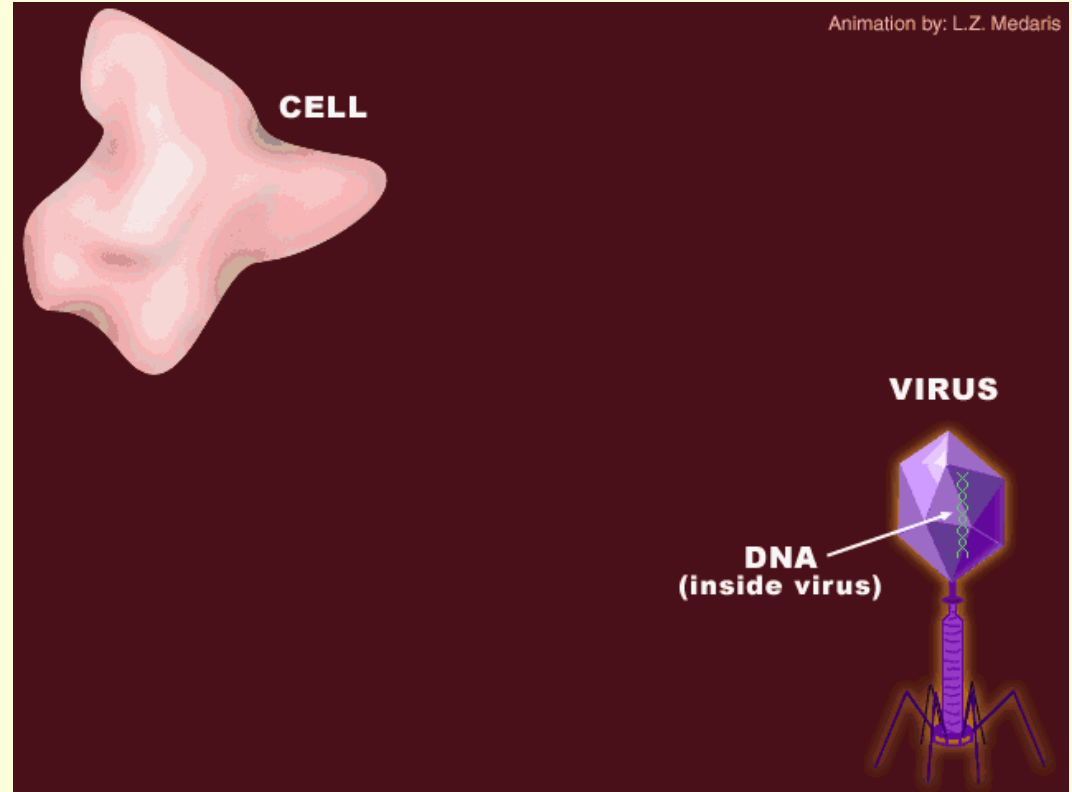


Amnion protects the embryo



# Disease is a failure of Homeostasis

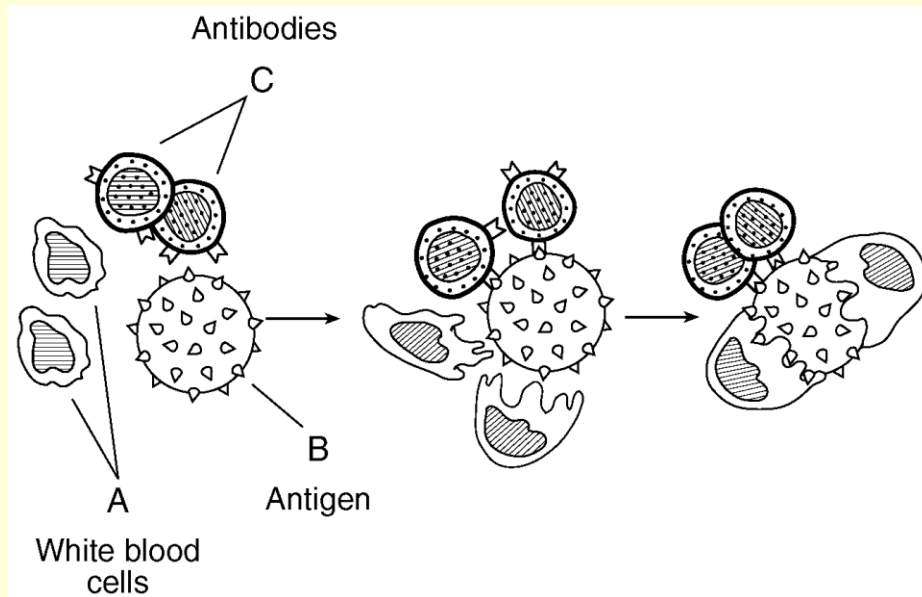
Virus, bacteria, fungi, and parasites may cause infections



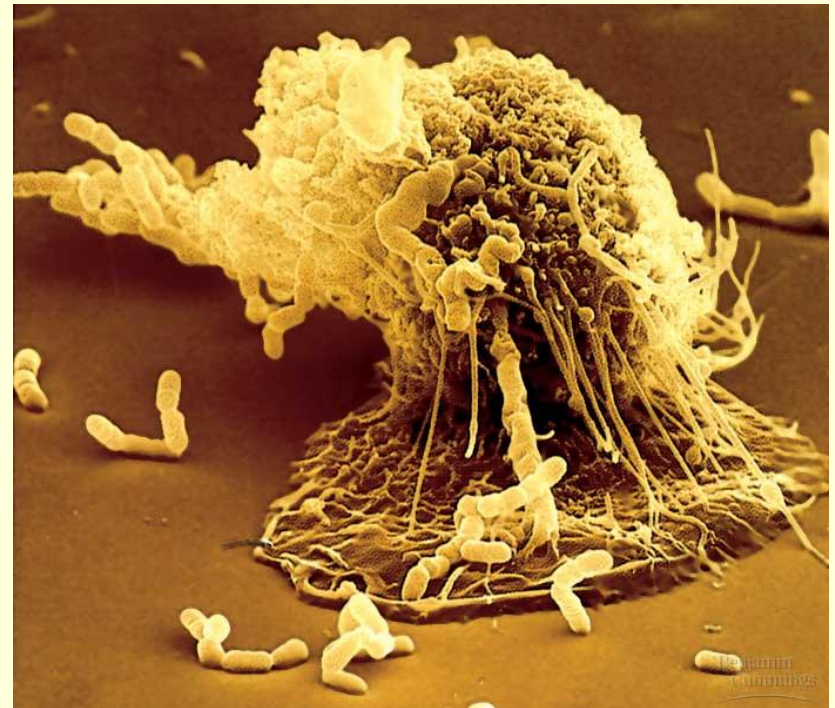
**Immune system** from foreign substances and pathogenic organisms

**Antigens:** factors the body “sees” as foreign

**Pathogenic Organisms:** cause disease

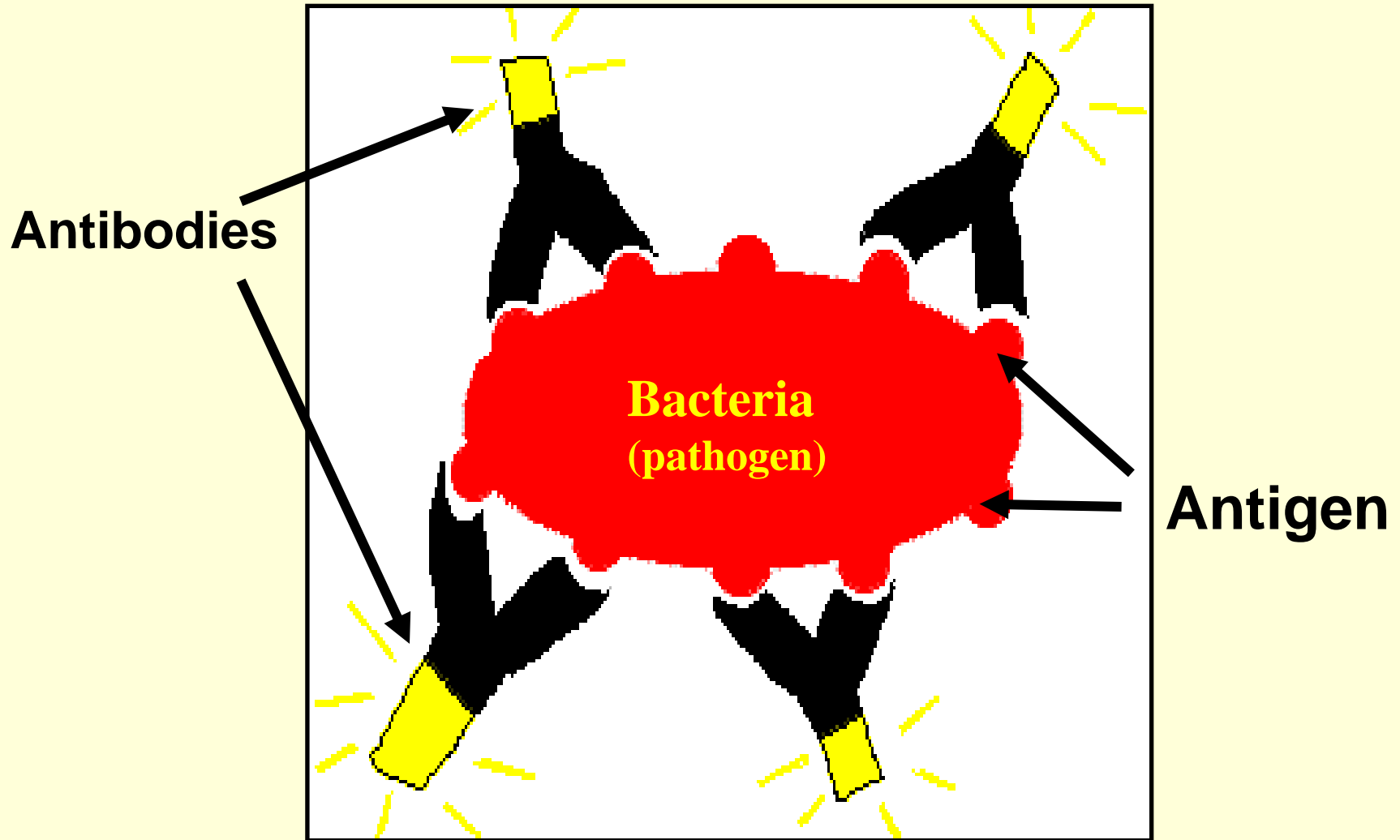


Antibody-antigen interaction



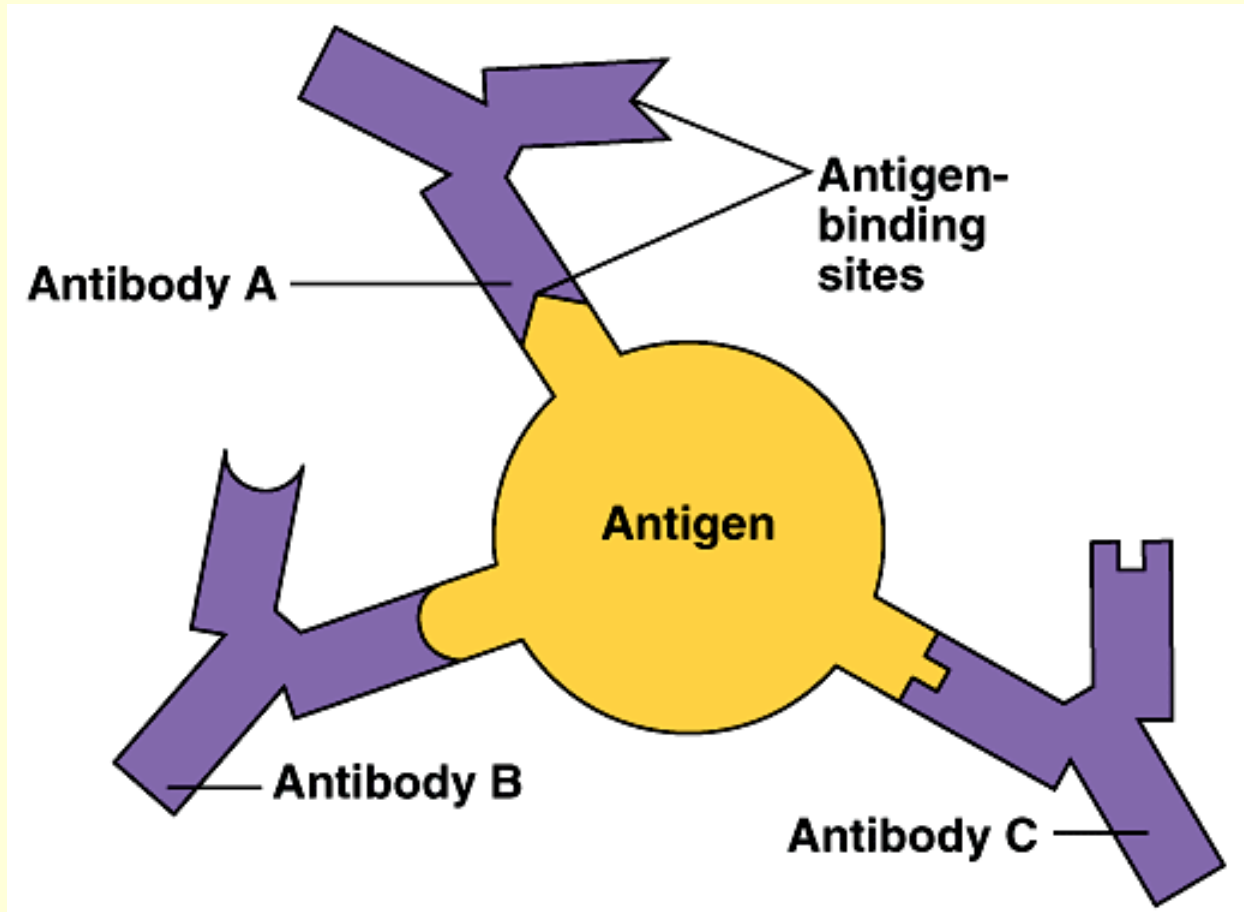
Engulfing White Blood Cell

**Special white blood cells make antibodies that mark the pathogen for destruction by other cells.**





**Antibodies** are structure specific to the antigen

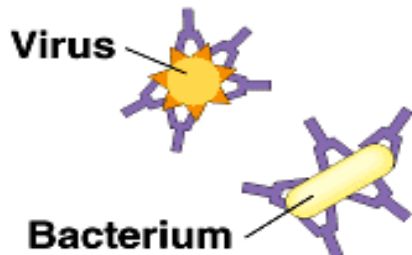


Due to their protein nature, antibody shape “fits” binding sites on the antigens.

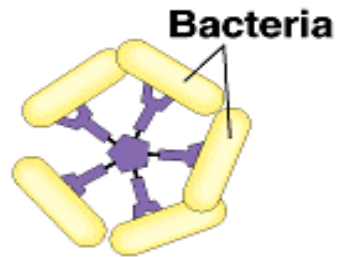
# Antibodies inactivates antigens several ways

## Binding of antibodies to antigens inactivates antigens by

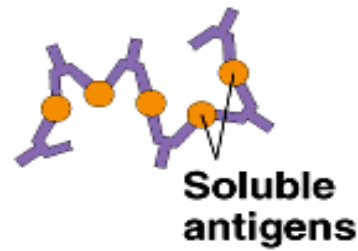
**Neutralization**  
(blocks viral binding sites;  
coats bacteria and/or  
opsonization)



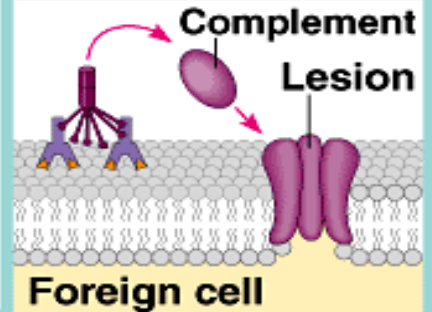
**Agglutination of  
antigen-bearing  
particles, such as  
microbes**



**Precipitation of  
soluble antigens**

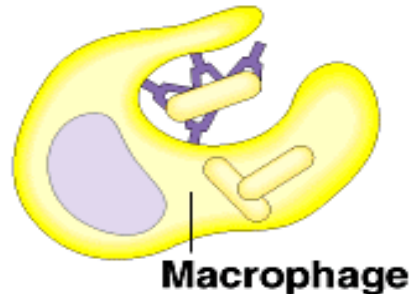


**Complement fixation  
(activation  
of complement)**



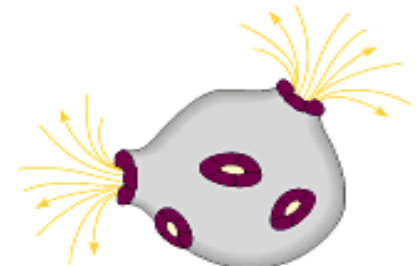
**Enhances**

**Phagocytosis**



**Leads to**

**Cell lysis**



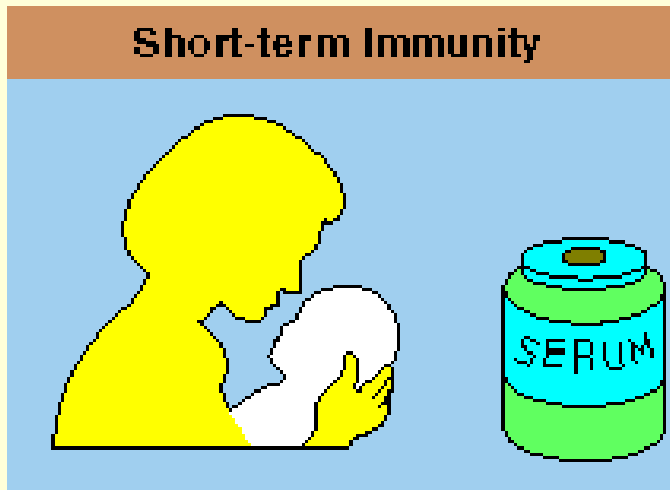
# Immunity can occur naturally or artificially

1. **Active Immunity:** stimulates the infected person's immune system
  - a. Immunization by vaccination give the person a weakened, dead, fragment of the pathogen
  - b. Recover from the infection



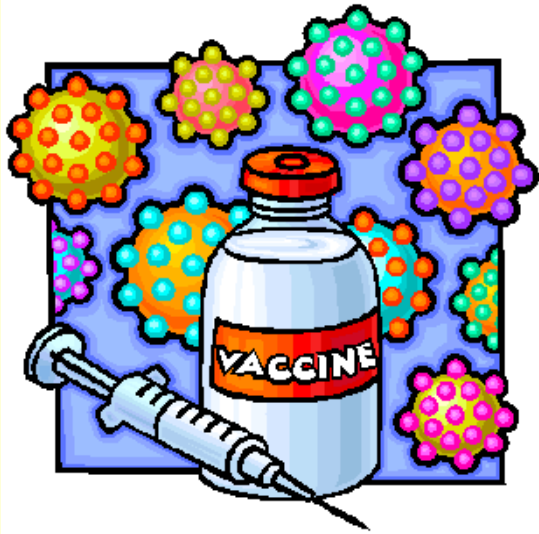
2. **Passive Immunity:** person receives antibodies only so it is temporary

- a. Maternal immunity occurs when antibodies pass from mother to baby through placenta and breast milk
- b. Artificial injection of antibodies gives short term immunity

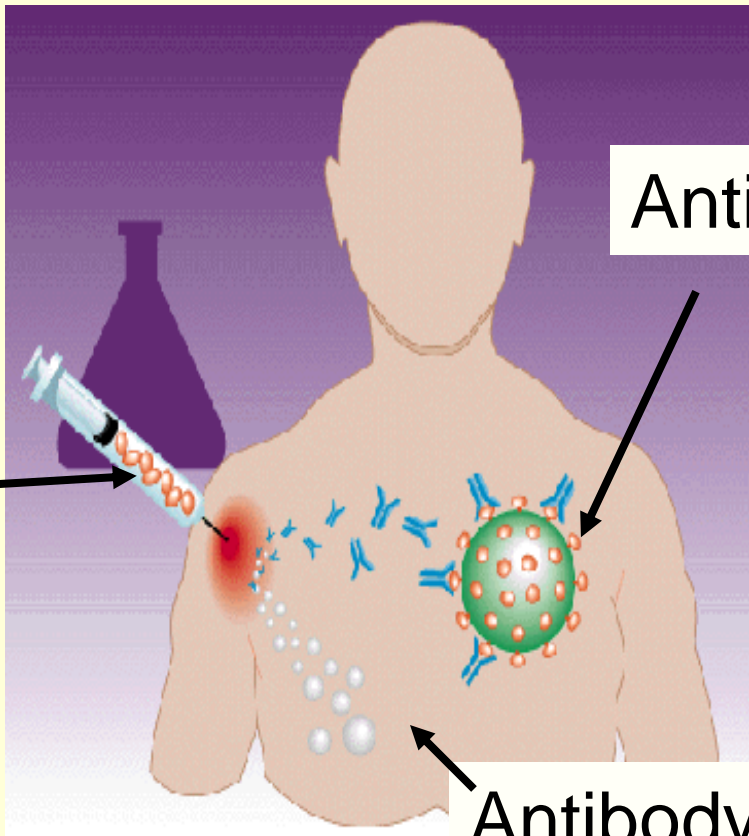




**Vaccinations:** Patient receive weakened versions of pathogen to stimulate the immune system



Weakened Pathogen



Antigen

Antibody



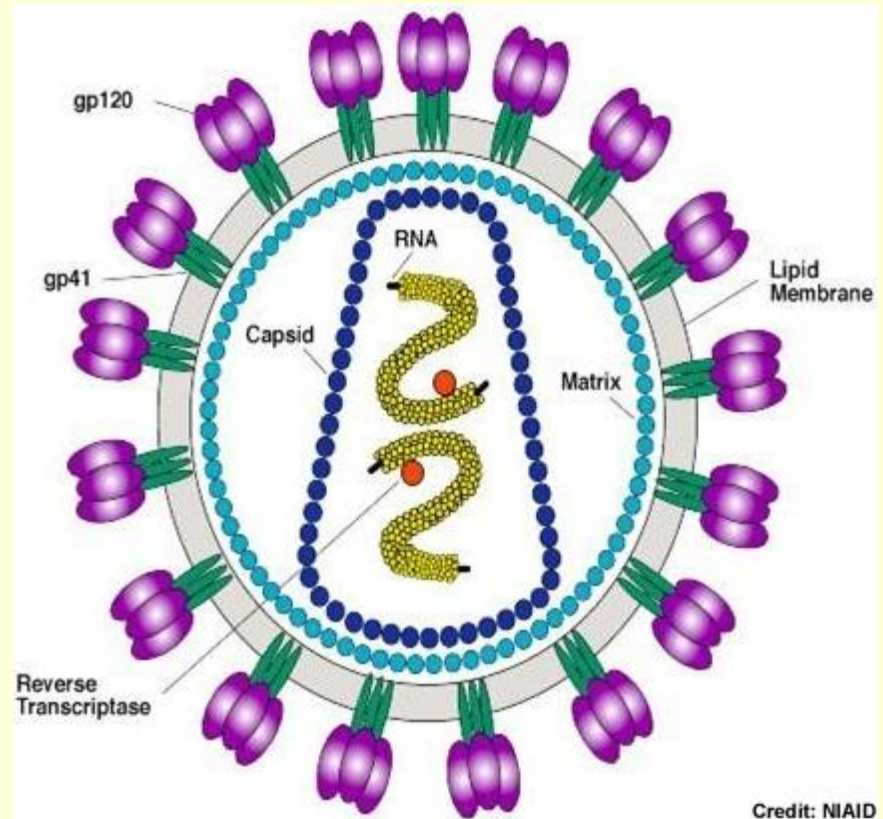
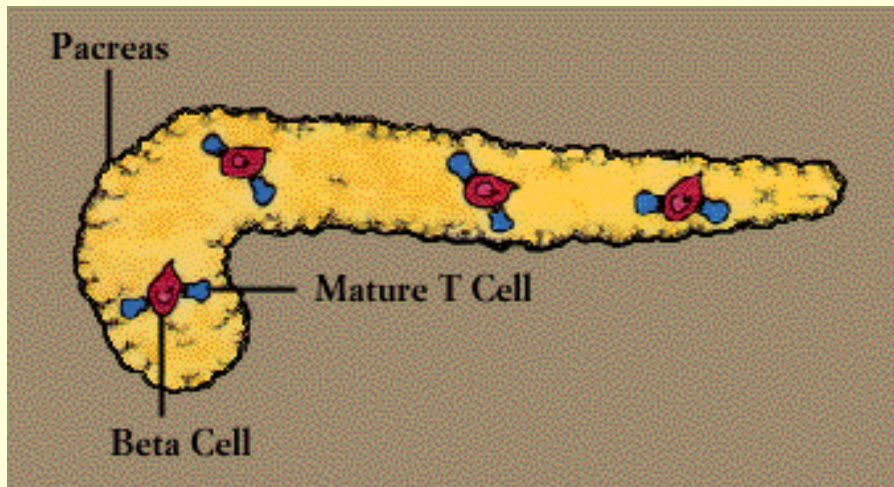
# Vaccines movie



# Immune System Failures

Autoimmune diseases: immune system destroys body cells, type I diabetes, multiple sclerosis, rheumatoid arthritis

AIDS: Acquired Immune Deficiency Disease

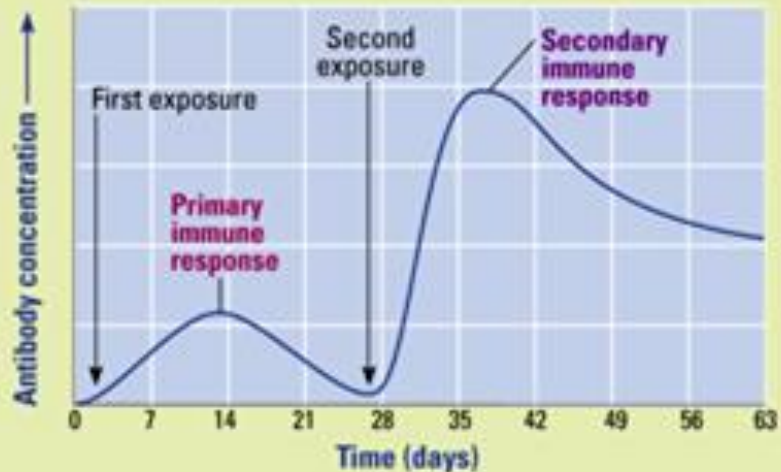


Credit: NIAID



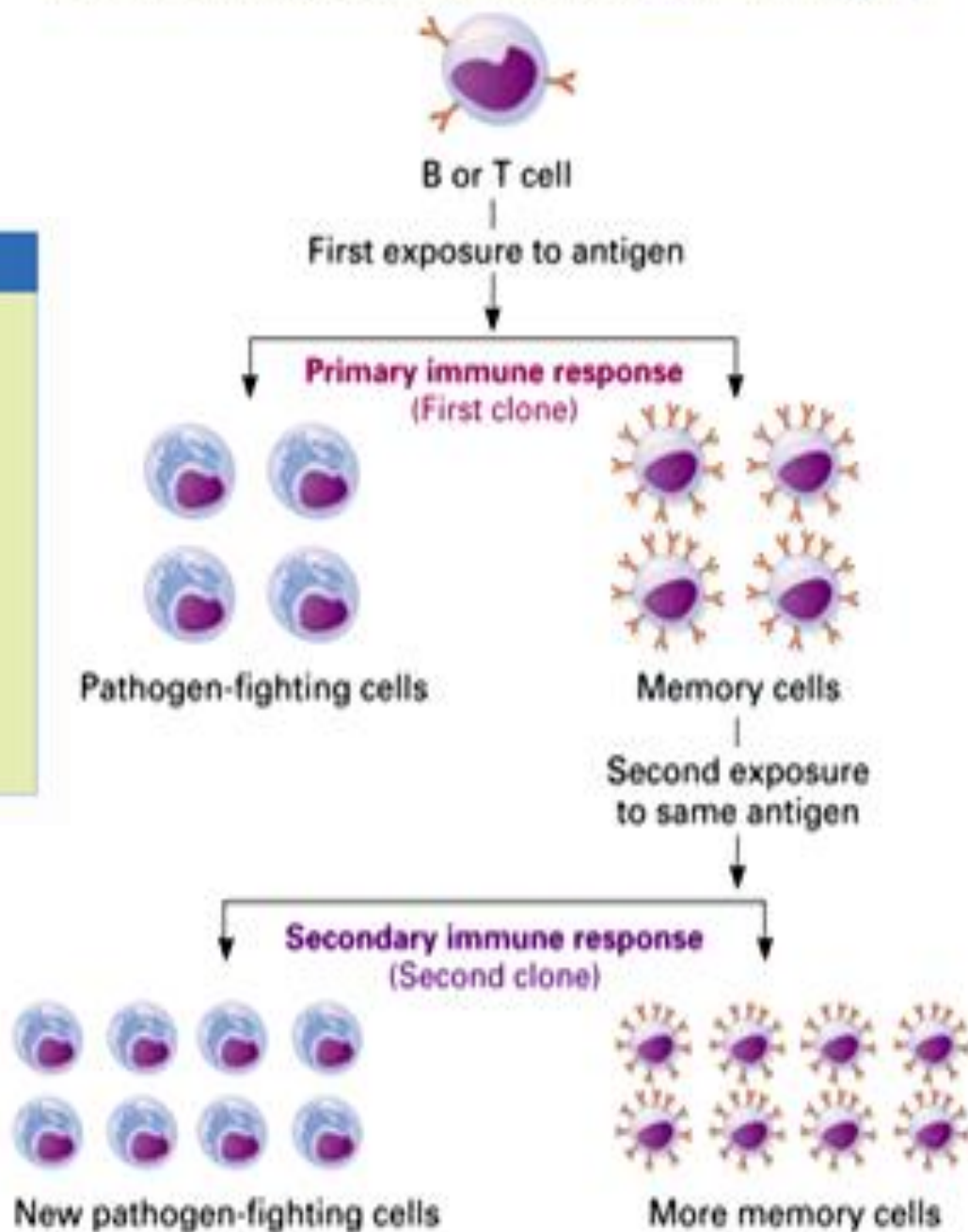
# Primary and Secondary Immune Responses

Primary and Secondary Immune Responses



The first exposure to a pathogen memory cells specific to that pathogen. A second exposure activates those memory cells.

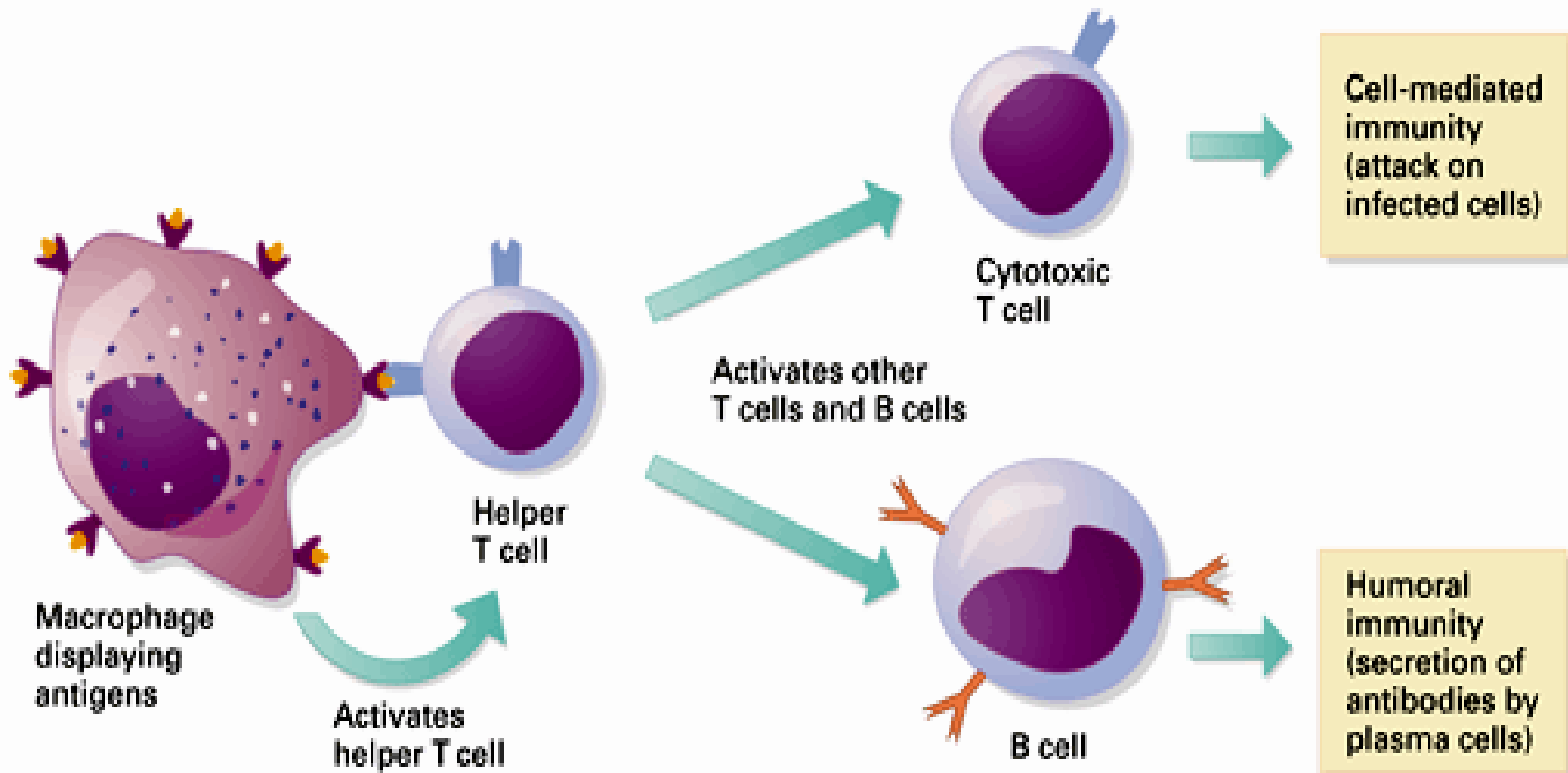
## How the Immune System "Remembers" Pathogens





**Large White Blood Cells** engulf pathogens. They display antigens and activates helper T cells. The helper T cells stimulate other T cells and B cells.

**HIV virus** kills Helper T cells.



**Allergies:** immune reaction involving histamines to a “harmless” allergen.

# ALLERGIC REACTIONS

## Skin Contact

-  poison plants
-  animal dander
-  pollen
-  latex

## Injection

-  bee sting
-  medication

## Ingestion

-  medication
-  nuts & shellfish

## Inhalation

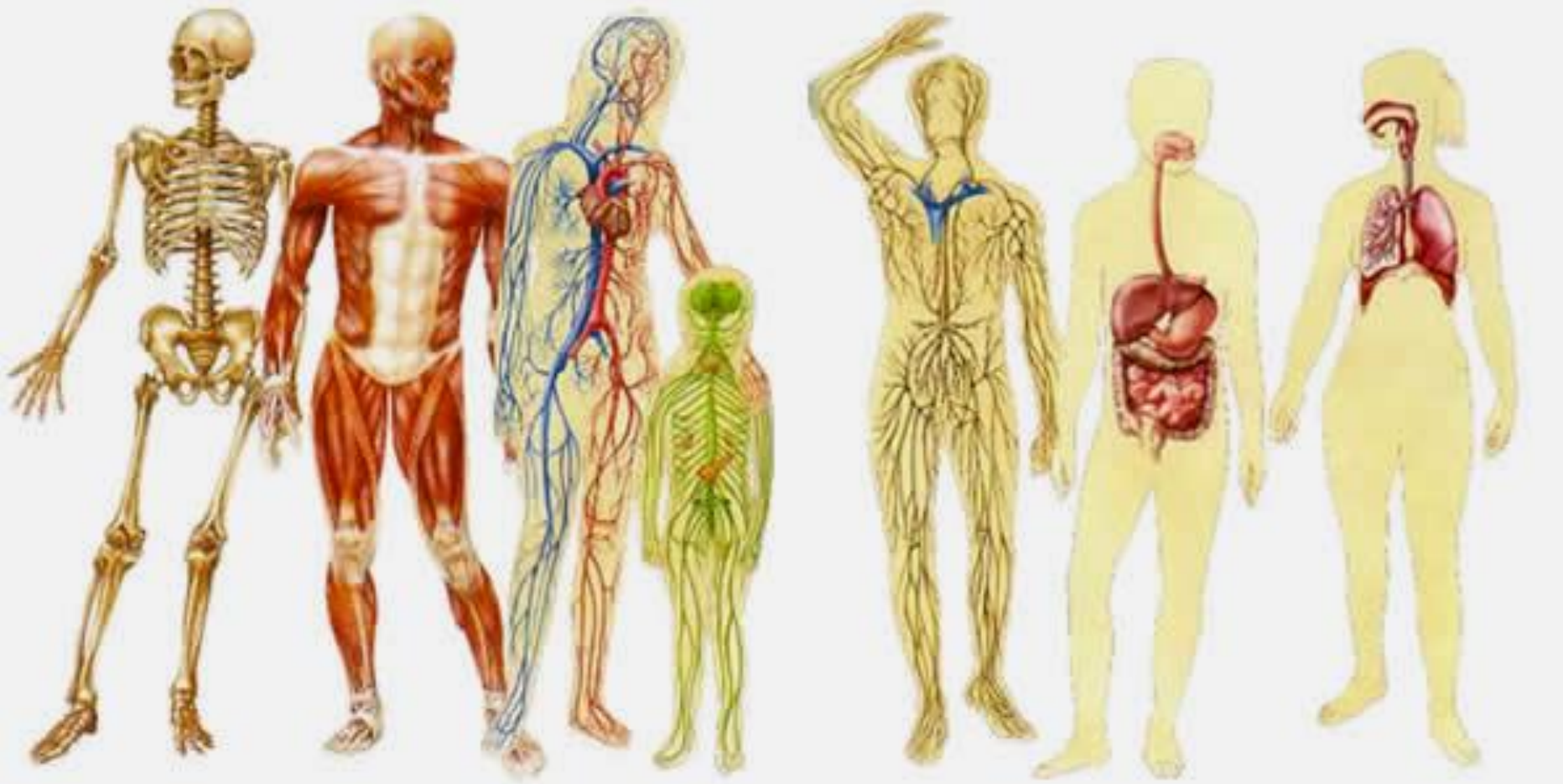
-  pollen
-  dust
-  mold & mildew
-  animal dander



# Human Systems

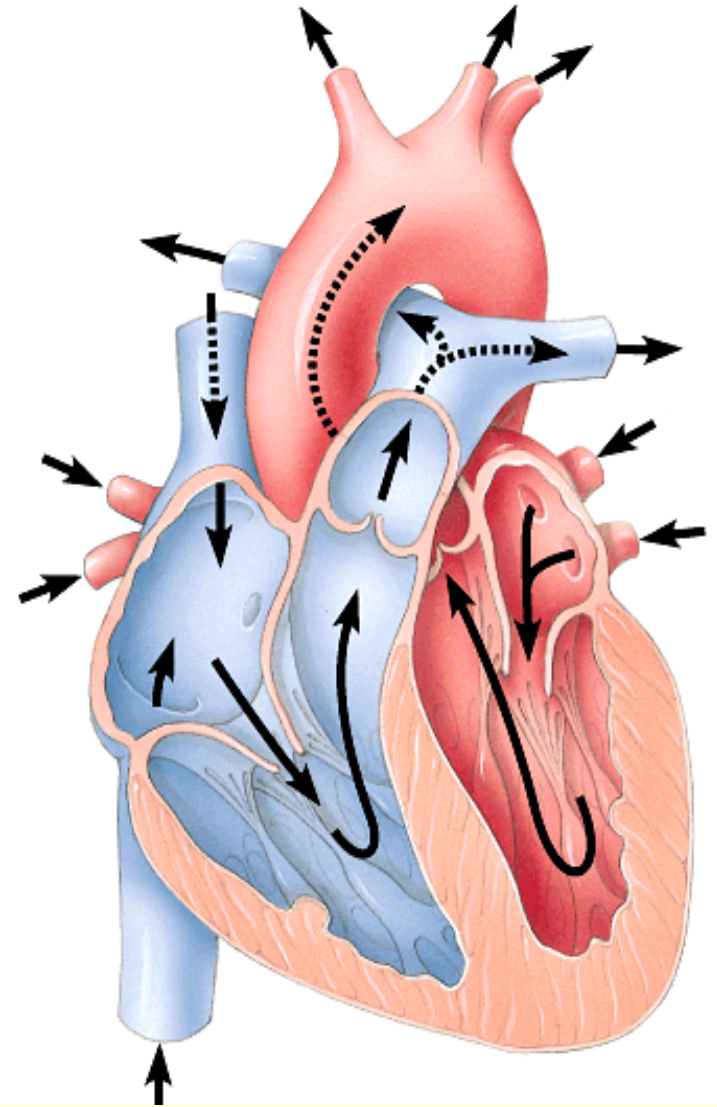
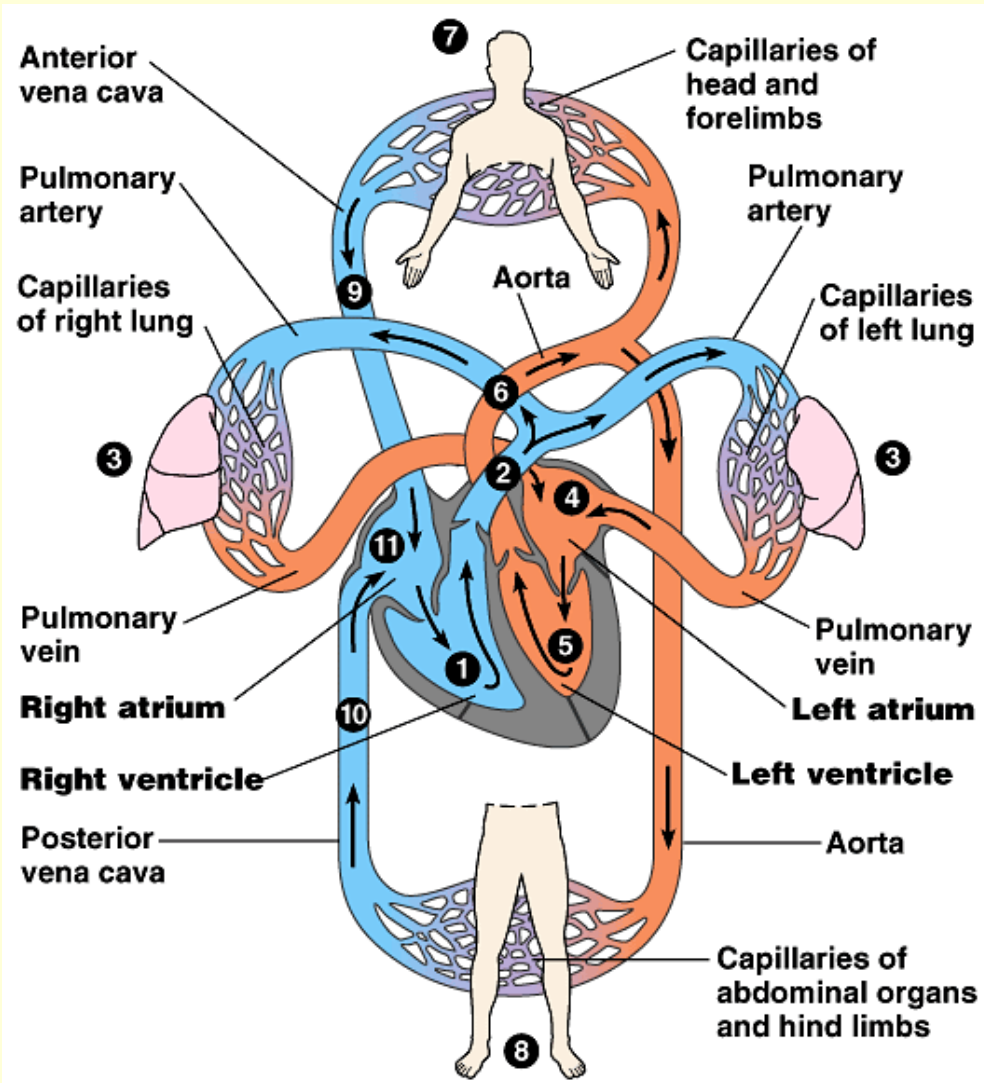
Humans are complex organisms with multiple systems.

The systems interact to perform life functions.



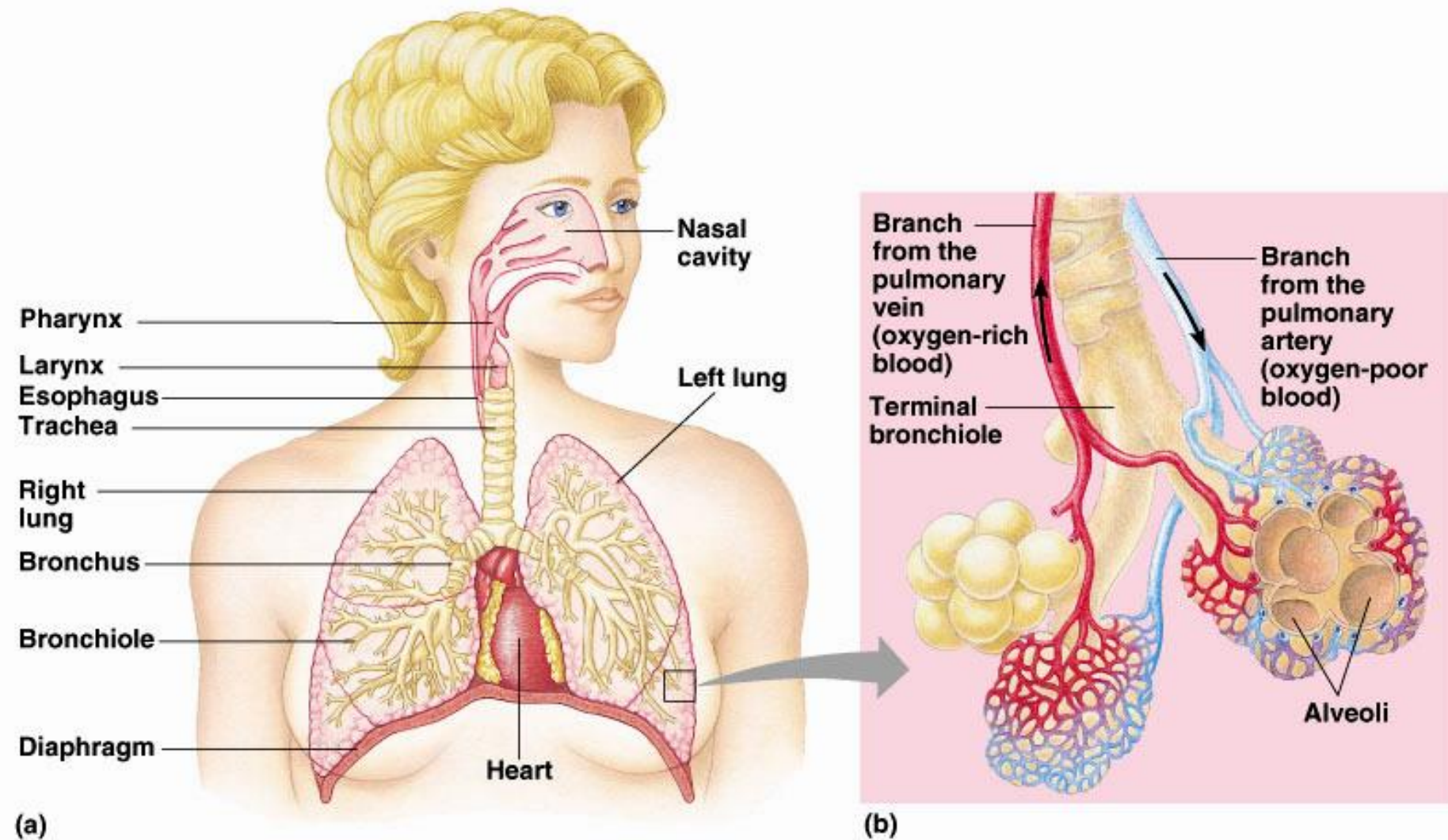


**Transport System:** provides for the circulation and distribution of materials to the cells.

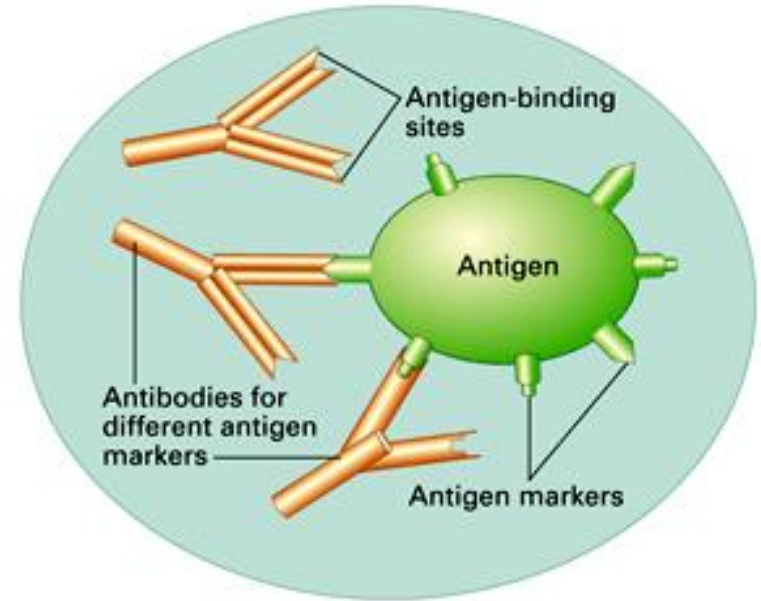
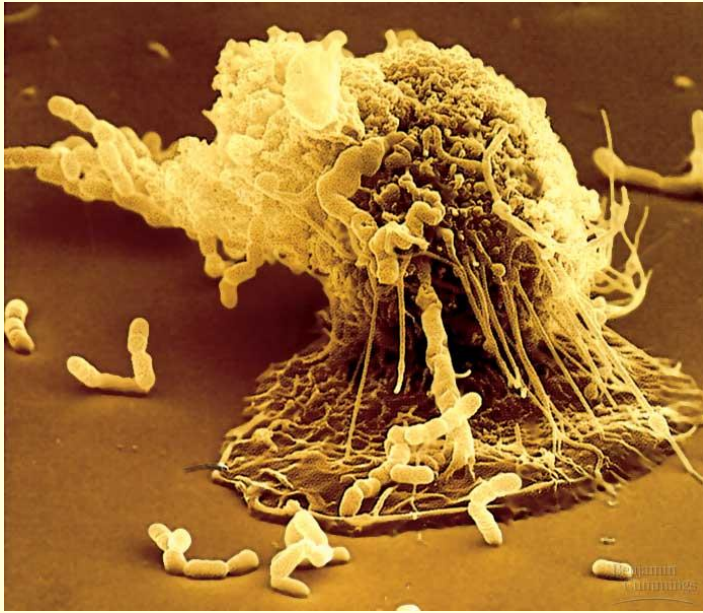




**Respiratory System:** provides for gas exchange to supply the cells with  $O_2$  and removal of  $CO_2$ .

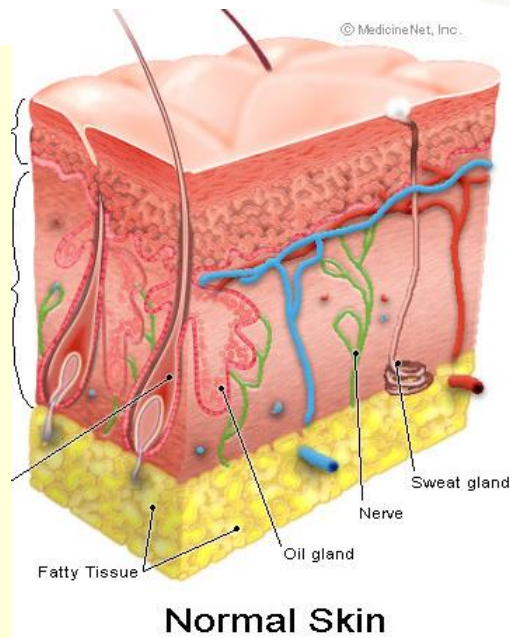
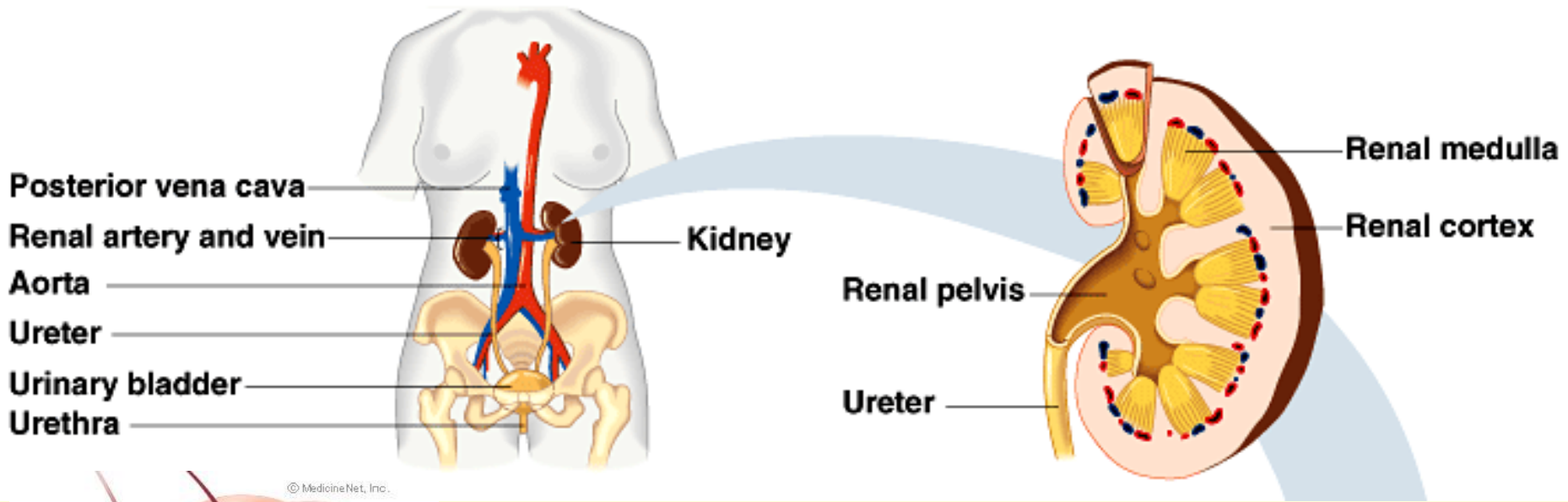


# Immunity: provides for protection from pathogens

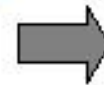
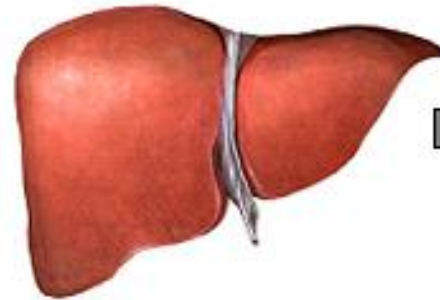
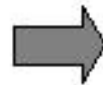




**Excretion:** provides for the elimination of metabolic wastes  
Many organs help with excretion: Skin, kidneys, lungs, liver



**Drug enters liver after entering the bloodstream.**

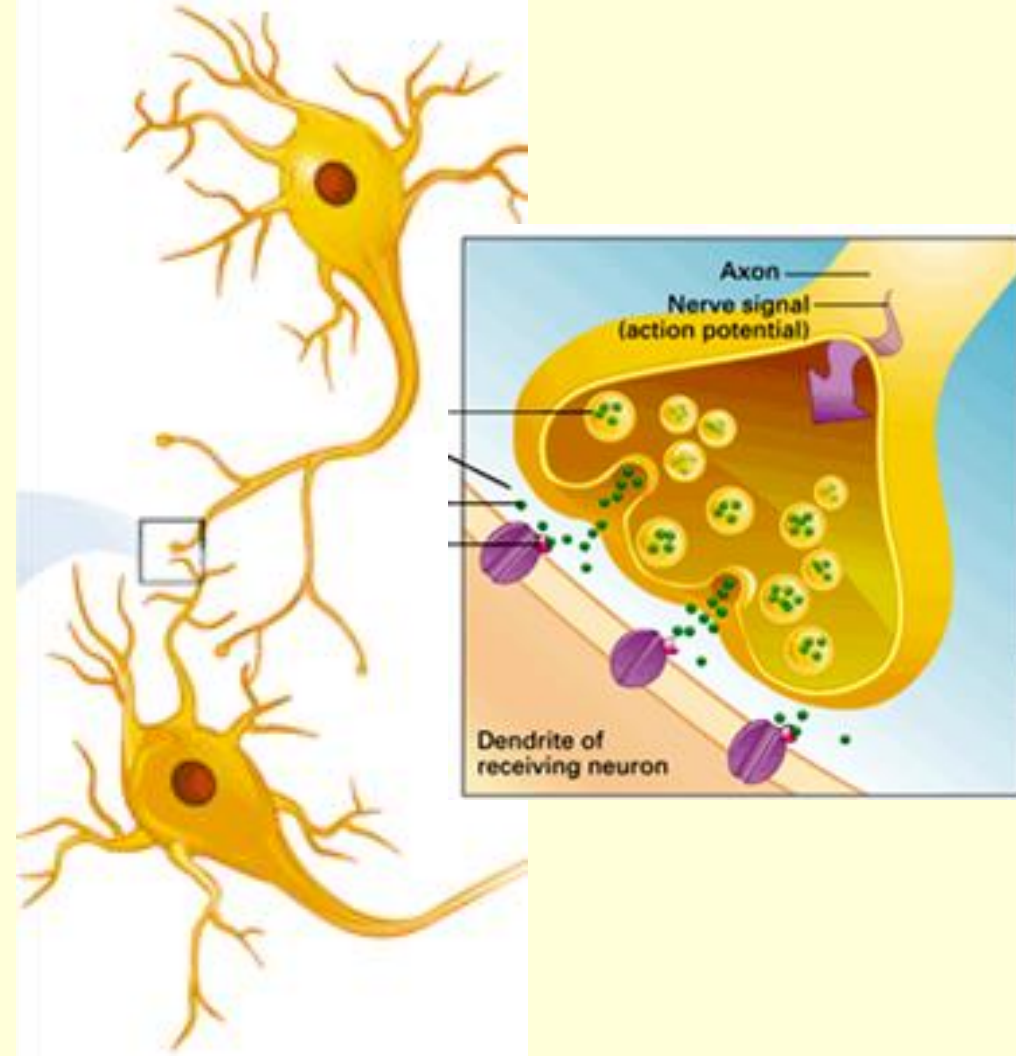


**Elimination by urination or defecation.**

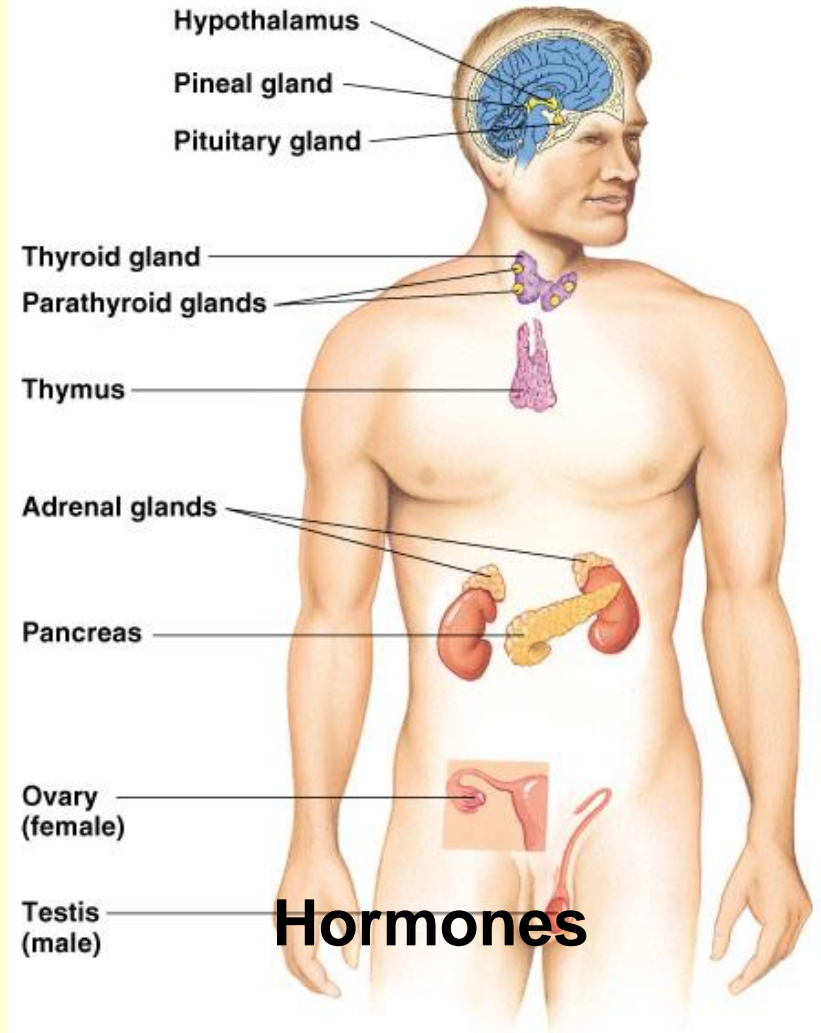
**Liver enzymes metabolize drug into less toxic form.**

**Coordination of the cells** is provided by the regulatory systems of Nerves and Glands  
Chemical regulating molecules are produced.

## Nerves

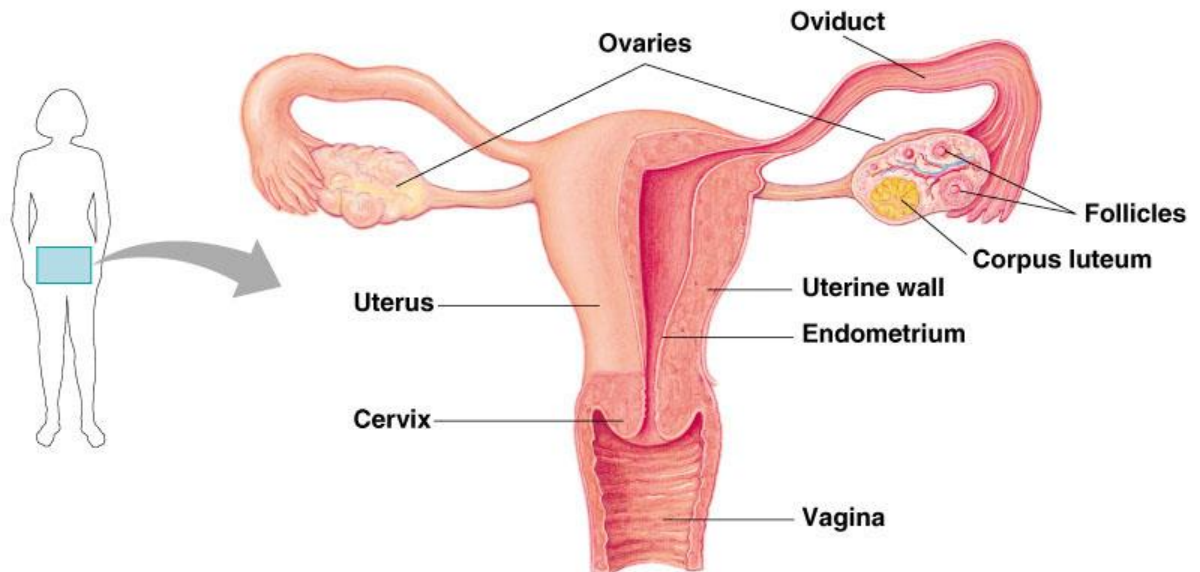
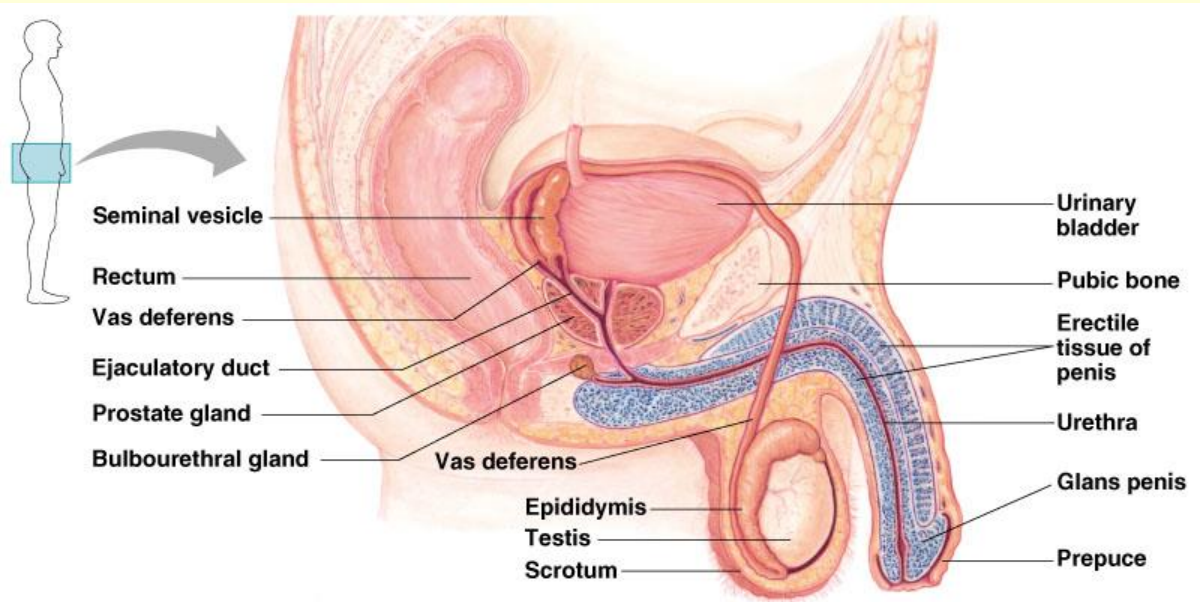


## Endocrine System

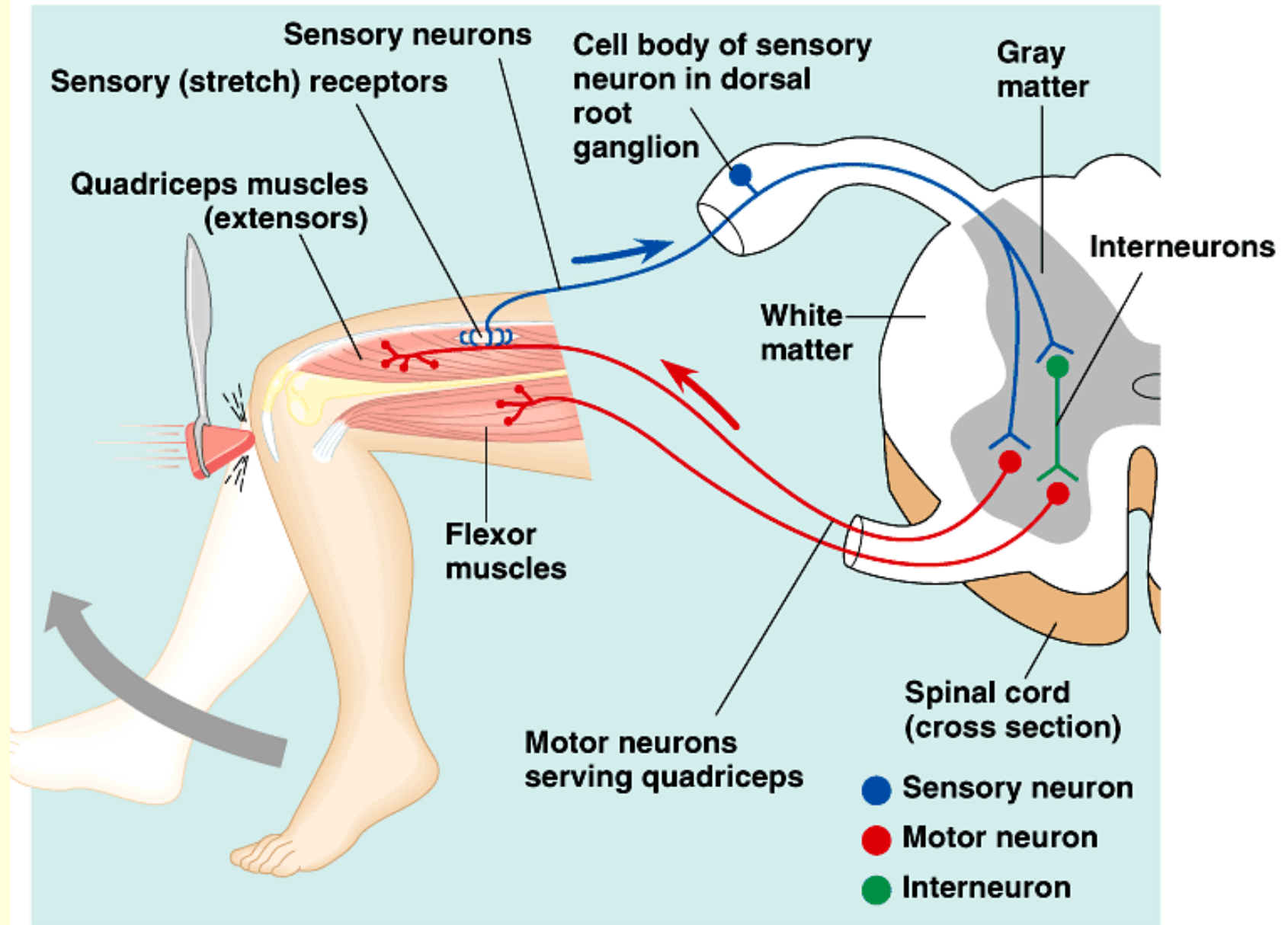




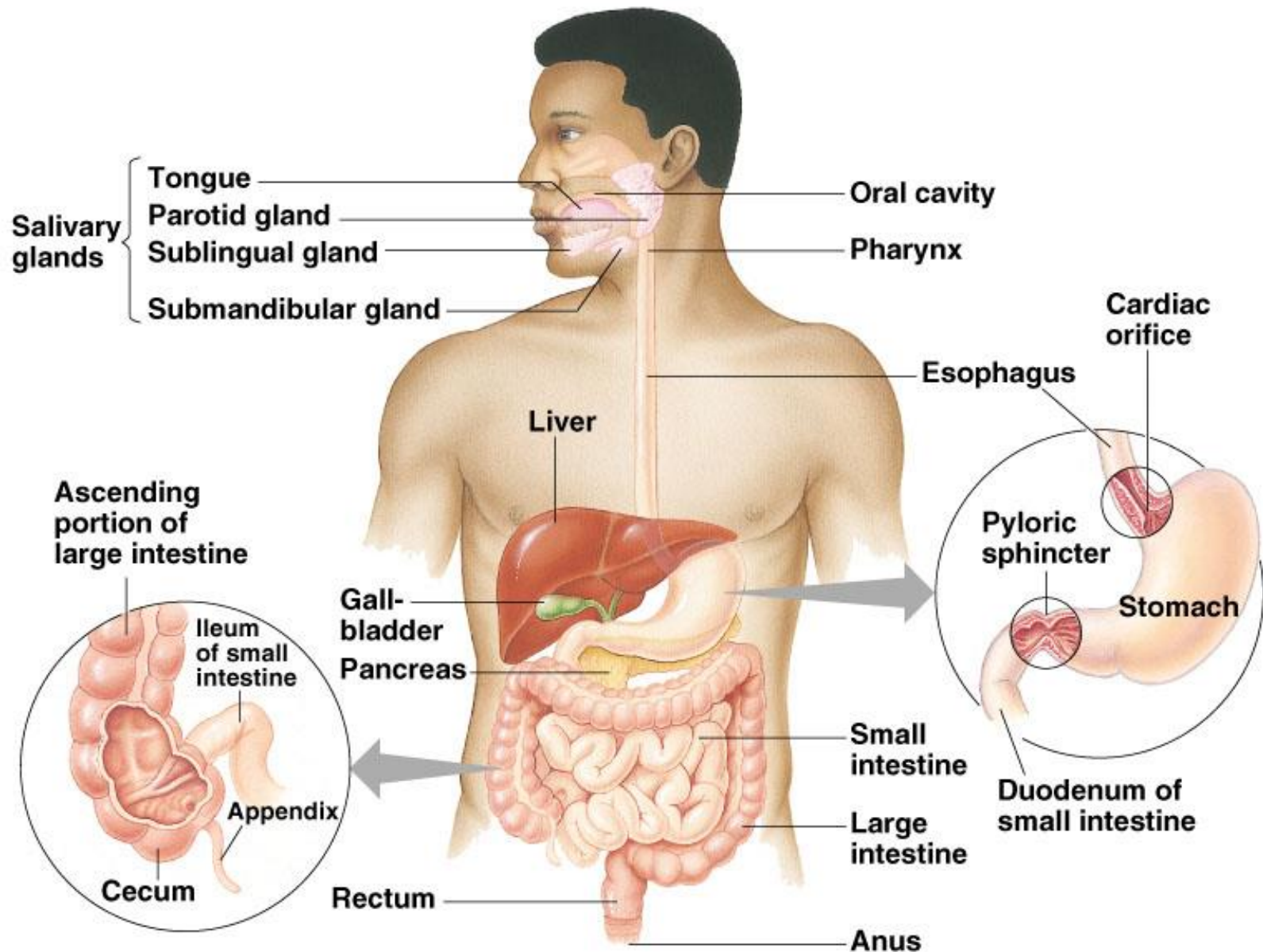
# Reproduction: producing offspring is necessary for survival of the species



**Movement** is provided by a system of muscles and skeleton  
**Control** is provided by the nervous system



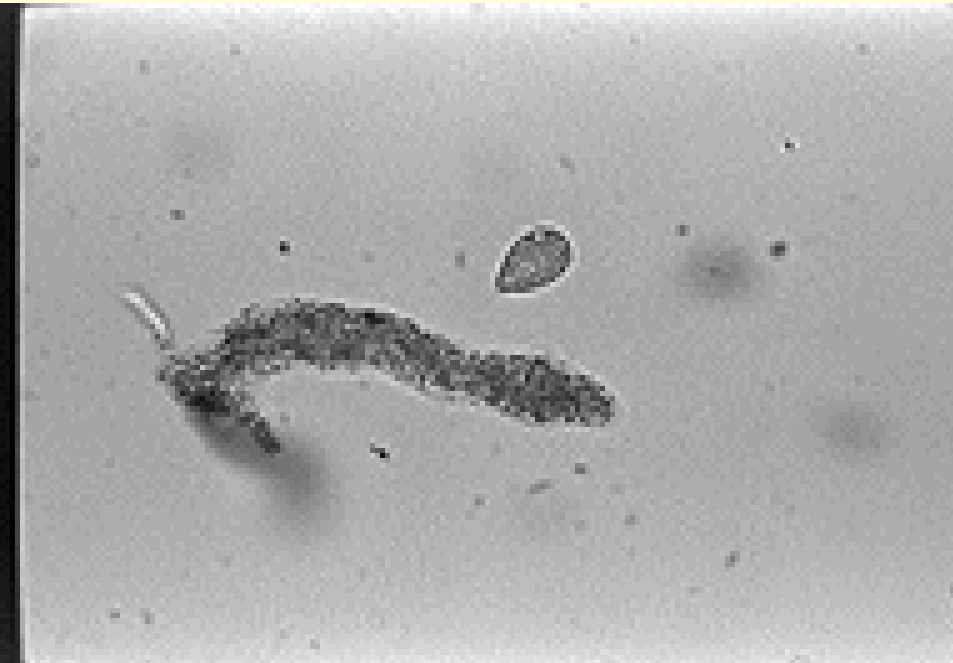
# Digestive System: Consumption and digestion of food provides nutrients to the cells



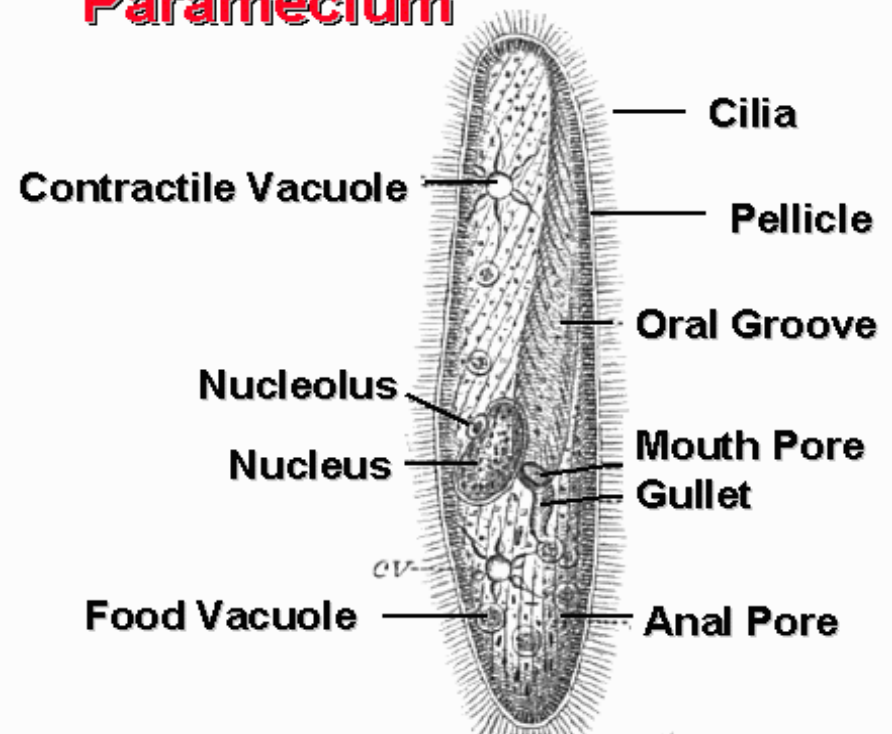


**One-celled organisms** function without the levels of the organization in complex organisms.

Their organelles act like the systems in multicellular organisms.



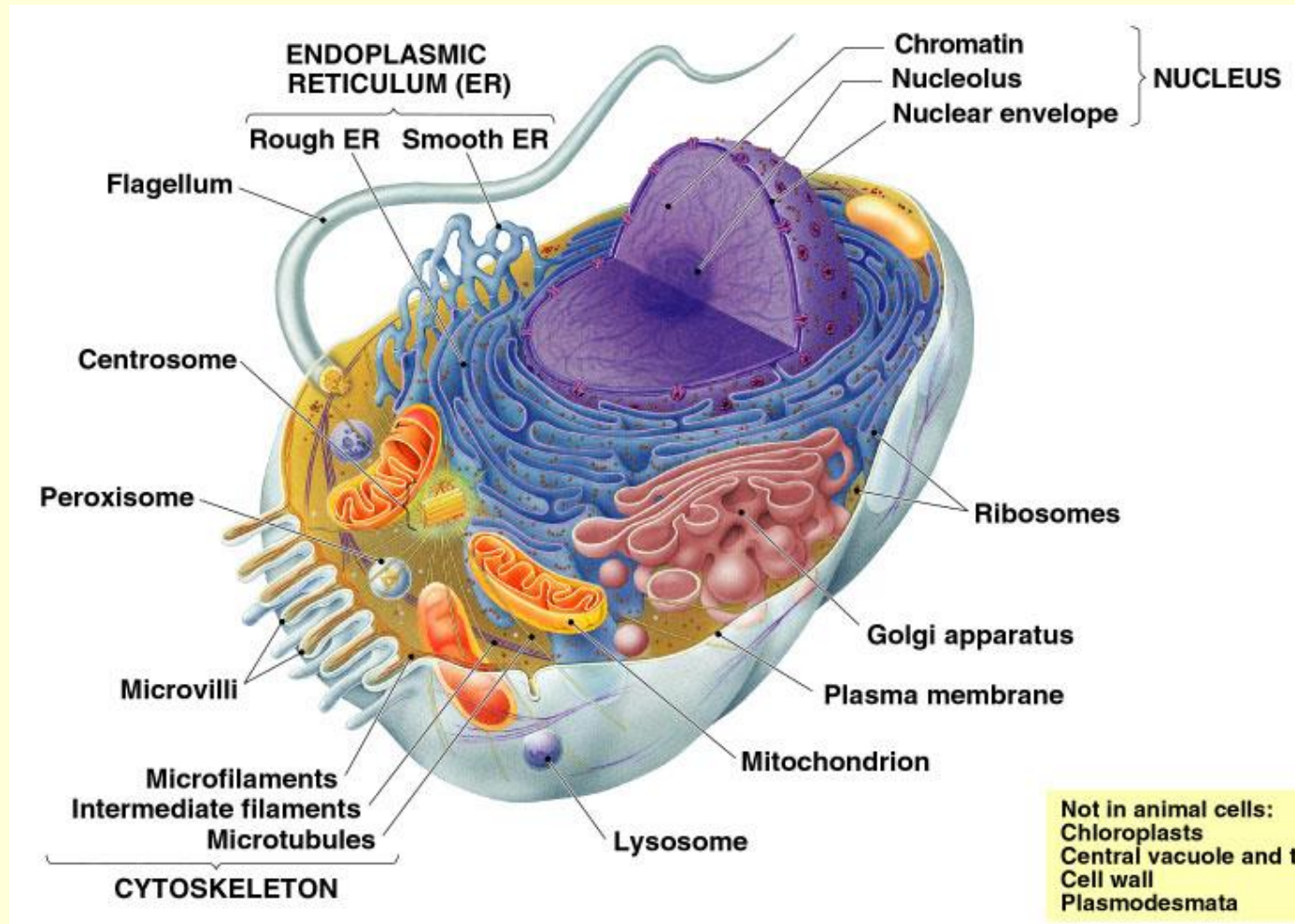
## Paramecium



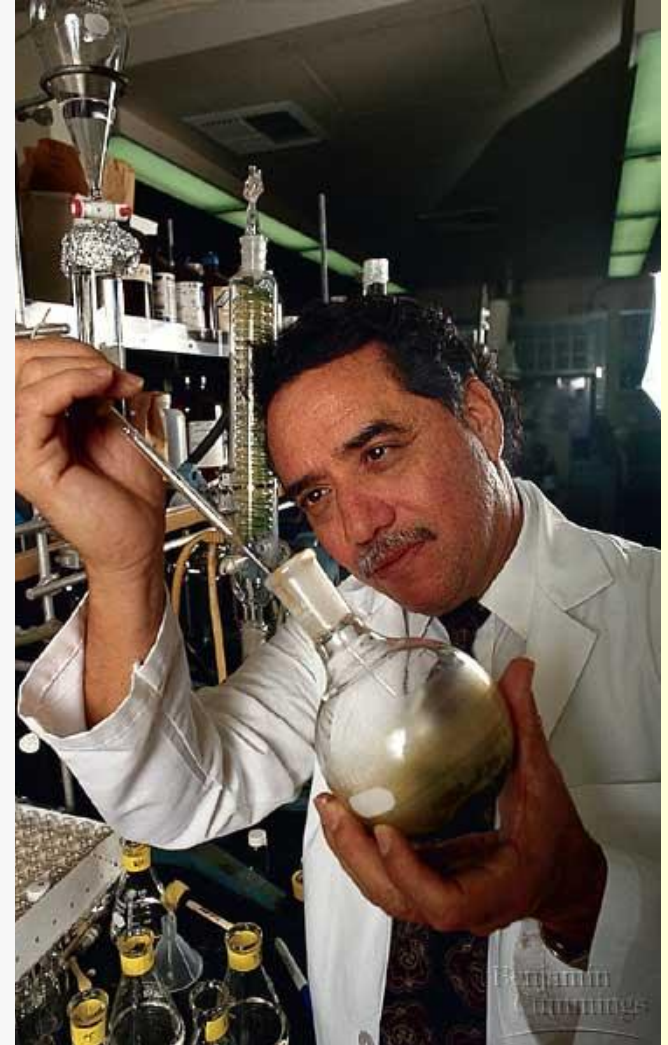
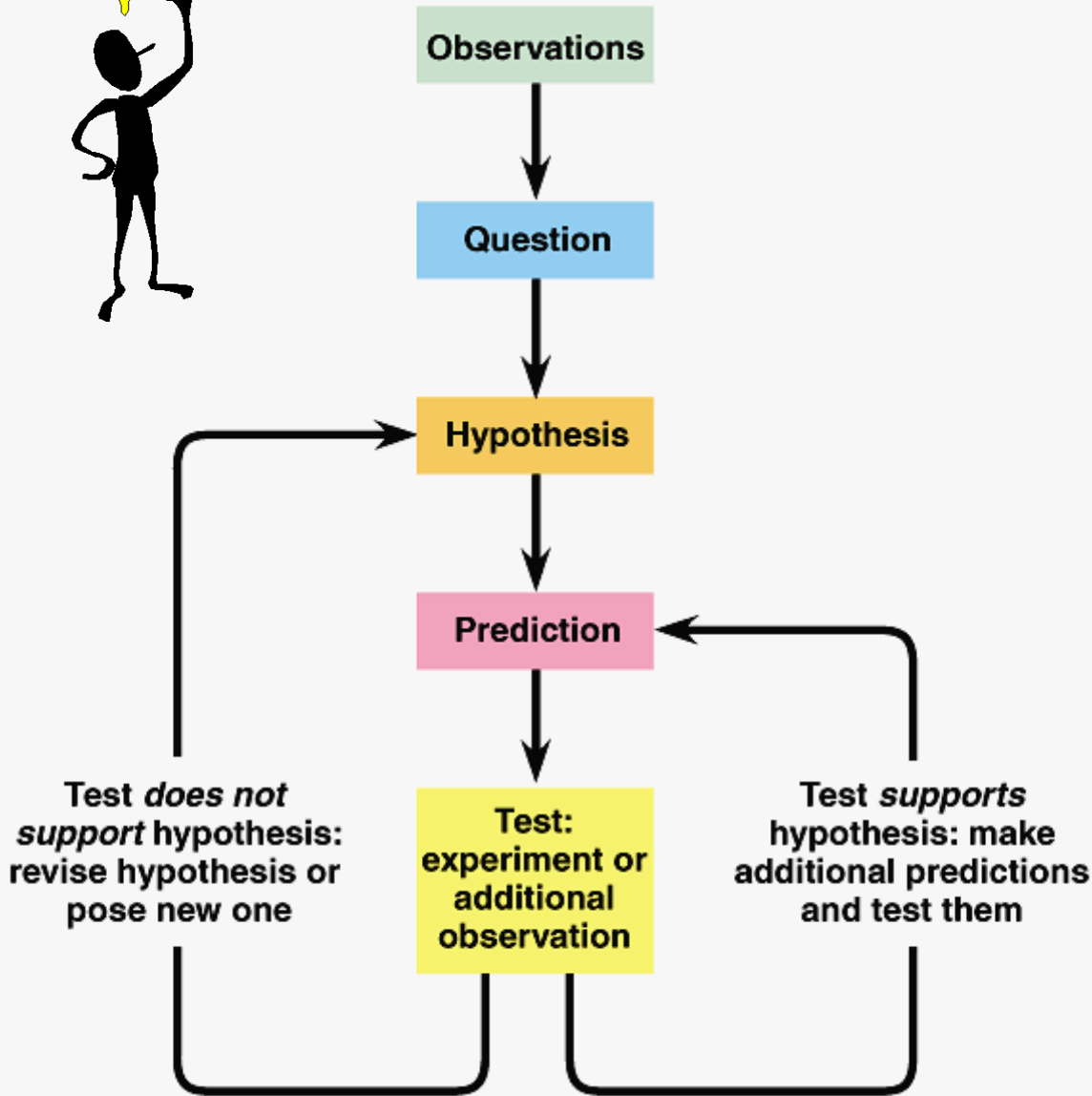


**One-celled organisms** function without the levels of the organization in complex organisms.

Their organelles act like the systems in multicellular organisms.



# Science is a process of inquiry that includes repeatable observations and testable hypotheses



# Designing a Controlled Experiment

- **Controlled experiment:** tests the effect of a single variable.
- **Variable:** any factor that can be changed
  - **Dependent variable** is the measured effect caused by the
  - **Independent variable** which is the factor being studied
- **Controlled Factors:** all other variables must be held constant.
- **Hypothesis:** "If . . . , then . . ."



**Observation:** Both poisonous coral snakes and nonpoisonous kingsnakes have red, yellow, and black rings.

**Question:** What is the function of the kingsnakes' mimicry of coral snakes?

**Hypothesis:** Mimicry of coral snakes helps protect the kingsnakes from predators.

**Prediction:** *If* predators confuse kingsnakes with coral snakes, *then* predators should attack fewer ringed artificial snakes than brown artificial snakes.

**Experiment:** Compare data on attacks on ringed versus brown artificial snakes.

# Observations may lead to questions and hypothesis



Warning coloration: Why is this frog so colorful and visible?



Why does this fly look so much like a bee?



**Data:** is the measured results of the experiments

Growth Chart	
Age (years)	Height (cm)
2.0	86
2.5	90
3.0	93
3.5	98
4.0	100
4.5	104
5.0	107
5.5	110
6.0	114

Data of height vs. age of a child's growth.

Independent Variable: Age

Dependent Variable: Height

# Components of a Controlled Experiment

- State a hypothesis
- Identify the independent variable
- Control all other factors
- Identify the dependent variable
- Identify or make a control group
- Control all other factors
- Collect and record data
- Make data table and graphs
- Verify results with repeats