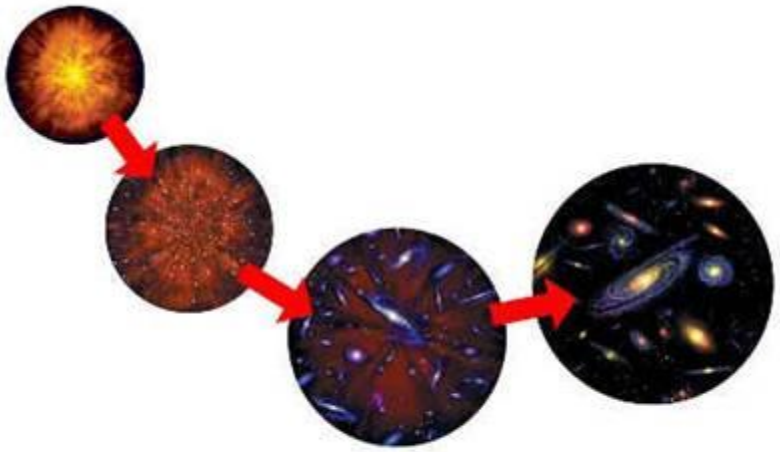
Introduction to Biology

Biology – The Study of Life

- Life arose more than 3.5 billion years ago
- First organisms (living things) were single celled
- Only life on Earth for millions of years
- Organisms changed over time (evolved)



Big Bang Theory

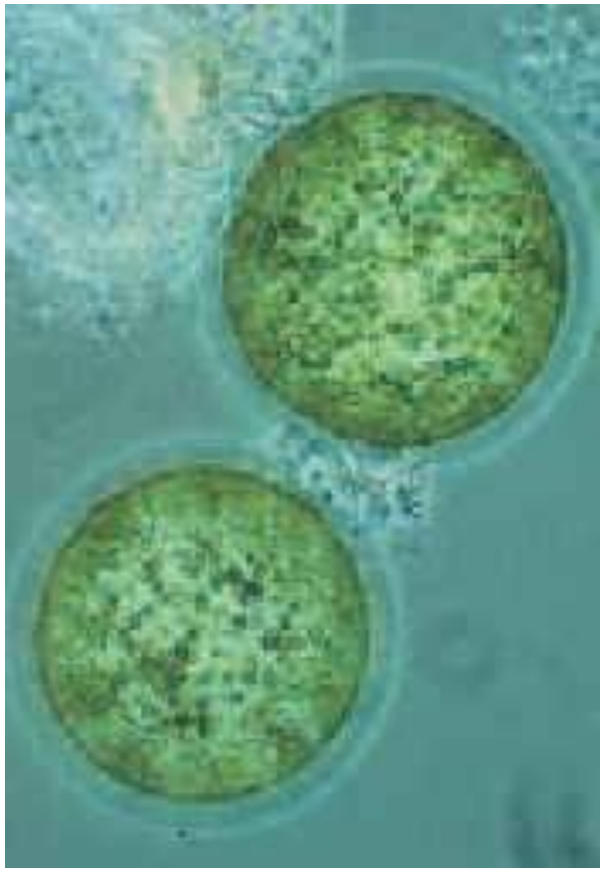
- New organisms arose from older kinds
- Today there are millions of species
- They inhabit almost every region of Earth today

Themes of Biology

- Cell structure and function
- Stability and homeostasis
- Reproduction and inheritance
- Evolution
- Interdependence of organisms
- Matter, energy, and organization

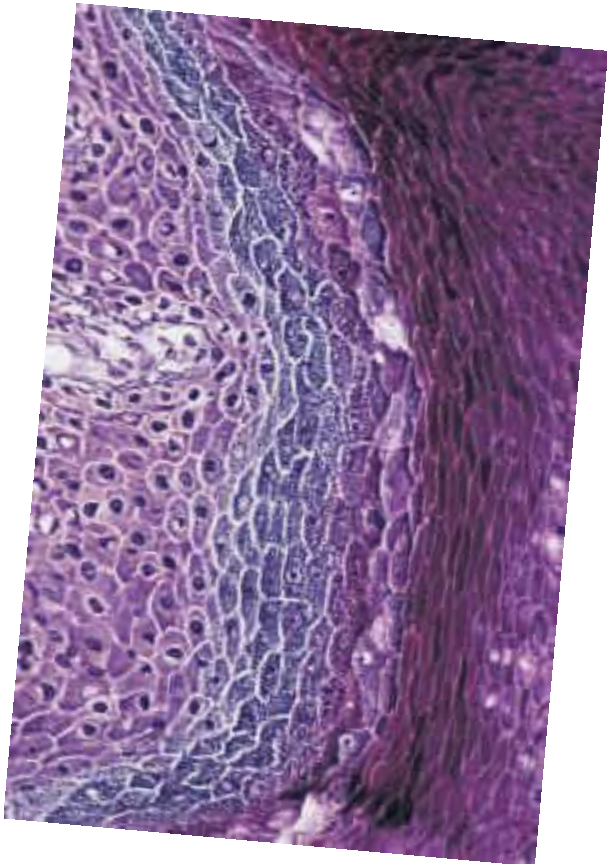
Cell Structure and Function

- **Cell** basic unit of life
- All organisms are **made of and develop from cells**
- Some composed of only a single cell **(unicellular)** which is usually **identical to parent**

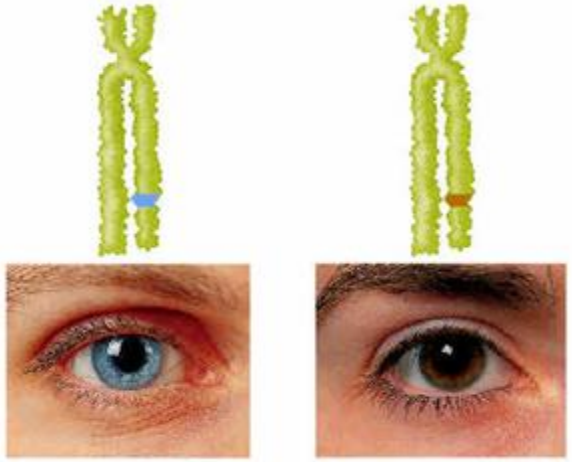


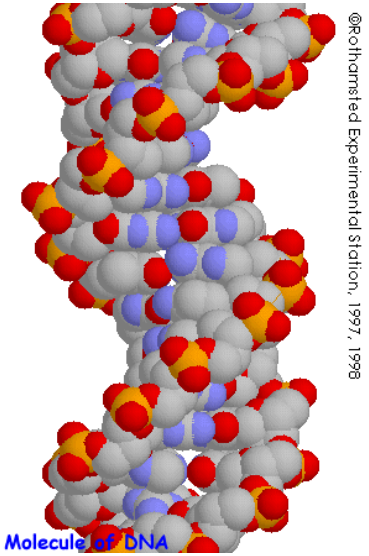
Cells

- Most organisms are composed of many cells **(multicellular)**
  - Cells are **different** (undergo differentiation)
- Cells are **small**
- Cells are **highly organized**



- Cells contain specialized structures (organelles) that carry out the cell's life processes
- Many different kinds of cells exist
- All cells surrounded by a plasma membrane
- Contain a set of instructions called DNA (genetic information)





Stability and Homeostasis

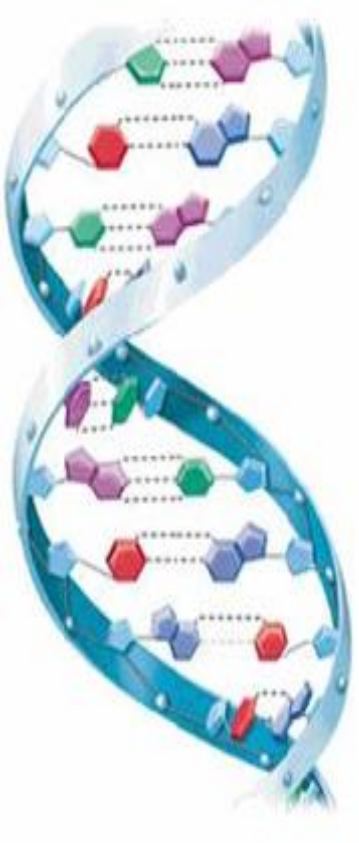
- Organisms must Maintain very stable internal conditions - HOMEOSTASIS
- Temperature, water content, chemical content, etc. must be maintained

Reproduction and Inheritance

- All organisms produce new organisms like themselves **REPRODUCE**
- Organisms transmit hereditary information to their offspring **INHERITANCE**

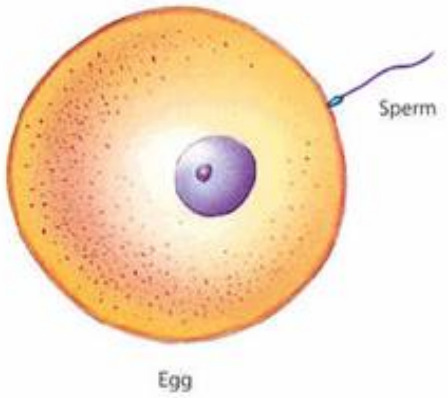
DNA

- Genetic Information in **all cells**
- **Deoxyribonucleic Acid**
- DNA contains instructions for traits **GENES**
- Make the structures and complex chemicals necessary for life **PROTEINS**
- DNA in every body cell (**SOMATIC CELLS**) is exactly alike



Sexual Reproduction

- Hereditary information from **two different organisms** of the same species are combined
- Egg and sperm → **zygote (fertilized egg)**
- Zygote contains hereditary information from **both parents**

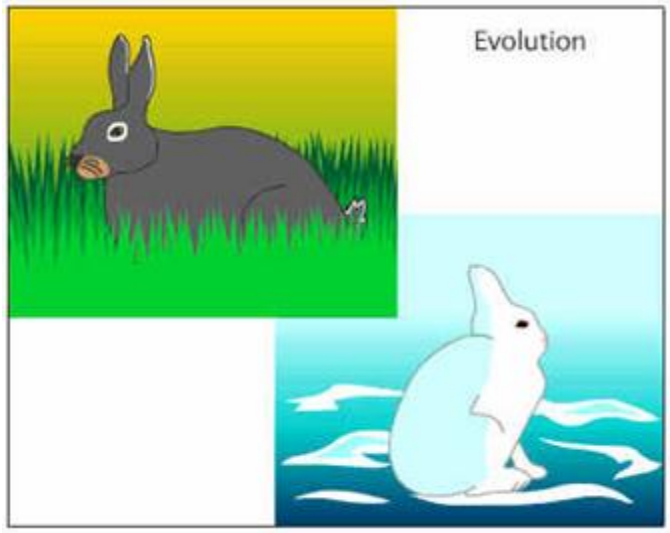


Asexual Reproduction

- Hereditary information from one, usually unicellular, organism that divides
- Resulting cells contain identical hereditary information
- Genetic information from single parent

Evolution

- Populations of organisms change (evolve) over generations (time)
- Explains how many different kinds of organisms came into existence SPECIES
- Explains how modern organisms are related to past organisms



- Explains why **organisms look and behave** the way they do
- Provides a basis for exploring the **relationships among** different groups of organisms

Natural Selection

- Natural selection is the **driving force in evolution**
- Organisms that have certain **favorable traits** are better able to **successfully reproduce** than organisms that lack these traits

Natural Selection

- Survival of organisms with favorable traits cause a gradual change in populations over many generations
- Also Called "Survival of the Fittest"

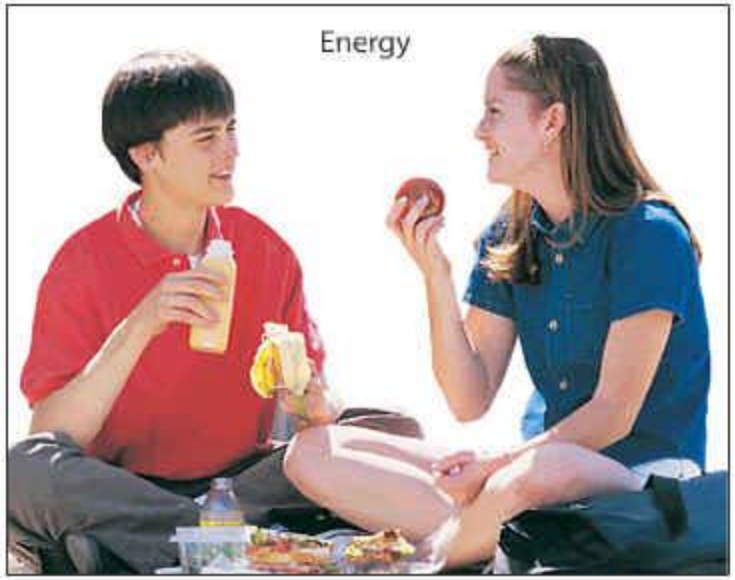
Interdependence of Organisms

- Interaction of organisms with one another and with their environment ECOLOGY
- Insects depend and flowers DEPEND on each other for food & pollination COEVOLUTION

- All organisms need substances such as **nutrients, water, and gases** from the environment
- The **stability of the environment** depends on the healthy functioning of organisms in that environment

Matter, Energy and Organization

- Living things are **highly organized**
- Require a **constant supply of energy** to maintain their orderly state



Energy

- ALL energy comes from the SUN (directly or indirectly)
- Photosynthesis is the process by which some organisms capture the energy from the sun (solar) and transform it into energy (chemical) that can be used by living things

Autotrophs

- Organisms that make their own food are called **autotrophs**
- **Phototrophs** – use solar energy (photosynthesis) to get energy
- Convert **H_2O and CO_2** into **sugar and O2**
- **Chemotrophs** – use different chemical processes to get energy

Heterotrophs

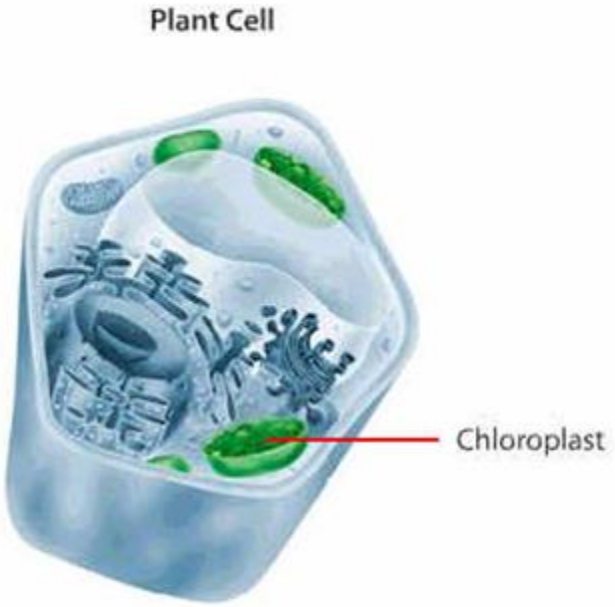
- Organisms that must take in food to meet their energy needs are called **heterotrophs** Consume autotrophs **(herbivores),** other heterotrophs **(carnivores)** or both **(omnivores)** for their energy needs

- Complex chemicals are broken down and **reassembled into chemicals** and structures needed by organisms

Characteristics of Life

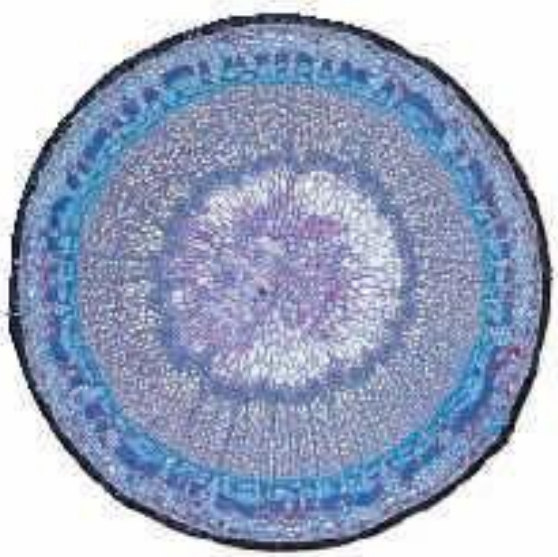
Cells

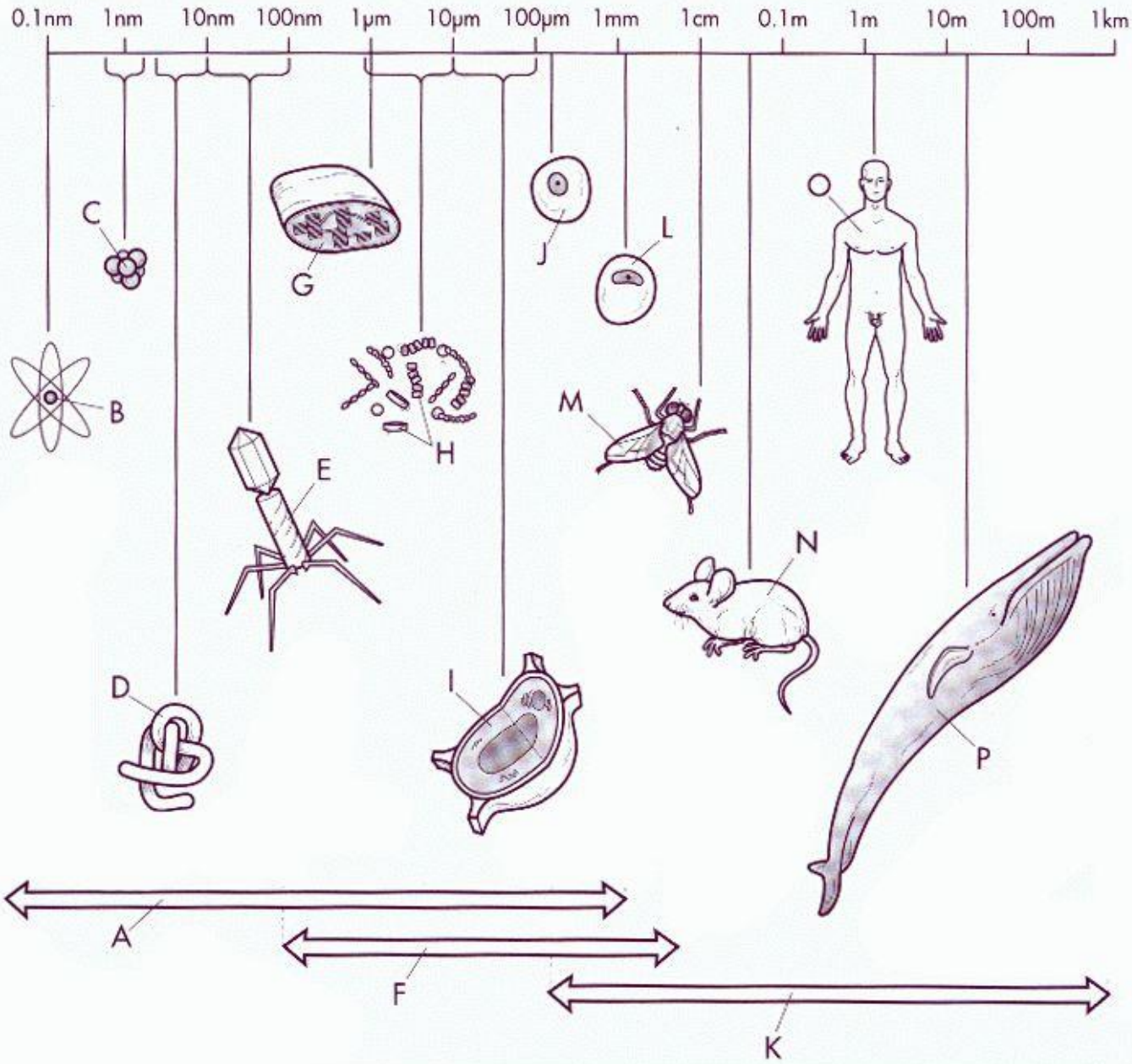
- All living things are composed of **cells**
- In multicellular organisms, many are **specialized** to perform specific functions
- Cells are always very **small**
- The size of multi-celled organisms depends on **the number of cells NOT their size**



Organization

- Organized at both the **molecular and cellular levels**
- Take in substances from the environment and organize them in complex ways
- Specific cell structures **(organelles)** carry out particular functions

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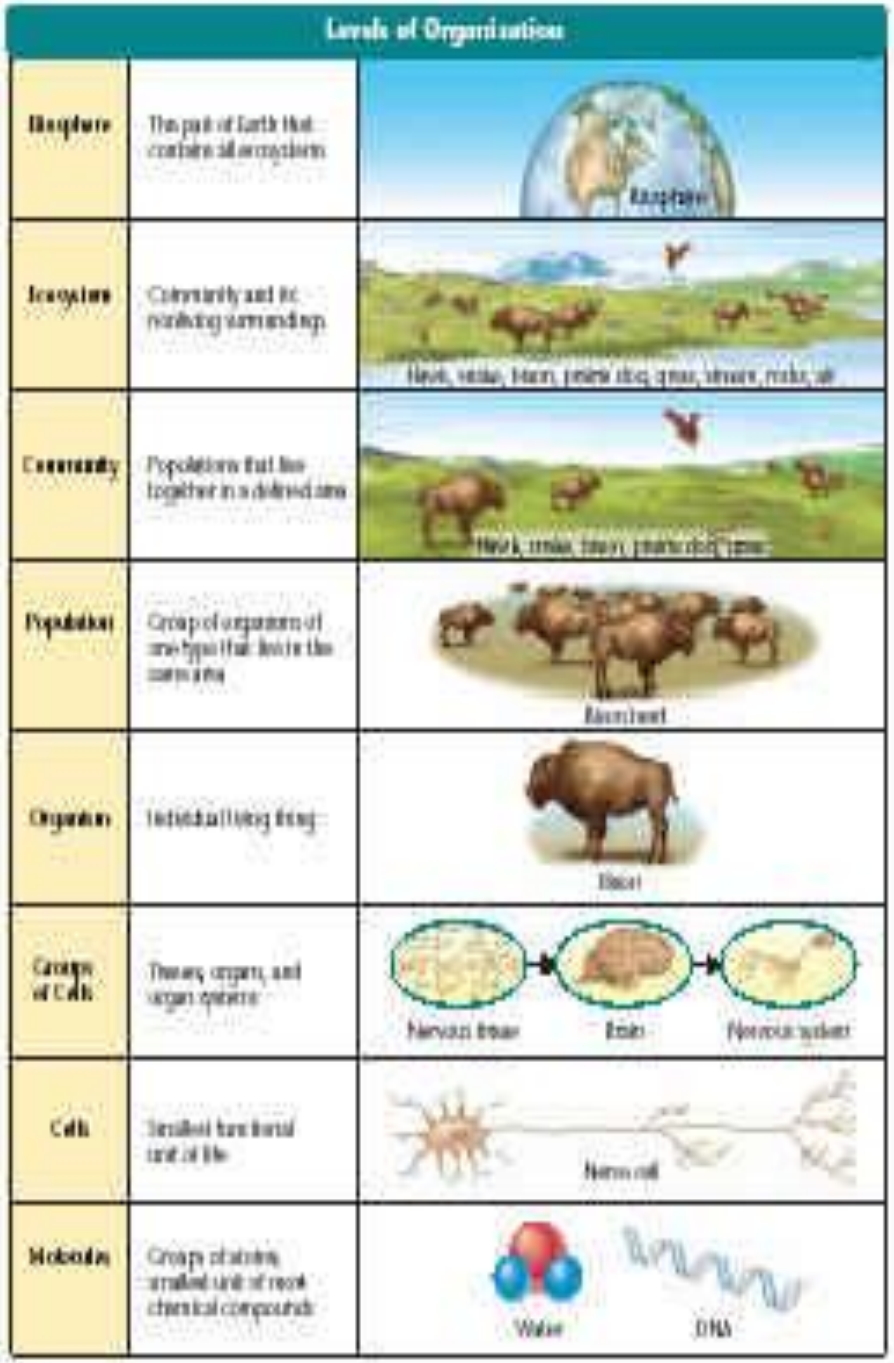
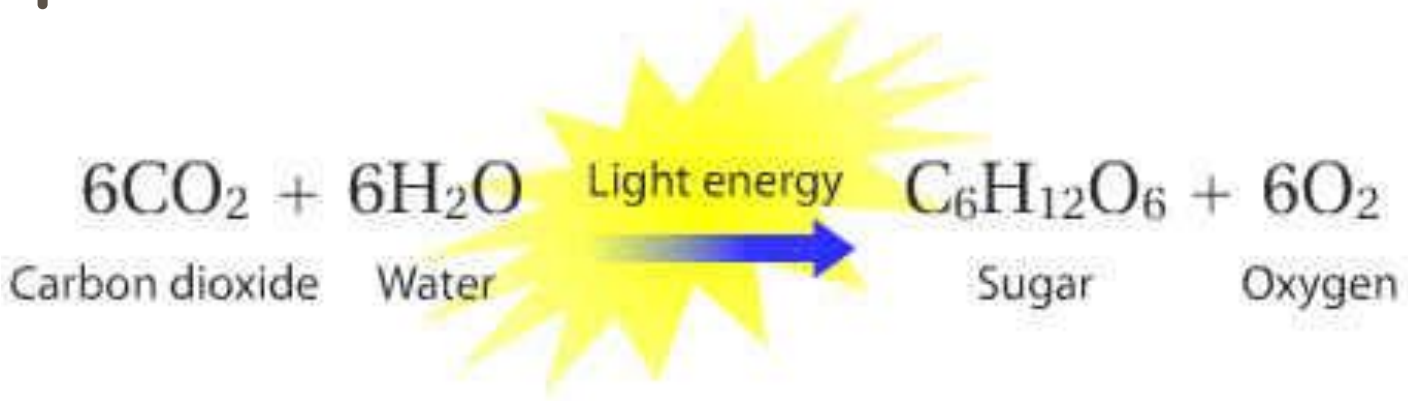
- In **multicellular organisms,** cells and groups of cells (tissues) are organized by their function
  - **Cells** → tissues
  - **Tissues** → organs
  - **Organs** → systems
  - **Systems** →
  - **ORGANISM**



Energy Use

- Use energy in a process called **metabolism**
  - ***Sum of all chemical processes***
- Require energy to maintain their molecular and cellular organization, grow and reproduce



Homeostasis

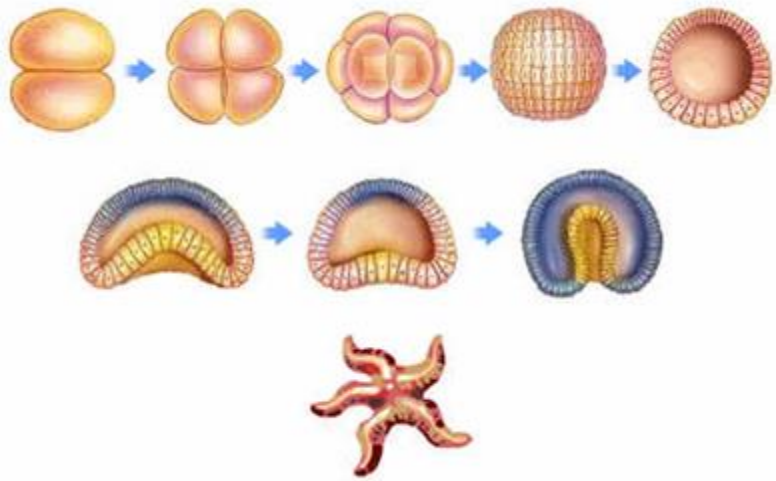
- Maintain **stable internal conditions**
- **Temperature, pH, etc.**

Growth

- Grow occurs as the result of **cell division and cell enlargement**
- **Cell division** is the formation of two cells from a **preexisting cell**
- New cells enlarge as they mature
- When a cell grows to a size where its **surface area isn't big enough for its volume**, the cell divides

Development

- The process by which an adult organism arise is called **development**
  - Repeated cell divisions and **cell differentiation**



Reproduction

- All species have the **ability to reproduce**
  - **Not essential to survival of individual** but is essential for continuation of a species

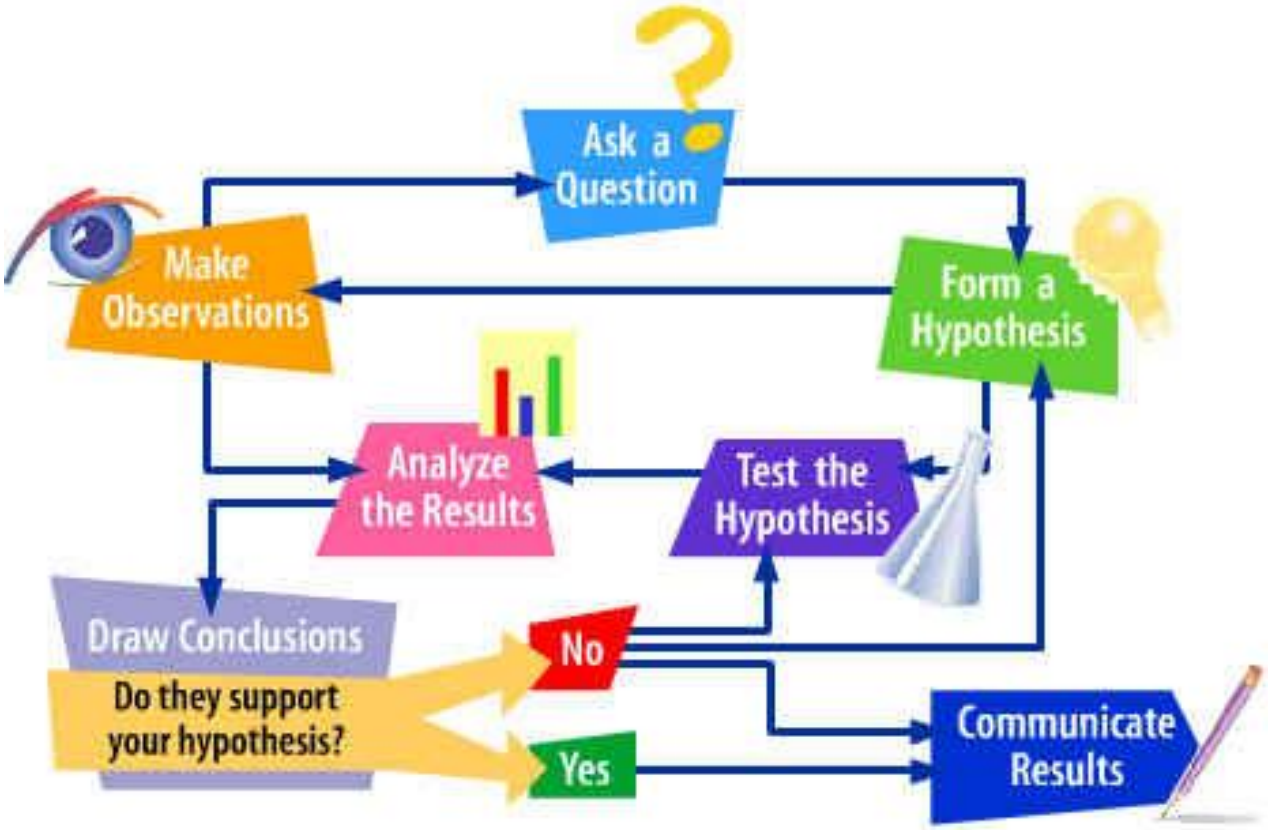
Responsiveness

- **Respond to stimuli** in the external environment
- Detect and respond to changes in **light, heat, sound and chemical and mechanical contact**
- Coordinates it's responses

Evolve

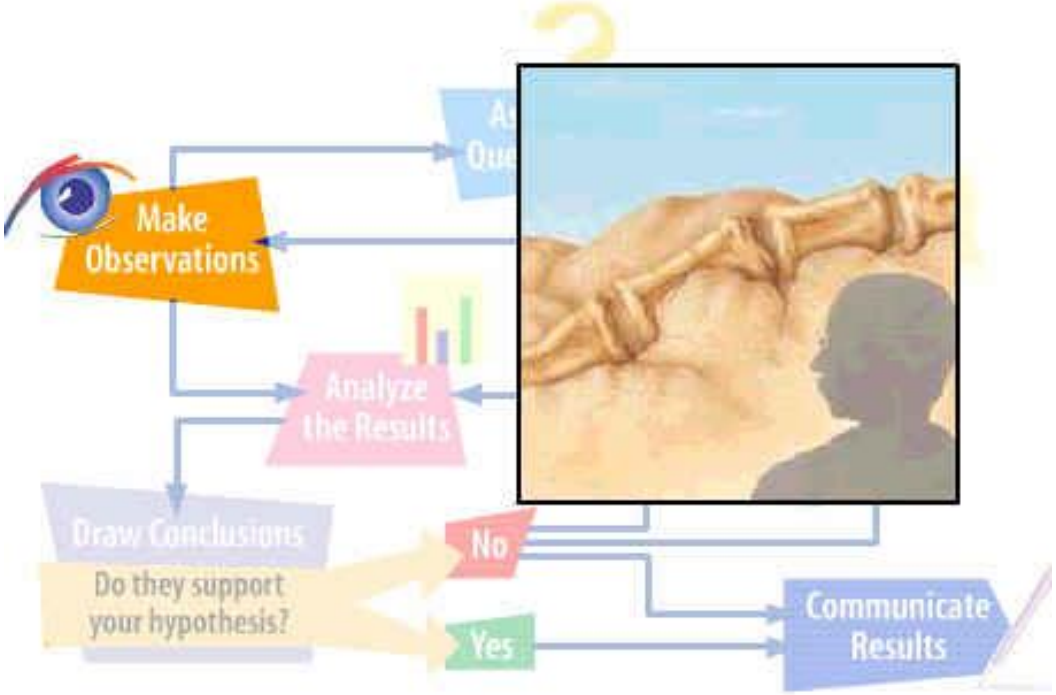
- Ability to adapt to their environment through the process of **evolution**
- **Favorable characteristics** are selected for and passed on to offspring
- Called **adaptations**
- Driven by **natural selection** or **"survival of the fittest"**

Scientific Method



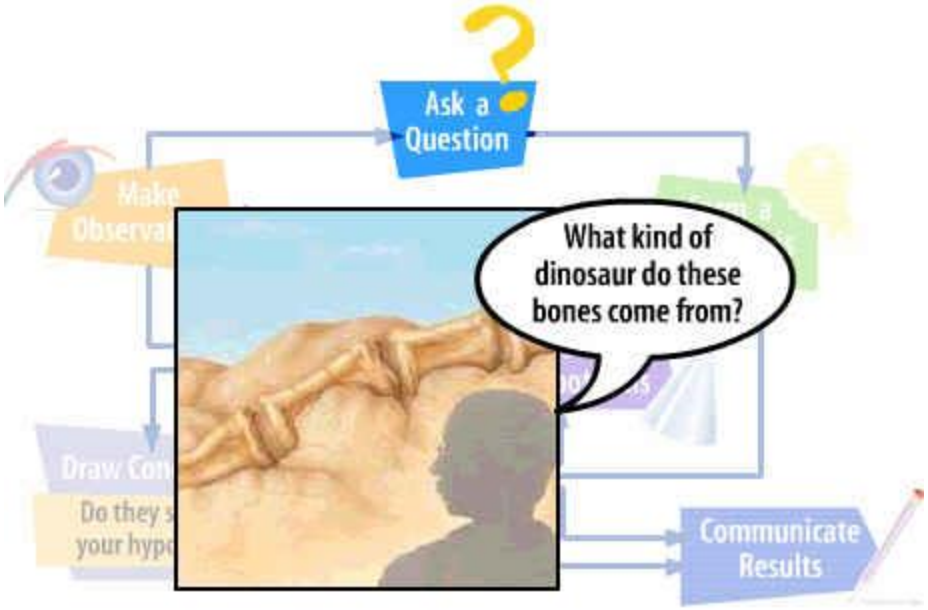
Observation – STEP 1

- Employing your **five senses** to perceive objects or events



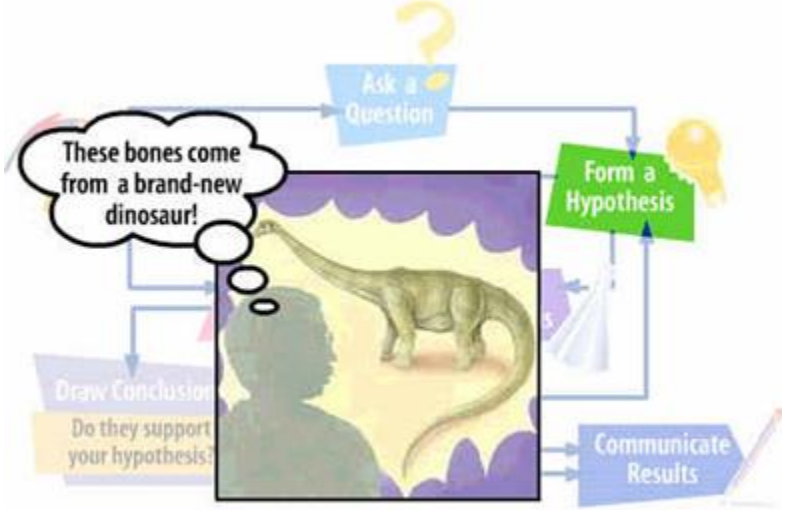
Asking a Question

- Based on observations; **one or more questions are generated**



Forming a Hypothesis – STEP 2

- A statement is **testable** if evidence can be collected that either does or doesn't support it
- It can never be proven beyond doubt
- Often must be **refined and revised or discarded**

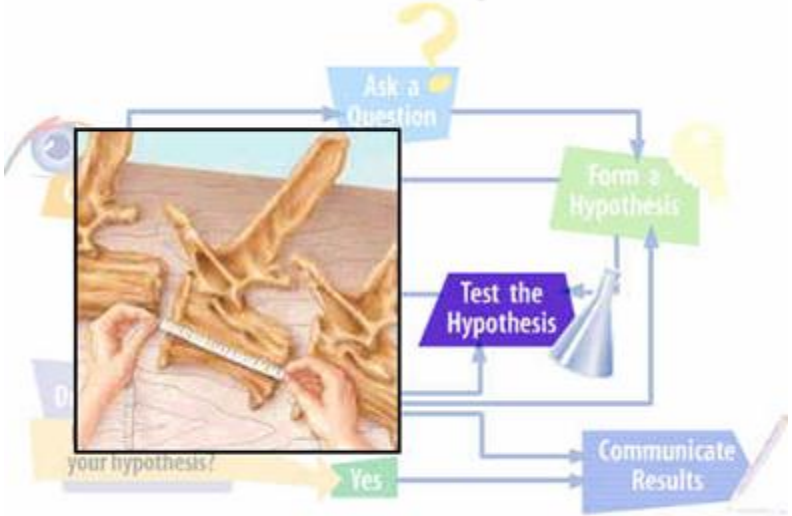


The Hypothesis ---

- **Is a statement made in advance that states the results that will be obtained from testing the hypothesis**
- Often written in the form of an **"if-then" statement**

Experimenting – STEP 3

- **Testing a hypothesis** or prediction by gathering data under **controlled conditions** – conducting a controlled experiment
  - Based on a comparison of a **control group** with an **experimental group**



- Both groups are identical **except for one factor** (**independent variable**)
- Observations and measurements are taken for a particular factor (**dependent variable**) in both groups
  - Driven by or results from independent variable

Testing the Effect of UV Light on Frogs

Factors	Groups		
	#1 Control	#2 Experimental	#3 Experimental
Type of frog	leopard frog	leopard frog	leopard frog
# of eggs	100	100	100
Temperature of water	25°C	25°C	25°C
Variable: UV light exposure	0 days	15 days	24 days

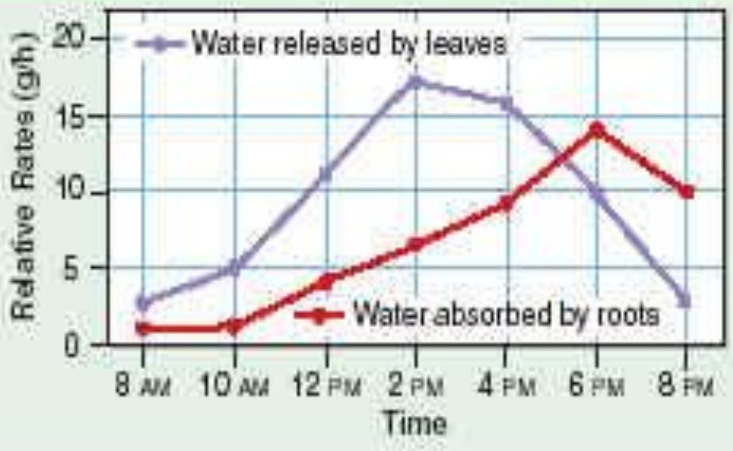
- Measuring
  - Involves **quantitative data** that can be measured in **numbers** &/or **qualitative data** information that isn't numbers
- Sampling
  - Technique of using a **sample** – a small part – to **represent the entire population**

Organizing Data – STEP 4

- Involves placing observations and measurement (data) in order
  - **Graphs, charts, tables, or maps**

Water Released and Absorbed by Tree

Time	Absorbed by Roots (g/h)	Released by Leaves (g/h)
8 AM	1	2
10 AM	1	5
12 PM	4	12
2 PM	6	17
4 PM	9	16
6 PM	14	10
8 PM	10	3



Analyzing Data – STEP 4 cont)

- Collected and organized data must be analyzed
  - Process of **determining whether data are reliable or whether they support or do not support a hypothesis** or prediction

Conclusion – STEP 5

- Conclusions are made on the basis of facts, not observations
  - Often **drawn from data** gathered from a study or experiment
  - Should **support the hypothesis**
  - Should be **re-testable**

Communication – STEP 6

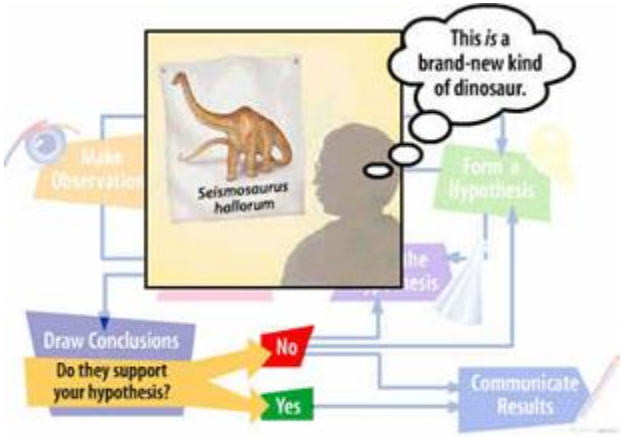
- Scientists must **share the results of their studies** with other scientists (peers)
- **Publish** findings in **journals**
- Present their findings at **scientific meetings**
- Scientists must be **unbiased**
  - Should not tamper with their data
  - Only publish & report tested & proven ideas

Communication

- **Sharing of information** is essential to scientific process
- Subject to examination and **verification** by other scientists
- Allows scientists to build on the work of others

Theories

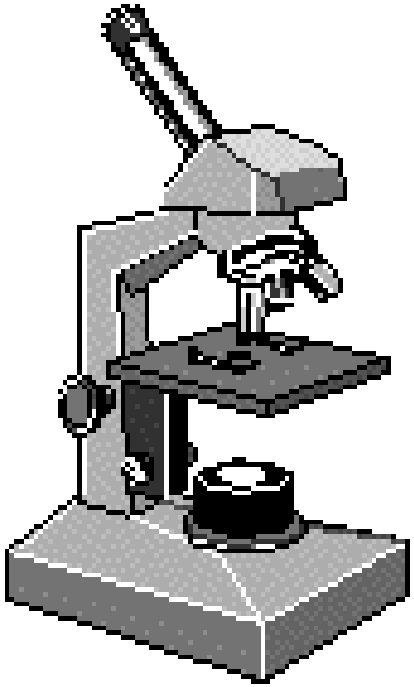
- A **theory** may be formed after many related hypotheses have been tested and supported with experimental evidence
- A **broad and comprehensive statement of what is thought to be true**
- Supported by **considerable evidence**
- Ties together related hypotheses



Laws

- A **Statement of fact** that concisely explains an action or group of actions
  e.g. Law of Gravity
- **Accepted to be true**
- **Universal**
- May be expressed as a math equation
  e.g. $E=mc^2$

MICROSCOPES

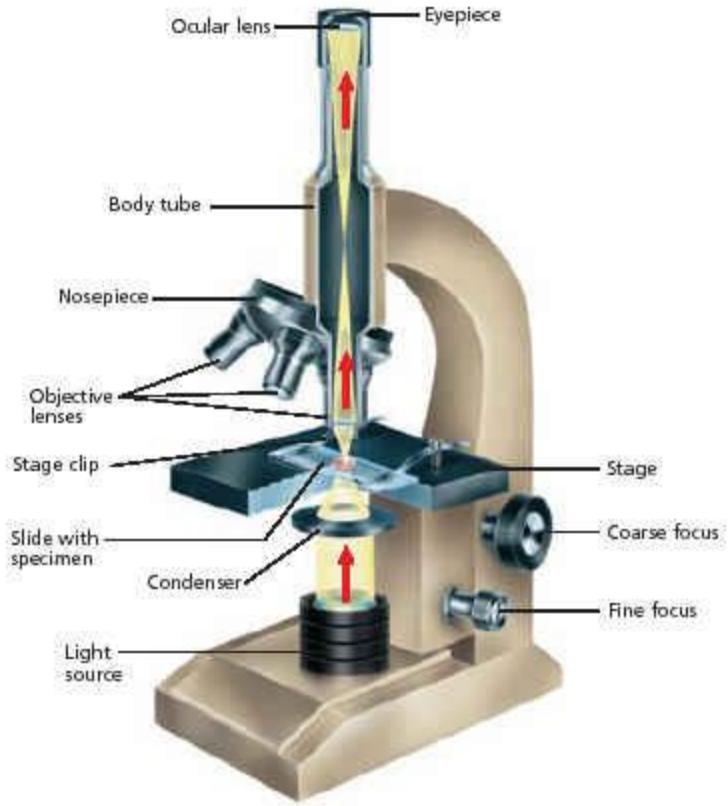


Microscopy and Measurement

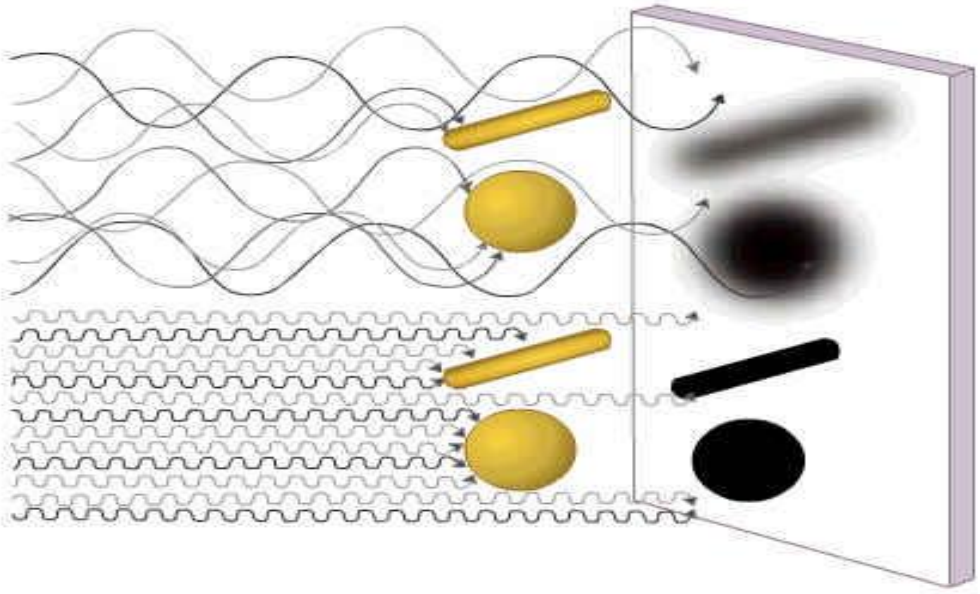
- Microscopes – **produce an enlarged image of an object**
  - Used to study organisms, cells, and cell parts
  - Increase in apparent size is called **magnification**
  - The ability to show details clearly is called **resolution**
  - Microscopes vary in both magnification and resolution

Compound Light Microscopes

- **Specimen** mounted on a **glass slide**
- Must be thinly sliced or very small
- Pair of **lenses**
  - **Ocular** lens (eye piece)
  - **Objective** lens (nose piece)
- Can be used to study **LIVE specimens**



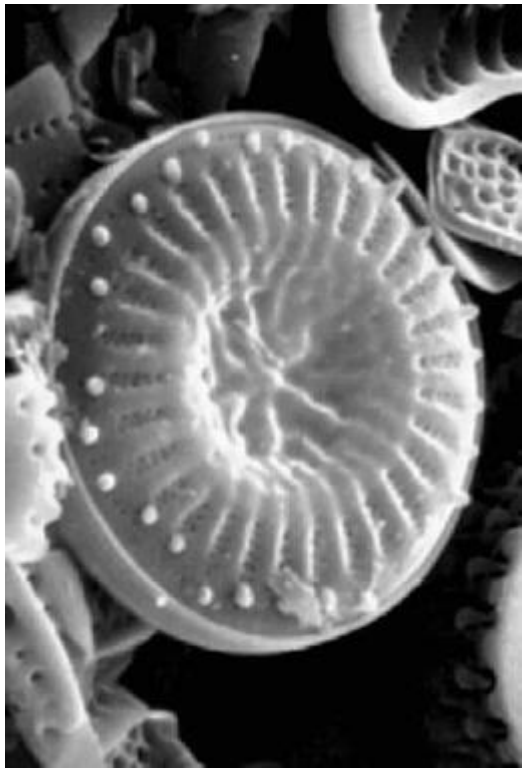
- **Magnification** determined by multiplying power of both lenses
- Eyepiece 10X times Objective power (20X, 40X…)
- **Highest** Maximum magnification is around **1000X**



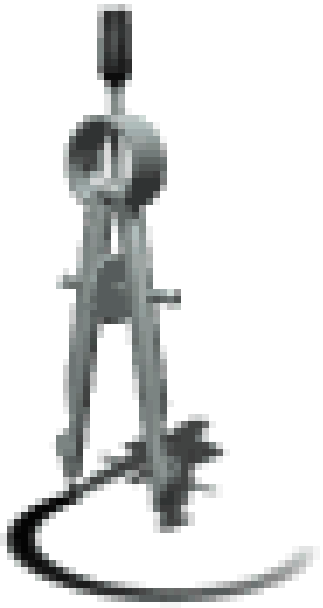
Electron Microscope

- **Transmission EM (TEM)**
  - Uses a **beam of electrons** to produce an enlarged image of very thinly sliced specimen on screen or photographic plate
  - Image focused by **magnetic lenses**
  - 200,000X magnification
  - **Cannot be used to view living specimens**

- Scanning EM (SEM)
  - 3D image
  - Specimens not sliced for viewing
  - Surface sprayed with fine metal coating
  - Also uses electron beam and fluorescent screen or photographic plates
  - 100,000X magnification
  - Cannot be used to view living specimens



MEASUREMENTS



Measurements

- We will be using **SI units or metric** system when possible --- the WHOLE world uses it except us (USA)

TABLE 1-4 Other Units Acceptable for Use with SI

Name	Abbreviation	Value in SI units
Minute	min	1 min = 60 s
Hour	h	1 h = 60 min = 3,600 s
Day	d	1 d = 24 h = 86,400 s
Liter	L	1 L = 1 dm^3 = 0.001 m^3
Metric ton	t	1 t = 1,000 kg

TABLE 1-2 *Some SI Prefixes*

Prefix	Abbreviation	Factor of base unit
giga	G	1,000,000,000
mega	M	1,000,000
kilo	k	1,000
hecto	h	100
deka	da	10
deci	d	0.1
centi	c	0.01
milli	m	0.001
micro	μ	0.000001
nano	n	0.000000001
pico	p	0.000000000001

TABLE 1-3 SI Derived Units Often Used in Biology

Derived quantity	Name	Abbreviation
Area	square meter	m^2
Volume	cubic meter	m^3
Mass density	kilogram per cubic meter	kg/m^3
Specific volume	cubic meter per kilogram	m^3/kg
Celsius temperature	degree Celsius	°C

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The End

- Finally…