INTRODUCTION TO BIOLOGY

Take home points

- Biology: A brief history
- Modern biology
- What is life
- Characteristics of living things

What is Biology?

- Science has **two** aspects--
  - Itself a body of knowledge
  - Methods for discovering new knowledge

- “BIOS”= life & “logos”= Thought. [Greek words]
- Biology= Study of life.

Origin of Life

Big Bang Theory: Origin of Earth

: Explosion from a pin sized to a Huge Universe.
: Among all Planets, Earth only contains life.

Earth without life

: High temperature, poisonous gases, no free oxygen/ water.
: Life evolved from chemical reactions and gradual changes.

Evolution of life

: Life begins when the cell forms.
: Single to multi-cellular organisms.
: Survival of the fittest.

History: Cave Painting

Over 30 thousands years ago, in France and Spain, caves were decorated with animal paintings.

History: Food Collection

Using sense!

- ✔ Hunted animals
- ✔ Cultivated crops
- ✔ Also knew the behavior of predator animals
- ✔ No labs/ equipments/microscopes

History: Agricultural way of life

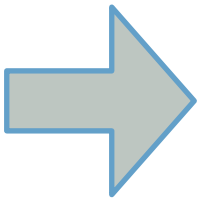
- Started about 10 thousands years ago

- Knowledge about plants and animals
  - Seed planting time
  - Amount of moisture required
  - What to feed their animals
  - Life span of animals

- Studied living things- hence, biologists

History: Use of Sense

- By time, prehistoric people started asking some common questions?
  - What are the common things?
  - What are the differences?
  - Why/Where the specific things are found?
  - Which environment supports which group?
- Common outcome:
  - classifications
  - ecology
  - cultivations



More complex questions
- Composition?
- Organization?

Modern Biology

- During 17th century
- Started when human had knowledge, skill & equipments
  - Robert Hooke: Cell walls were first seen (~1665)
  - Anton van Leeuwenhoek: Visualized living cells ‘very little animalcules’ (~1674)
  - William Harvey: First described the systemic circulation and properties of blood (~1628)
- **More complex question:**
  - What do the parts of living things do?
  - How does the parts work?

Biology Today

- Vast Science
- Over 1,500,000 (1.5 million) different species/ kinds of organisms
- Yet a lot to be discovered
- Vaccines, Therapeutics, Agricultural aspects, Human genome, cloning etc
- Classified to many subdivisions for better understanding.

Group of organisms being studied

1. Botany : The study of plants.
2. Zoology : The study of animals.
3. Microbiology : The study of microscopic organisms.
4. Bacteriology : The study of bacteria.
5. Virology : The study of viruses.
6. Mycology : The study of fungi.
7. Entomology : The study of insects.
8. Ornithology : The study of birds.

Approaches taken to study Biology

Taxonomy	The classification of organisms
Morphology	The study of the external form and structure of organisms
Anatomy	The study of the internal structure of organisms
Physiology	The study of the function in living system
Cytology	The study of cells
Ecology	The study of the relationship of organisms to their environment
Genetics	The study of inheritance
Pathology	The study of diseases

Unifying Themes of Biology

- **Hierarchical organization of life**
  -- structural make up, from the smallest, simple to largest complex
- **Cell theory**
  -- all organisms are made of cells, central idea in all studies of biology
- **Heredity**
  -- Biological information is inherited from parents in one generation by the offspring in the next.
- **Evolution**
  -- the modification of populations over time

Unifying Themes of Biology

- **Regulation**
  -- To survive and reproduce, all forms of life must regulate their internal, and sometimes external, environment.
- **Structure and function**
  -- Correlations between the structure of a biological object, and its function.
- **Environmental interactions**
  -- Individuals interact with other organisms of their own species and those of the greater community.
- **Energy flow**
  -- Energy flows through a food chain, cycles through an ecosystem, or is converted to different forms within the cells of an organism.

So…
Biology: Redefined

- Biology was first defined as the science that deals with the study of life

- However, as we learn more, we see that biology involves many other things. It is also a study of all those things that affect life.

- Thus the following is a more accurate definition of biology:

Biology is the study of living things and the things that were once alive, together with the matter and energy that surround them.

What is Life?

Human, animals, plants vs. stones, laptops, cell phones !

What are the special characteristics of living thing?

Characteristics of living things

There are nine characteristics of living things.

- The need for energy
- Movement
- Cellular structure and organization
- Growth and development
- Maintenance and repair
- Reproduction
- Response to stimuli
- Variation and adaptation
- Metabolism

1. Need for Energy

SUN

Every living organism need energy to run many activities.

Sun is the universal energy source.

1. **Primary Producers:** Plants and Green organisms -->produce food from sun

2. **Primary consumers:** Animals and non-green organisms--> get food from Primary producers.

3. **Secondary consumers:** Get food from both Producers and Primary consumers.

4. **Tertiary consumers:** Lives on primary and secondary consumers.

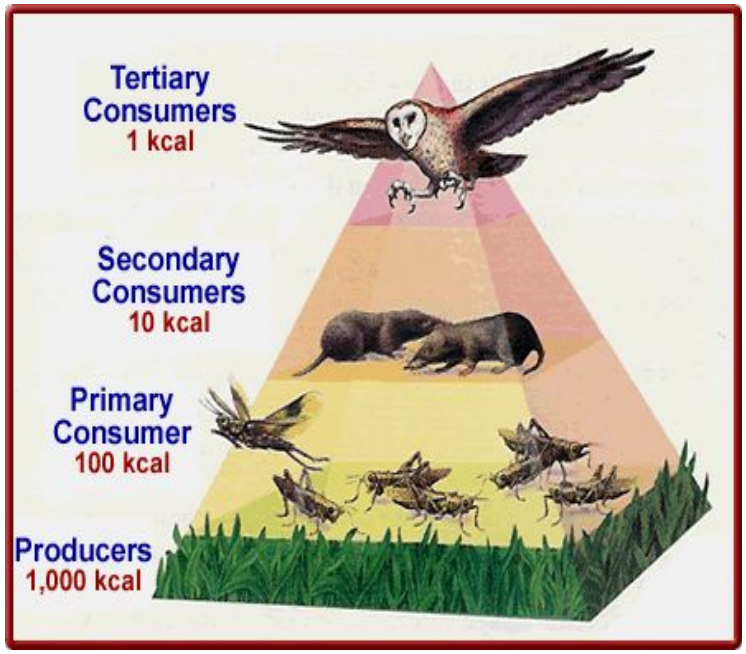


Figure: Energy Pyramid

1. Need for Energy

Why ?

- Movement
- Growth & development
- Repair and maintenance
- Response to stimuli
- Variations and Adaptation
- Reproduction
- Metabolism

------etc.

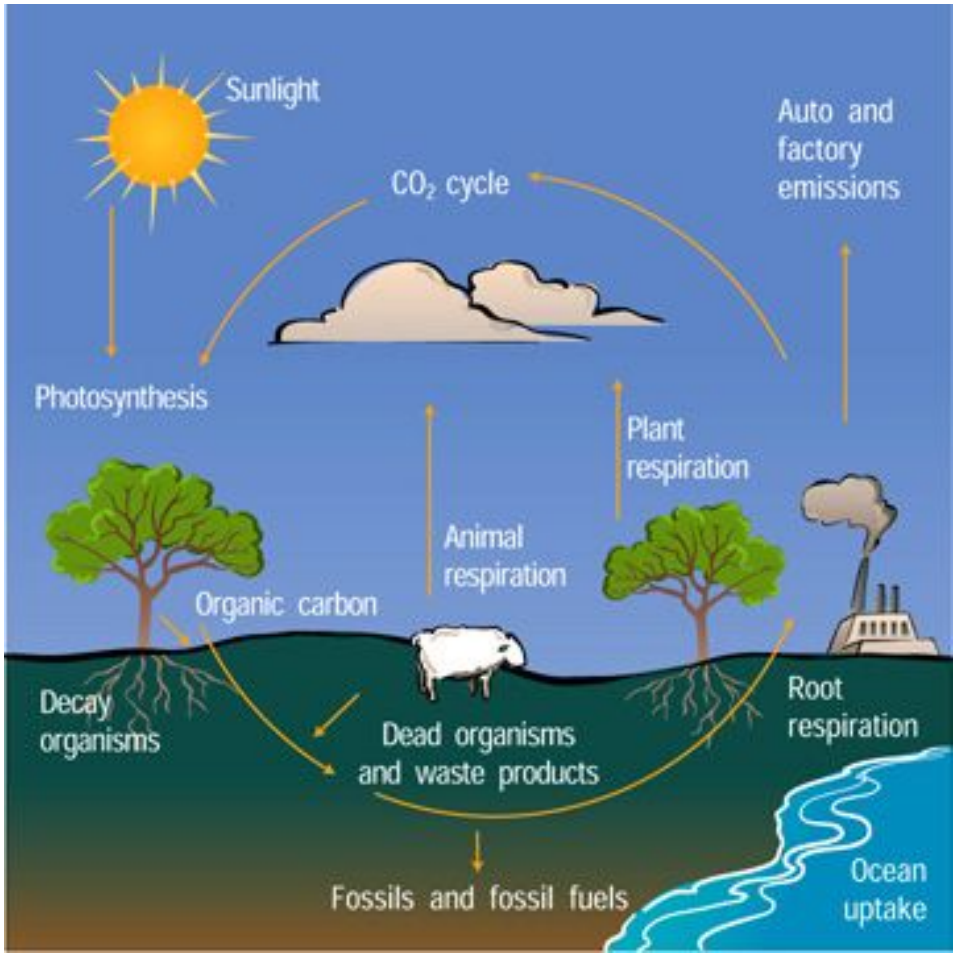


Figure: The Energy Cycle

2. Movement

Animal: Most obvious/visual

Plant:

-Opening of buds

-Turning of leaves toward sun

-*Mimosa pudica* (the sensitive plant)

-'Sundew' of northern bogs: Carnivorous

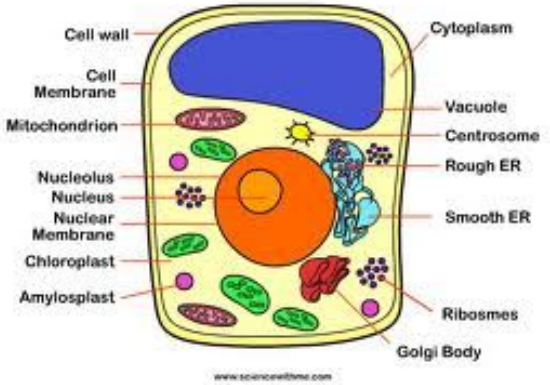
Figure: 'sundew' of northern bogs.

Figure: *Mimosa pudica*

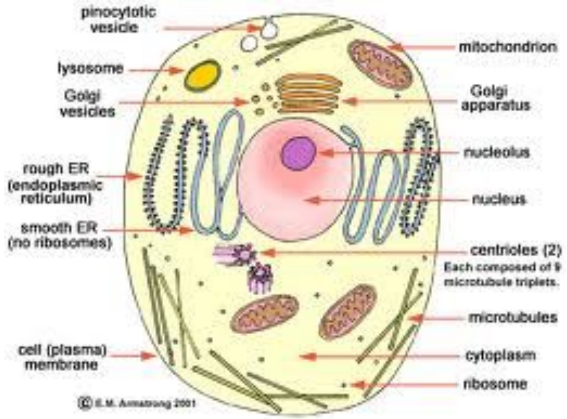
2. Movement: Locomotion

- self-propulsion by the organism.
- can be swimming, running, flying, walk etc.
- microorganisms also can propel by thei own locomotion mechanism.
- But any change of location is not locomotion. e.g. wind moves the branch of trees!

3. Cellular Structure & Organization

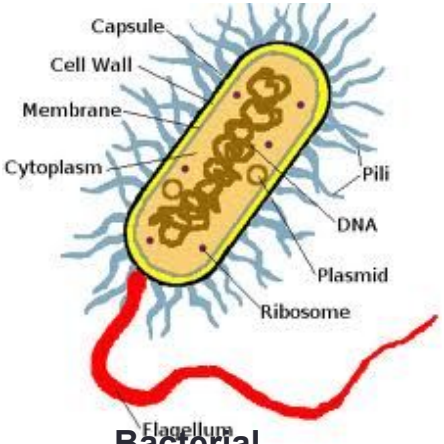


Plant Cell



Animal Cell

All Living thing are made up of **CELLS**



Bacterial Cell

3. Cellular Structure & Organization

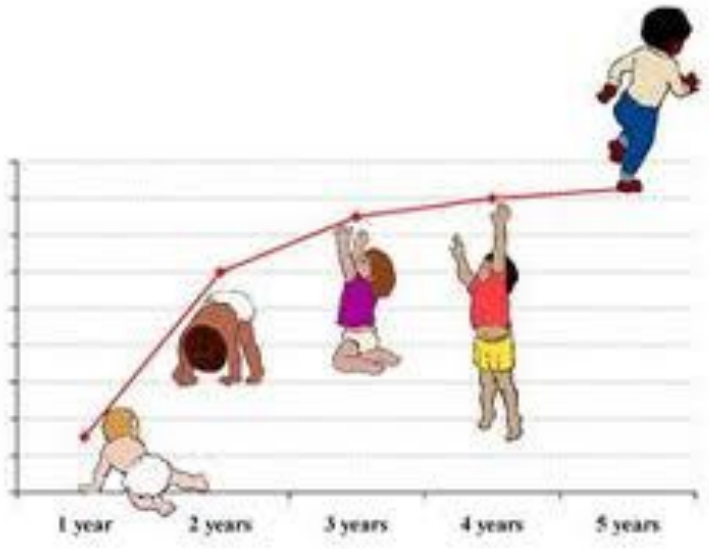
Protoplasm

- Complex mixture of substances
- All living cells have Protoplasm
- Made up of-- carbohydrates, fats, proteins, water etc.
- Ensures the living condition.
- Composition is different in different organisms.
- Even in same organism, protoplasm differs from one part to another.--> always changing.
- Living things can organize material into protoplasm and organize protoplasm to make cell and ..... can organize cells to make a total living thing.--> So, for this organizing capacity, they are called "**Organisms**"

4. Growth & Development

Growth:

- Getting larger is not only the Growth.
- Collection of things are not the Growth.
- *By organizing materials, living things make special kind of protoplasm, reproduce cells/increase the cell number, goes from one state to another.*



4. Growth & Development

Development:

- A series of changes that take place in as an organism grows toward **final** form, is called development.
- By development an organism becomes a unique living thing with specialized parts and different from other.

5. Maintenance & Repair

- Part of growth and development
- Appears to have stopped growth
  - But actually system runs as ‘maintenance and repair’
- Example:
  - Replacing dead skin cells
  - Healing of cut fingers
  - Tail recovery of house lizard.

6. Reproduction

- Only living things can produce offspring's similar to themselves.
- Process can be different—
  - Laying eggs
  - Giving birth
  - Plant seeds develop to plants etc.

- Law of nature is;

“life produces life” & “like produces like”

6. Reproduction

Life span:

- Varies in organism to organism
- Examples:

  Human :~70 years

  Horse :~30 years

  Plants: 10/12/100/1000 years

  Limited life span□ continued offspring□

  Reproduction.

Energy Requiring process

Figure: Redwood in California

7. Response to Stimuli

Irritability : **Response to certain stimuli**

Animal:

- Have nervous system
- Use Eyes, nose, ear to response

Plants:

- Do not have nervous system
- Slow response to light, oxygen, nutrient etc

Microorganisms:

- Response to nutrients, environments
- Even single celled organism can response

7. Response to Stimuli

Coordination :
Doing the right thing in a right time

Behaviour:
Change to a stimuli, in a certain pattern

8. Variation and Adaptation

Variation:

Changes occur as a result of characteristic.

- Most variations do not affect an organism's chances of survival
- Give an organism a better chance of surviving in a changing environment

Adaptation:

The process by which a certain type of organisms becomes better suited to survive in its environment is called **adaptation**.

e.g.: Hibernation, Mimicry (The viceroy butterfly mimics the monarch butterfly by coloration. The monarch butterfly has a bitter taste to predators and predators avoid them.

9. Metabolism

- The exchange of matter and energy **between** the organisms and within an organism.

- Metabolism is the sum of all the processes occurring in an organism.

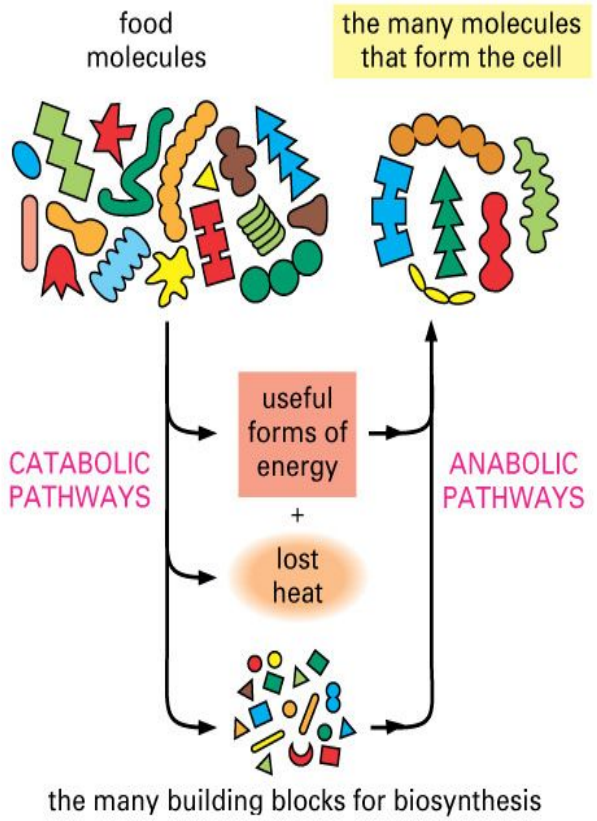
  - Ingestion
  - Digestion
  - Assimilation
  - Respiration
  - Excretion

9. Metabolism

Metabolism has two distinct phases--

1. Anabolism: Building up

2. Catabolism: Breaking down



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Questions?