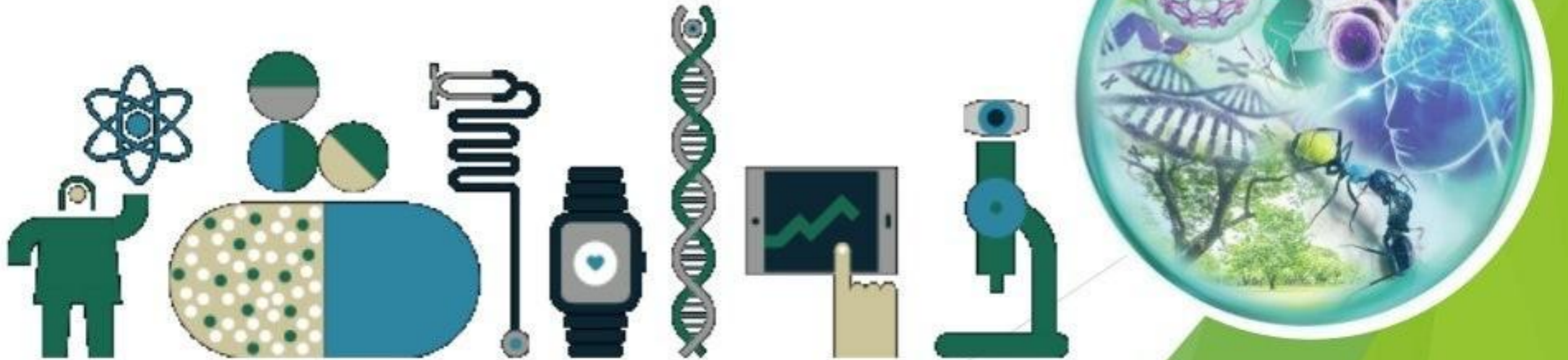


# Chapter 1:

# Introduction to Life Science







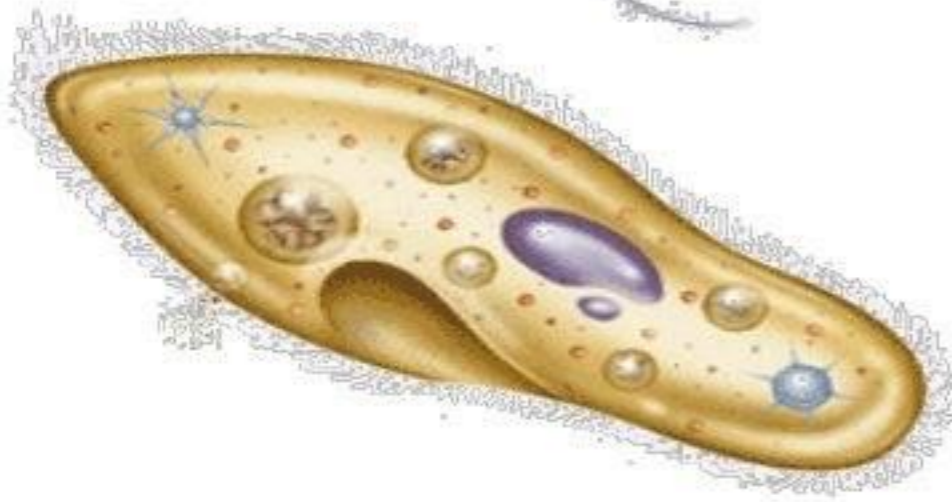
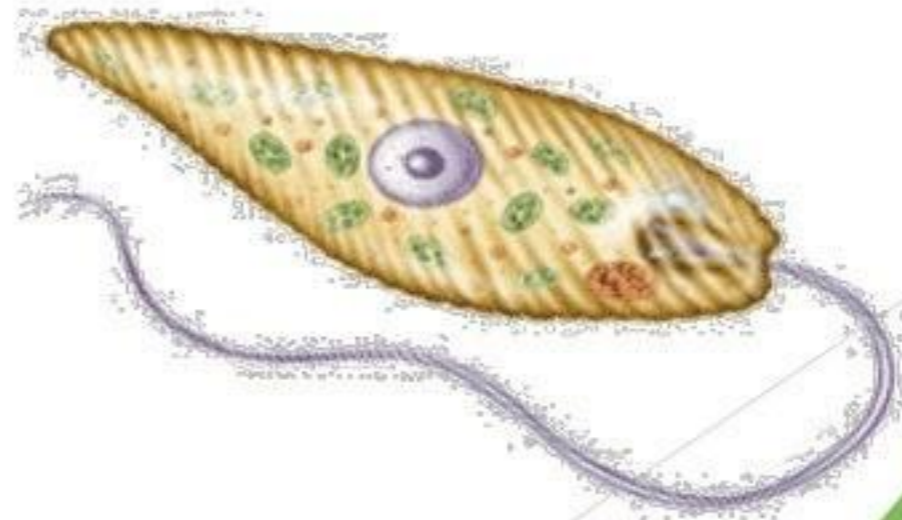
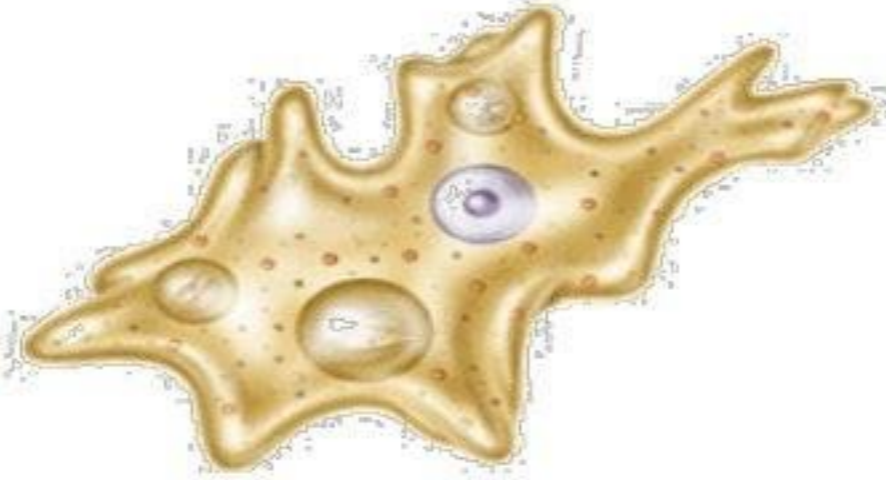
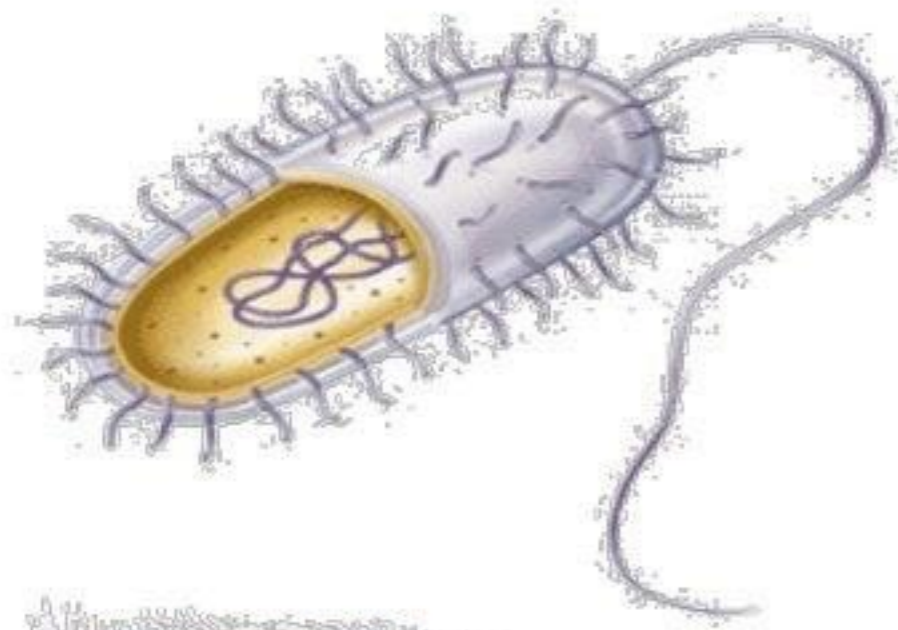


# CONCEPT OF LIFE

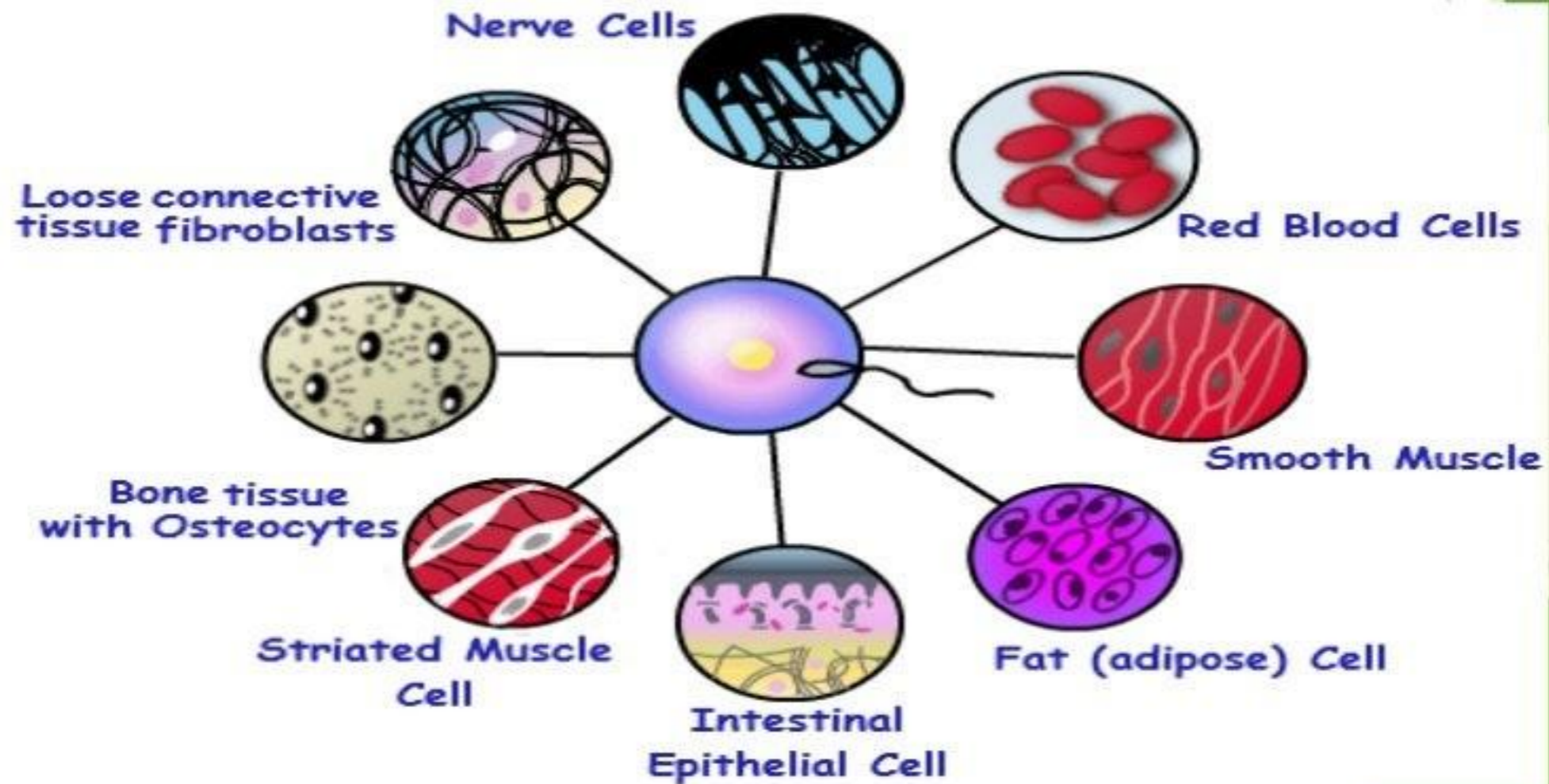
- ▶ Life on Earth began more than 3 billion years ago, evolving from the most basic of microbes into an array of complexity over time.
- ▶ Every aspect of life from the smallest submicroscopic living particle to the largest and most imposing of plant and animal species is included.
- ▶ All living things are made of cells. Some organisms are unicellular and some are multicellular.



**Unicellular** organisms consist of only a single cell that carries out all life processes. Ex. (in clockwise) Bacteria, Amoeba, Paramecium, Euglena



**Multicellular** organisms are composed of many cells which perform specialized and specific function





# ORIGIN OF LIFE

“Where did the first life come from?”

There are many theories to consider about the origin of life. The evolutionists, particularly Charles Darwin, talked more about the process of evolution to explain how life developed. According to him, there was growth from simple to complex form.

# THEORIES OF ORIGIN OF LIFE

➤ Several attempts have been made from time to time to explain the origin of life on earth

- ✓ Theory of special creation
- ✓ Theory of abiogenesis
- ✓ Theory of biogenesis
- ✓ Theory of panspermia
- ✓ Chemogenetic Theory





# THEORIES OF ORIGIN OF LIFE

## THEORY OF SPECIAL CREATION

- This is mythology based theory
- All the living beings on earth were created by god

### Hindu mythology

- Lord Brahma creator of the world
- He create all living and non living in the world

### Christian mythology

- God creates the earth and puts Adam and eve



# THEORIES OF ORIGIN OF LIFE



## THEORY OF ABIOGENESIS

- It is also called spontaneous generation or autobiogenesis
- Supporters :- Aristotle, Epicurus, Von Helmont

### They believed

- Insects arise from dew
- Fish & frog from mud
- Fly maggots from meat
- Opposers :- Francisco Redi, Spallanzani and Louis Pasteur

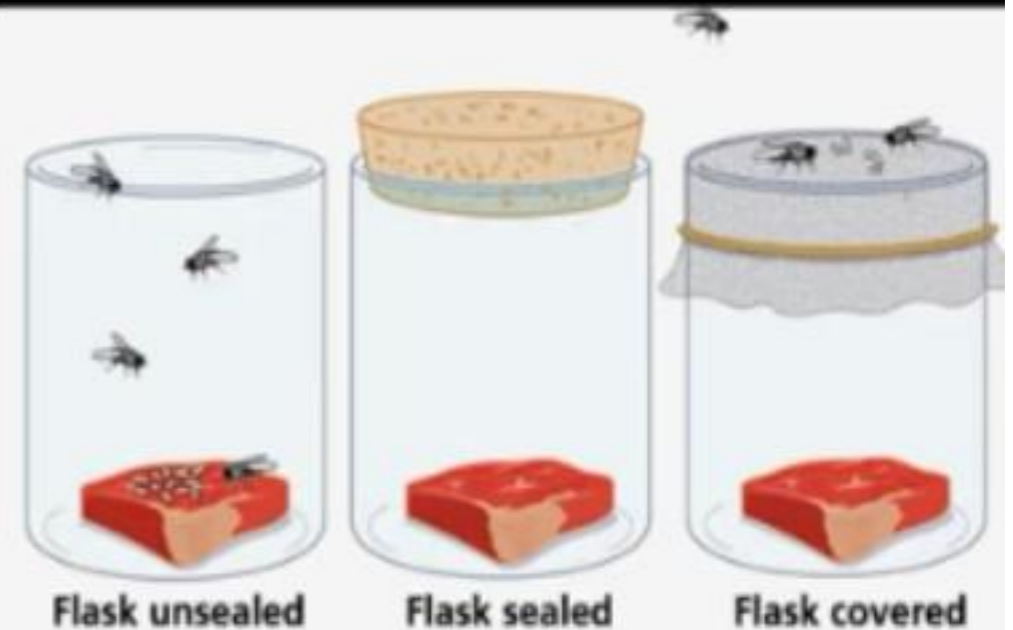




# THEORIES OF ORIGIN OF LIFE i

## THEORY OF BIOGENESIS

- Living organisms are always produced from pre-existing living forms by reproduction and not from non-living or lifeless matter
- This theory could not explain first life on earth
- Experiments of Fransisco Redi, Spallanzani and Louis Pasteur etc supported the theory of biogenesis



# THEORIES OF ORIGIN OF LIFE i

## THEORY OF PANSPERMIA

- Proposed by Richter in 1865
- Life on earth came from different planet in the form of spores or microorganisms
- This is called cosmozoa or panspermia which were preserved inside meteorites
- These meteorites struck into barren earth to release cosmozoa and help in development of various creature

Panspermia Theory





# THEORIES OF ORIGIN OF LIFE

## CHEMOGENETIC THEORY

- The Chemogenetic theory was
- Proposed by Oparin & Haldane (1924)
- Evidence provided by Urey & Miller (1953)
- Chemogenetic Theory divided into three parts:

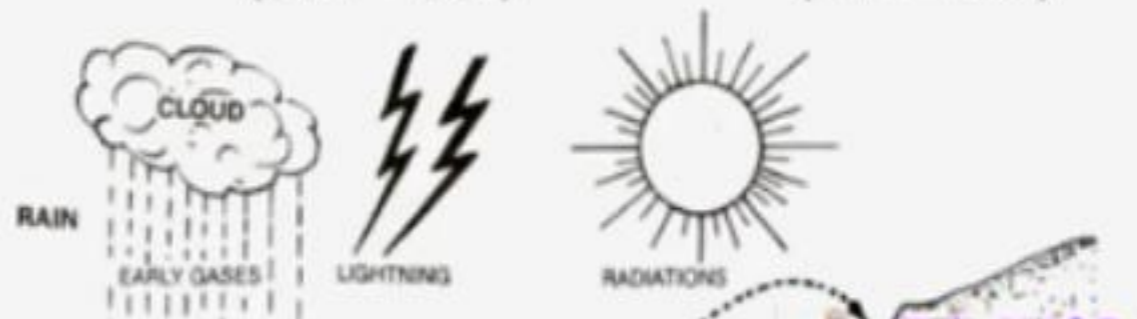
- I) Chemogeny (Chemical Evolution)
- II) Biogeny (Molecules evolution)
- III) Cogenogeny (Formation of life)



Aleksandr Ivanovich **Oparin**  
(1894 - 1980)



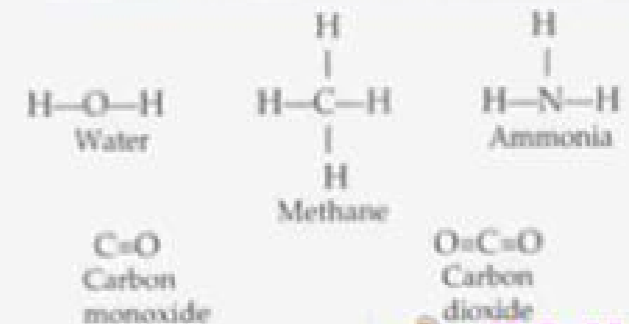
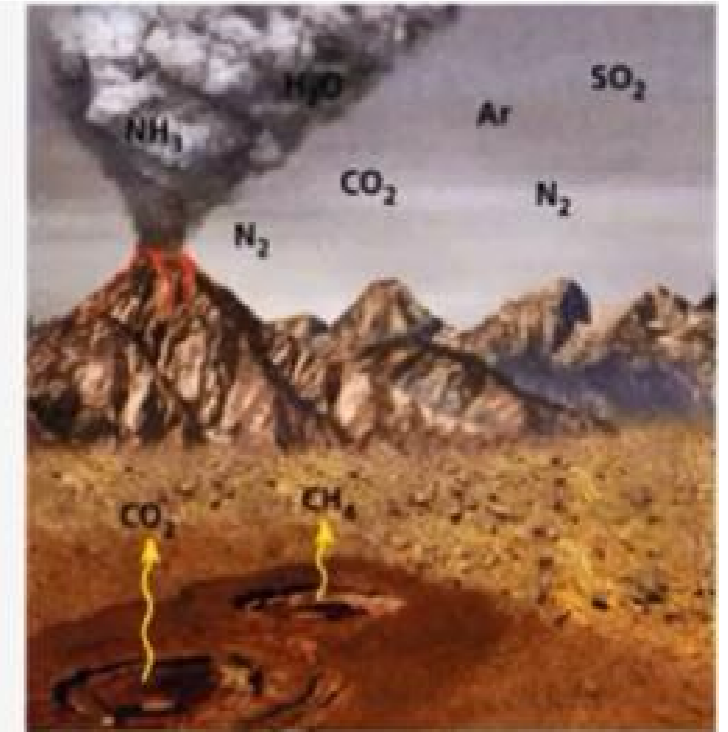
John Burton S. **Haldane**  
(1892 - 1964)



# CHEMOGENETIC THEORY

## CHEMOGENY

- Primitive condition of earth: High temperature, Volcanic storms and lightening
- Primitive earth contain large amount of H, N, C and few O
- H reacted with other atoms to form a variety of molecules
  - ✓ Ammonia: Hydrogen + Nitrogen
  - ✓ Methane: Hydrogen + carbon
  - ✓ Water: Hydrogen + oxygen
- Earth cooled down, water vapor fell as rain and form ocean
- During this molecules continued to react with each other and formed various Simple chemical compounds formed
  - E.g. Sugars, Aldehyde, N2 Base, Fatty acid
- Water of oceans became rich mixture of chemical compounds. its called pre biotic soup

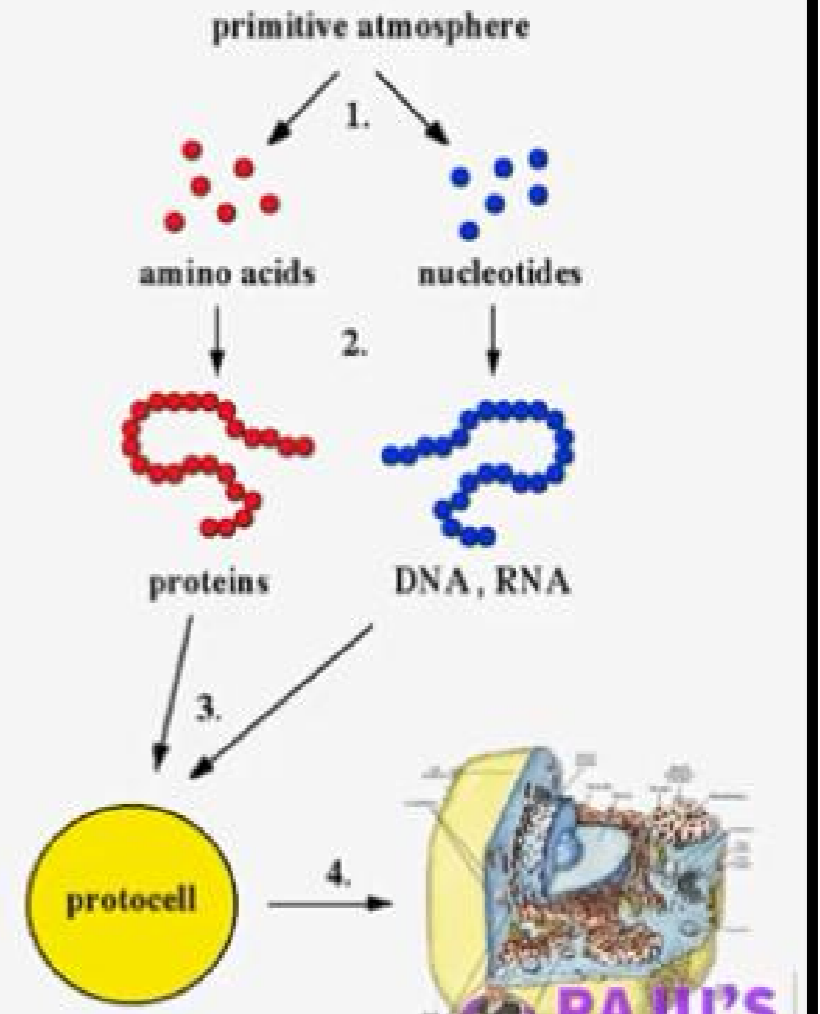




# CHEMOGENETIC THEORY

## ② BIOGENY

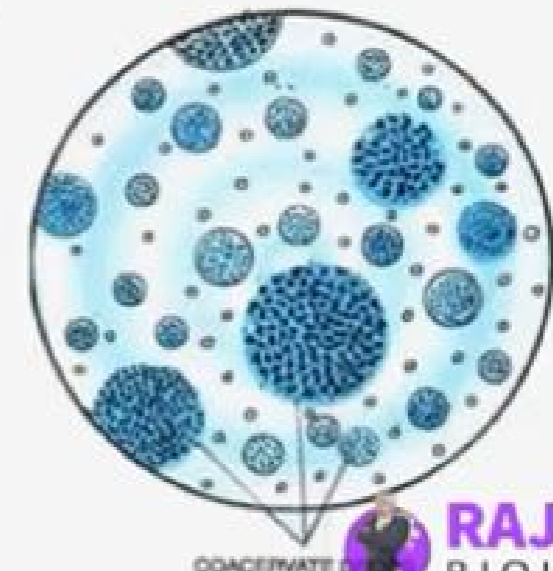
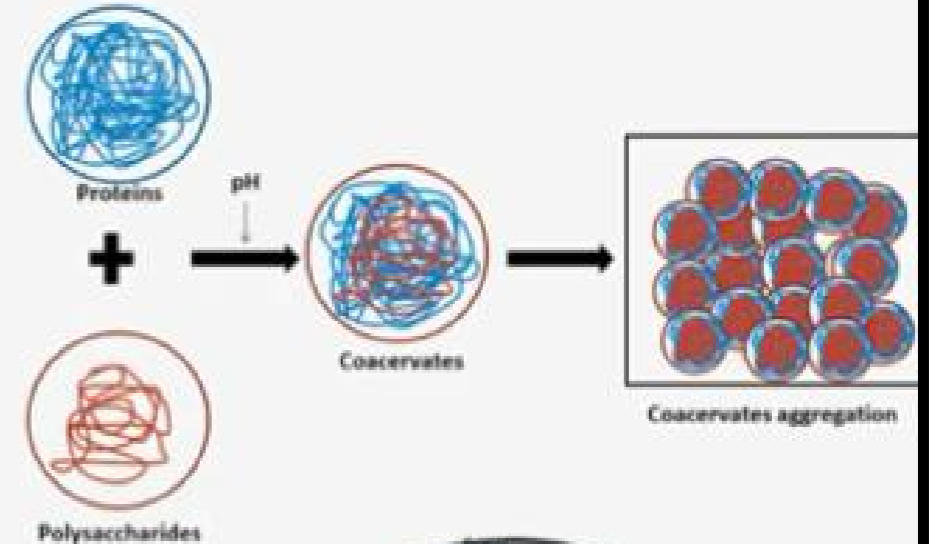
- Next step is formation of Biomolecules
- Simple organic compound come together, form colloids to form complex compound like polysaccharides, proteins, nucleosides, fats and nucleotides.
- The protein molecules formed by polymerization of amino acids (protoprotein)



# CHEMOGENETIC THEORY

## COGENOGENY

- Macromolecules formed by the polymerization of micromolecules underwent precipitation in the sea
- Precipitation resulted in the aggregation of macromolecules
- The aggregation resulted in formation of organized structures
- These organized structures called as coacervates
- Smaller coacervates fused together to form larger coacervates
- Coacervates were behave like living cells
- Oparin suggested that coacervates may give rise to cell like structures

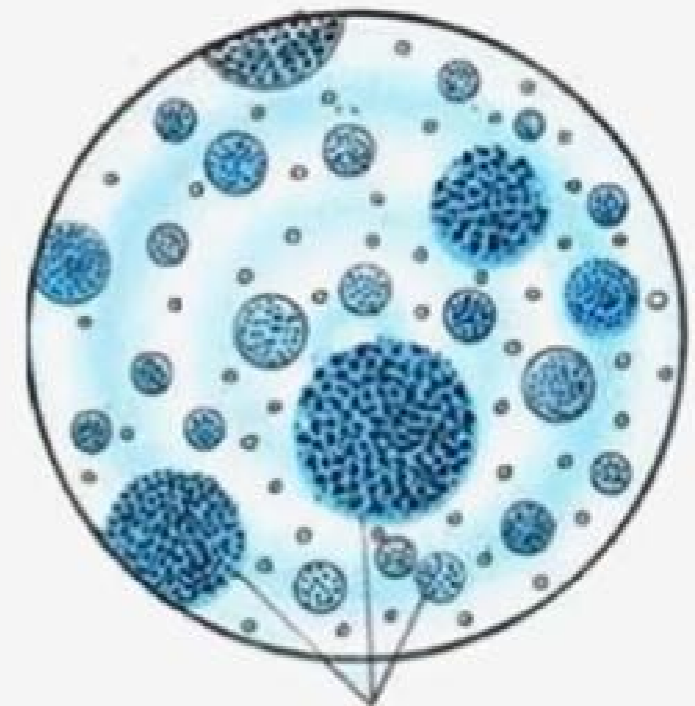




# CHEMOGENETIC THEORY

## COACERVATES

- Coacervates were not mixed with water
- They contained protein, Nucleic acids and other organic and inorganic compounds
- Surface of coacervates had the ability to selectively absorb
- Coacervates also called microspheres
- Microspheres shows features of living cell
- Microscopic in size, Spherical in shape, Had motility and growth
- Coacervates got transformed into the primitive cell called protobionts or eobionts
- These are first formed cells so called as pre cells or protocells



# THEORIES ON THE ORIGIN OF LIFE

## 1. Special Creation Theory

Many people believed that everything in this world was created by a Supreme Being. The Special Creation Theory emphasizes the source of all creation is God and with Him, nothing is impossible.





## 2. Spontaneous Generation Theory

During the ancient times, people used only their naked eyes to see things. They believed that life originated as a spontaneous event. It is a hypothetical process by which living organisms developed from nonliving matter, also, the archaic theory that utilized this process to explain the origin of life.

The idea of Spontaneous Generation Theory states that living organisms can originate from inanimate object such as dust creates fleas, maggots from rotting meat, and bread or wheat left in a dark corner produces mice.

However, there are several experiments made by different scientists to disprove the theory.

### Experiments disproving spontaneous generation

#### Francesco Redi 1668 experiment

wide-mouthed jars containing a piece of meat:

open jar



flies entered and laid eggs that hatched maggots

gauze-covered jar



no flies entered, but they laid eggs on the gauze that hatched maggots, or eggs fell through the gauze and hatched on the meat

sealed jar



no flies, maggots, or eggs could enter

---

#### Louis Pasteur 1859 experiment

broth was boiled in various flasks for one hour to sterilize it and allowed to cool, drawing in fresh air.



broth

open flask allowed air and any bacteria present in the air to enter



contaminated with bacteria



broth

cotton plug filtered bacteria from the air entering the flask



sterile



broth

bacteria were removed from the air entering the flask by settling in the long neck



sterile



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Courtesy Photo



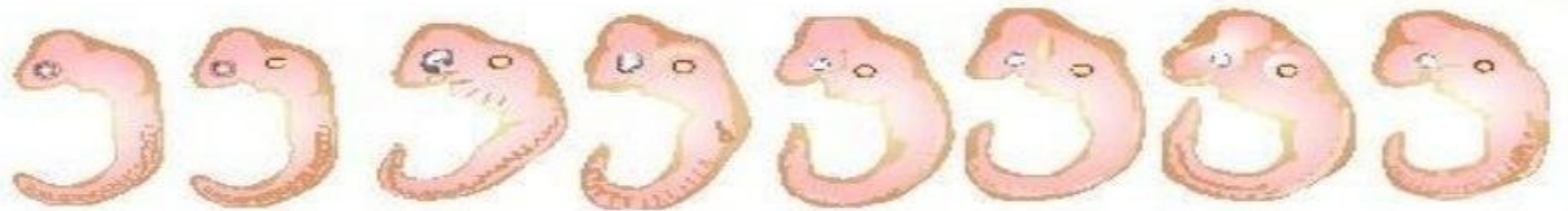
### 3. Biogenetic Theory

The Biogenetic Theory states that life produced life, that each animal and plant produced its own kind.

**“Ontogeny recapitulates phylogeny”**. This is a phrase made by Ernst Haeckel, a German biologist and philosopher which means that the development of an organism (ontogeny) expresses all the intermediate forms of its ancestors throughout evolution (phylogeny). The advances in science made it clear that living things created other living things.



I



II



III



Fish

Salamander

Tortoise

Chick

Hog

Calf

Rabbit

Human

## 4. Abiogenetic Synthesis Theory

Most biologists theory that life began in the primordial seas. Water formed as vapor liquefied and the seas appeared. Sunlight, acting on water where carbon dioxide and ammonia were present, formed more complex compounds suitable for the nourishment of living things. There was progressive development from nonliving things. Colloidal substances led to the formulation of viruses.



- ▶ According to **Alexander Oparin**, a Russian biochemist, “the first organisms were probably formed out of organic chemicals and processes that were much simpler than those that exist today. Out of the elements carbon, hydrogen, oxygen, nitrogen, and sulfur, molecules were formed from which complex compound developed. Then proteins, carbohydrates, and other compounds developed into coacervates converting the sea into a sort of ‘hot soup’, where cells formed.” It is believed that the first living cells were not able to make their own organic food.



# OTHER THEORIES ON THE ORIGIN OF LIFE

1. **Beneath the Ice** – Some evidence indicates that, around 3 billion years ago, Earth's oceans were covered with ice. This ice may have been hundreds of meters thick, mainly due to the sun being less fierce than it is nowadays. This theory contends that the ice may have protected the compounds, allowing them to interact and, thereby, creating life.

## ► Panspermia (Cosmozoic Theory)

- This is the proposal that life on Earth began from rocks and other debris from impacts, in the form of highly resistant spores (cosmozoa) such as meteorite.





## ► **Electricity**

It has been proven that electricity can produce simple sugars and amino acids from simple elements in the atmosphere. This leads to the theory that lightning may have been responsible for the origins of life, primarily by striking through rich volcanic clouds.

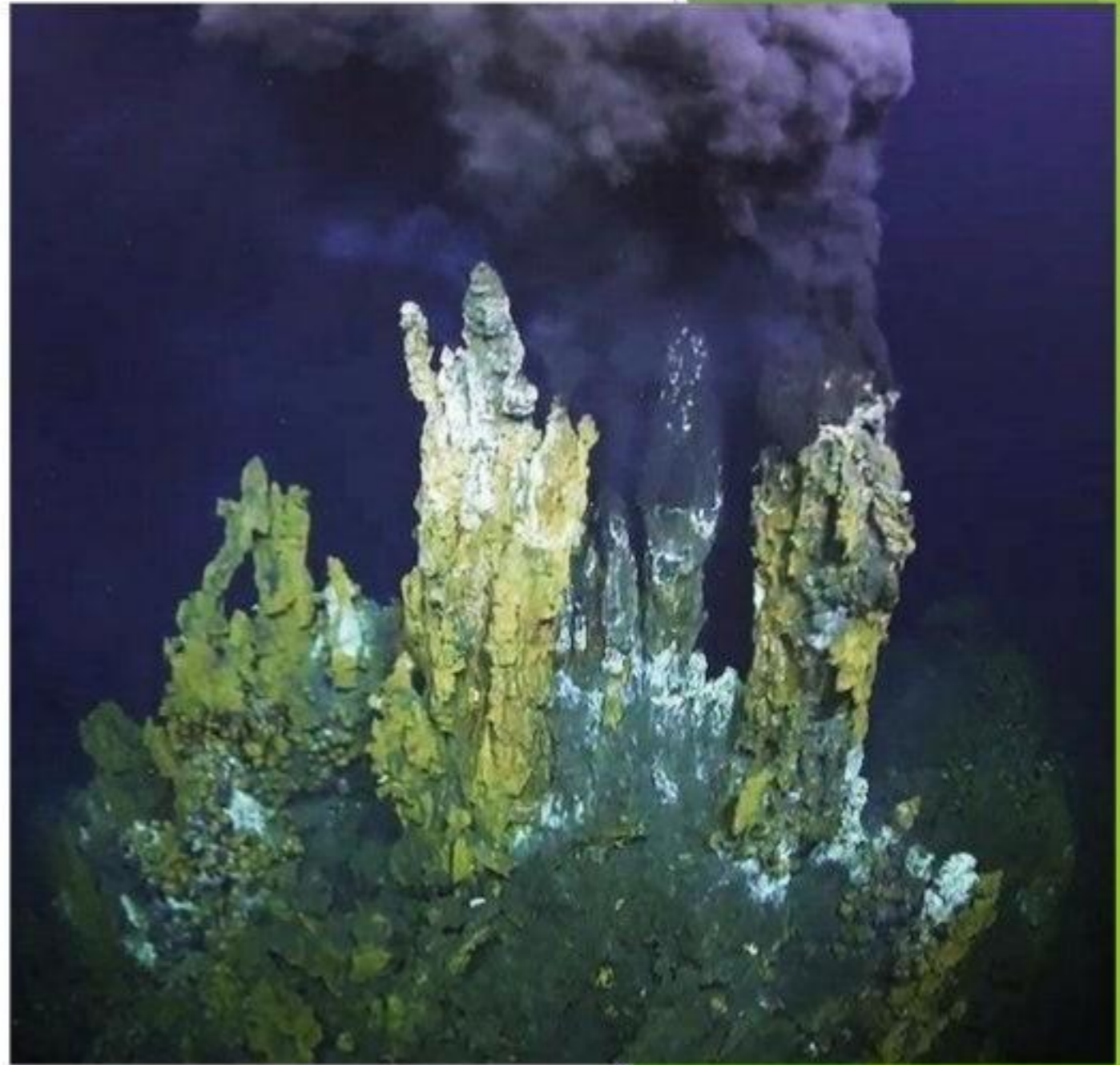




- ▶ **RNA World** – It is a hypothetical phase of the evolutionary history of life on Earth, in which self-replicating Ribonucleic acid (RNA) molecules proliferated before the evolution of DNA and proteins. Like DNA, RNA can store and replicate genetic information; like enzymes, it can catalyze chemical reactions that are critical for life (Ribozyme).
- ▶ **Simple Metabolism and Reactions** – In contrast to the RNA theory, this suggests that the primordial soup simply continued to react with itself over time., producing more and more complex molecules, yielding life.

## ► Submarine Hydrothermal Vents

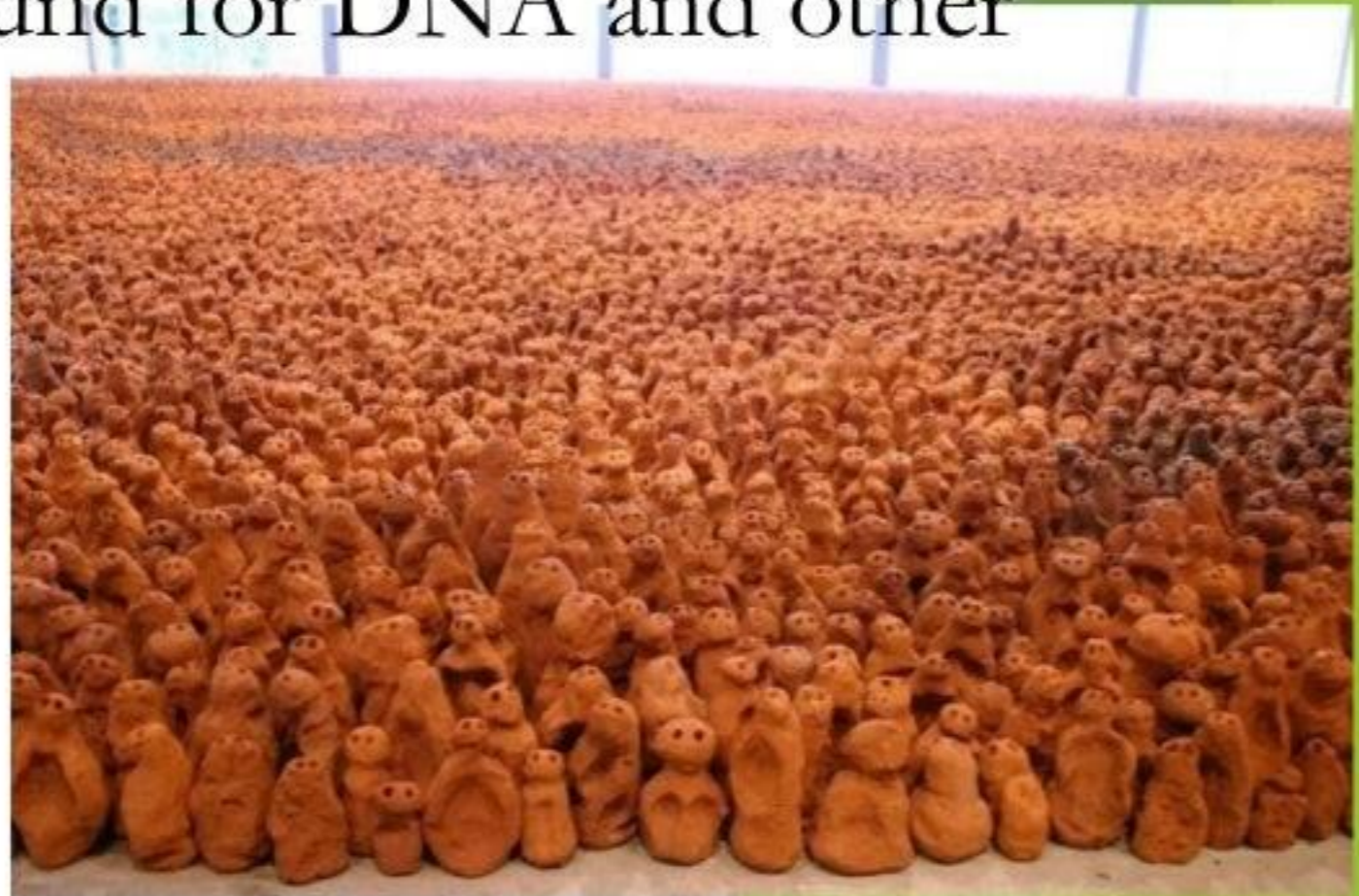
– or deep-sea vents, contains vast and diverse ecosystems. Studies suggest that life may have originated from within these vents, a theory that cannot be ignored.





► **Clay Breeding Ground** – Research at the University of Glasgow, Scotland, suggested that clay may have served as an area of concentrated chemical activity, providing a breeding ground for DNA and other components.

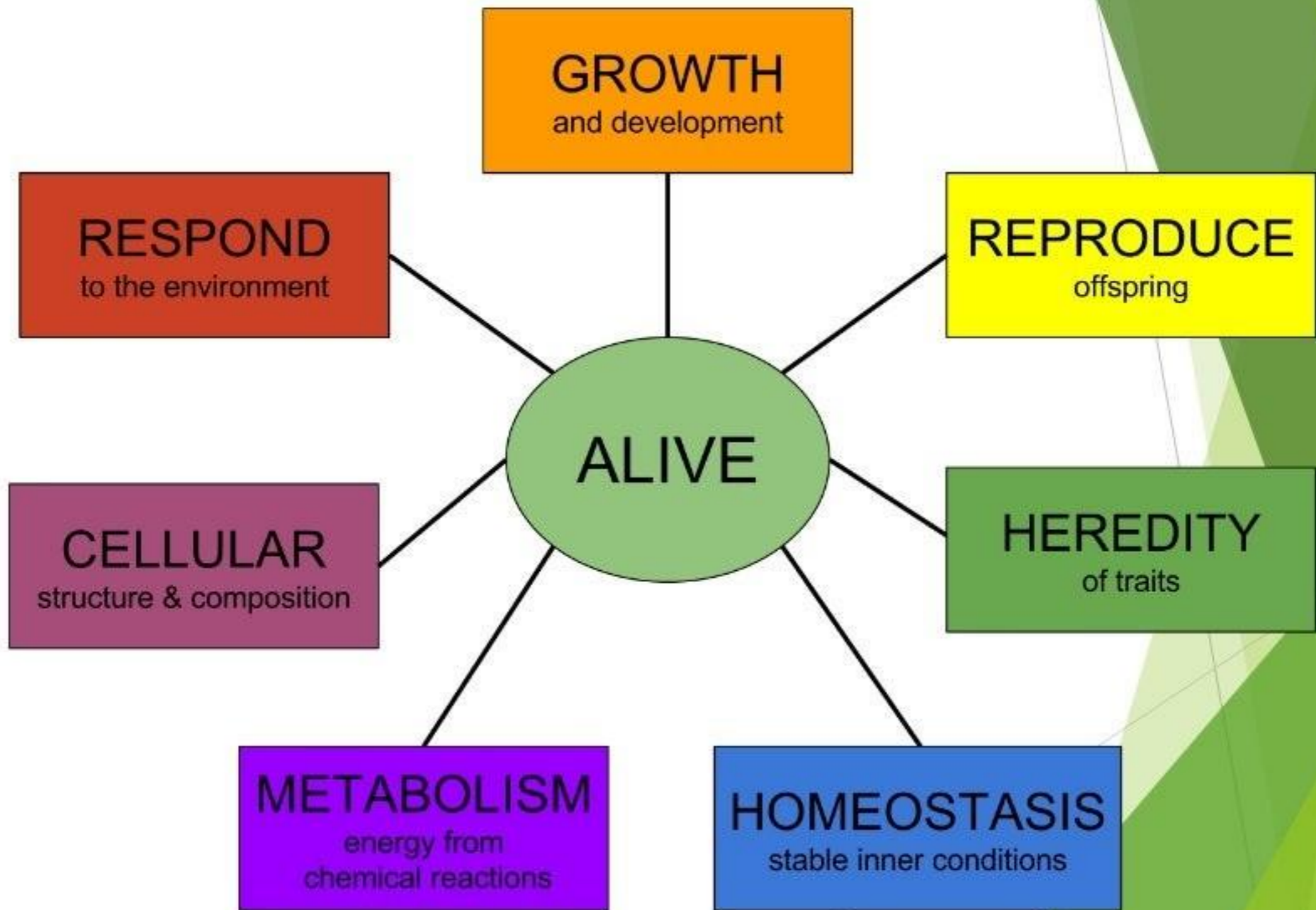
Mineral crystals in clay could have arranged organic molecules into organized patterns. Eventually, organic molecules organized themselves.





A close-up photograph of a green leaf with several water droplets on its surface. A small, dark insect is visible on the leaf, partially obscured by the text. The background is a soft, out-of-focus green.

# **CHARACTERISTICS OF LIFE**







A **living entity**, regardless of its structure, size, or behavior, is an organism that possesses characteristics that most biologists have agreed upon.

These are **locomotion, irritability, metabolism, growth, reproduction, cellular organization, adjustment, integration, and coordination.**



- ▶ **Irritability** is the ability of living things to react to the factors of the environment such as light, temperature, pressure, tension, chemicals, and gravity. This is the reason why living things react, or respond to their environment.
- ▶ **Locomotion** refers to the ability of organisms to move. Organisms have structure such as the **cilia**, **flagella**, **pseudopodia**, and **muscles** which help them move. There is in these organisms, a living substance called **protoplasm** which shows an intracellular movement called **cyclosis**.

- ▶ **Metabolism** refers to the sum total of the chemical reactions taking place. The building up reaction called **anabolism** is shown up by **respiration**.
- ▶ **Growth** is the increase in size and number of cells. The growth in living this is called **intussusception**. Growth in all animals begins when the zygote starts to develop and all the successive cell divisions take place then the cells become differentiated.



- ▶ **Reproduction** is the ability of living things to produce new individuals closely resembling them.
- ▶ **Cellular organization** refers to the parts and functions of the cells in an organism. An organism may have one or more **cells** that is the basic unit of life. Some organisms are composed of only one cell yet function as other complex organisms do. The living matter in a cell is the **protoplasm** which consists of a **cell membrane, cytoplasm, and nucleus.**

► **Adjustment, Integration, and Coordination** refer to the ability of a living organism to live in harmony with other organisms in the environment. It can make adjustments which call for adapting itself in a given situation. By the process of integration, an organism can act harmoniously with and relate itself to the environment.



# UNIFYING THEMES IN THE STUDY OF LIFE

## Biological Systems

- ▶ System is the combination of parts that can form a more complex organization. It has properties that are based on the arrangement and interactions of its parts.
- ▶ Our body, like that of any organism, is a living system that is certainly more than the sum of our parts, and so are all biological systems.

- ▶ An **ecosystem** such as **forest** is also a biological system. Like your body, an ecosystem has properties that depend on how its parts interacted.
- ▶ An organism in the ecosystem requires a steady supply of certain chemicals to live.
- ▶ The Biological systems theme applies to all levels of life, from the biosphere all the way down to the interactions of molecules in cells.

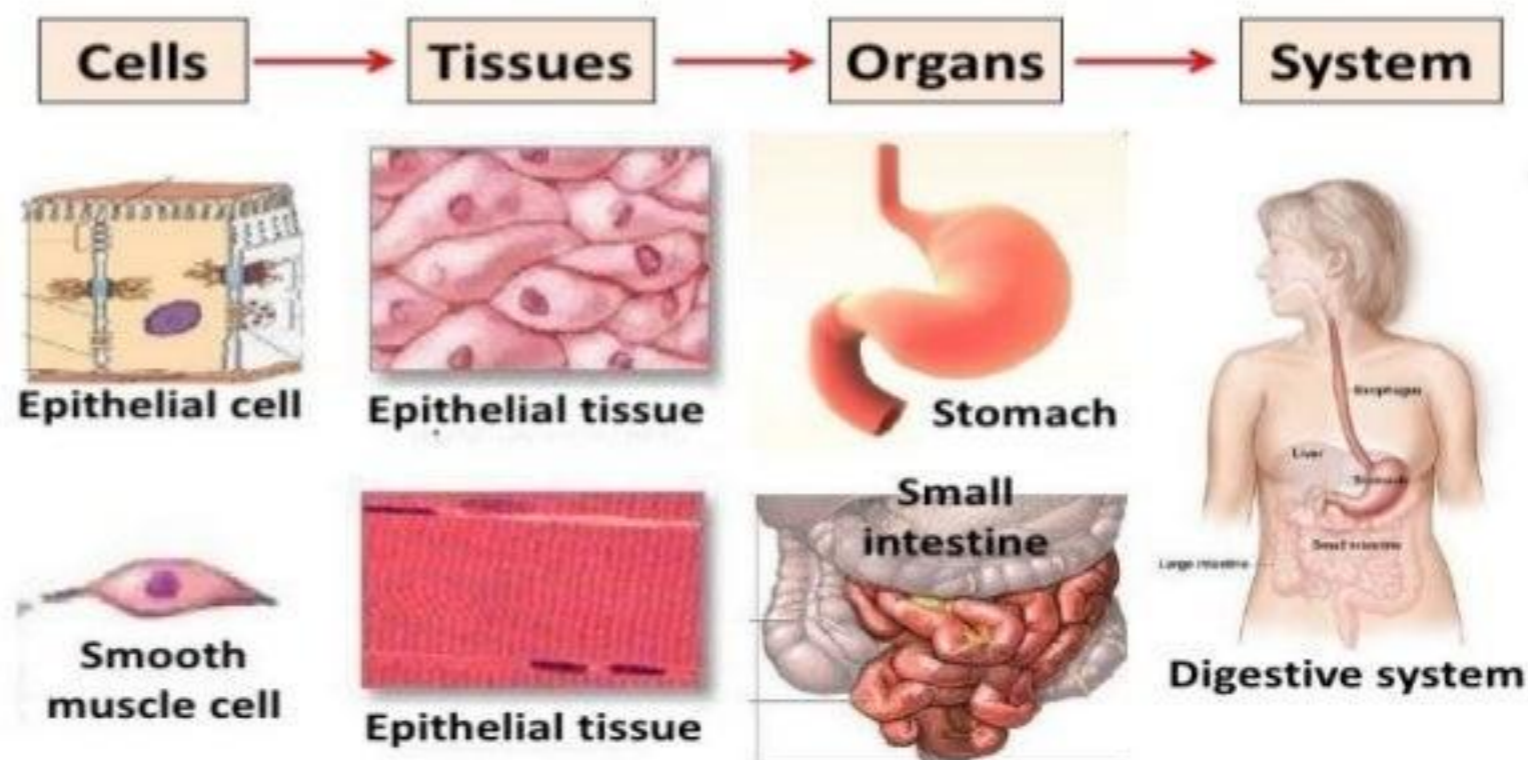


# The Cellular Basis of Life

- ▶ All organisms are made of cells.
- ▶ Most multicellular organisms have cells that are specialized for different functions.
- ▶ In most multicellular organisms, cells are organized into higher levels of organization. Beginning with the **cellular level**, the next is **tissue**, which is a group of similar cells that perform a specific function.
- ▶ Several types of tissue together may make up a structure called an **organ**.

- ▶ Several organs that together carry out a major body function make up an **organ system**.
- ▶ A multicellular organism's development and survival are based on the functions and interaction of its many cells.

## CELL ORGANIZATION





# CELL ORGANIZATION

Cells



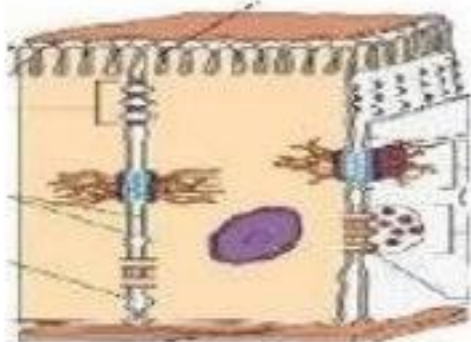
Tissues



Organs



System



Epithelial cell



Epithelial tissue



Stomach



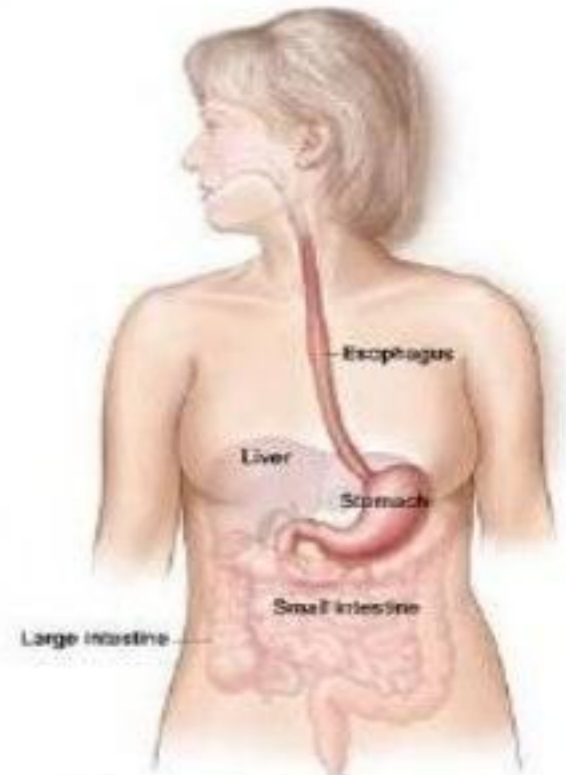
Smooth muscle cell



Epithelial tissue



Small intestine



Digestive system

## Form and Function

- ▶ “form fits function”. An example is the aerodynamic shape of a bird’s wing. The structure of the bird’s bones contributes to the bird’s ability to fly.
- ▶ The form-fits-function theme also extends down to the cellular level. Example, birds have long extensions of nerve cells that control their flight muscles.
- ▶ There’s harmony in form and function and how something works is related to its structure. In other words, form fits function.



## Reproduction and Inheritance

- ▶ “Like begets like”, an old saying that describes the ability of organisms to reproduce their own kind.
- ▶ Genes are responsible for family resemblance. Also, genes are made of information-rich molecules called **DNA**. Each cell in our body contains a copy of the entire DNA that we inherited from our parents.
- ▶ When a cell divides, it copies its DNA and passes this genetic information on to each of the cells it produces.
- ▶ The inherited DNA directs the transformation of the fertilized egg into a person with his/her characteristics.

## Interaction with the Environment

- ▶ No organism is completely isolated from its surroundings. As part of an ecosystem, each organism interacts continuously with its environment.
- ▶ Ex. A plant obtains water, nutrients, carbon dioxide, and energy from its surroundings to make food.
- ▶ Likewise, the plant also has an impact on its surroundings. As a plant grows, its roots break up rocks and release acids that change the soil. Those who live in the soil are affected. Plants also release oxygen which other organisms use for their own survival.
- ▶ Living requires a daily balance of such “inputs” and “outputs”.



## Energy and Life

- ▶ Energy is obtained in chemical form in sugar, fats, and other “fuel-like” molecules in your food. Your cells use this energy for all their work.
- ▶ You can trace energy through an ecosystem. Energy flows into an ecosystem as sunlight and exits in the form of heat. A simplified of this energy flow through a forest ecosystem.
- ▶ Chemical energy stored in our food is converted to other forms of energy as the organism carries out works and its life activities.

## Regulation

- ▶ The ability of organisms to regulate their internal conditions is an example of homeostasis, or “steady state”.
- ▶ It is a mechanism that makes organisms regulate their internal condition, despite changes in their external environment.
- ▶ Ex. A “thermostat” in your brain that reacts whenever your body temperature varies slightly from 37c. If this happens, your brain signals your skin to produce sweat. Sweating helps cool your body.



# Adaptation

- ▶ An adaptation is an inherited trait that helps the organism's ability to survive and reproduce in its particular environment.
- ▶ It is a change in the species over generations in order to better survive in the environment.

# Evolution

- ▶ Natural selection is the mechanism by which evolution occurs. The term evolution means “*a process of change*”. Biologists use the word evolution specifically to mean a generation-to-generation change in the proportion of different inherited genes in a population.
- ▶ Ex. The Beetle example, genes for dark color are becoming more common and genes for light color are becoming less common over the generations of beetles. The beetle population is said to be undergoing evolution, or evolving.



## **Biology and Society**

- ▶ More than ever before, modern biology is changing humans' everyday life.
- ▶ New findings about DNA affect such fields as medicine and agriculture.
- ▶ Ex. Research on the nervous system is improving the treatment of certain mental illness. The study of evolution is helping health professionals understand how disease-causing bacteria become resistant to antibiotic drugs. Environmental issues such as water & air pollution are changing how people think about their relationship to the biosphere.