1st. lecture /1st. Semester

1st. grade /Biology

Introduction to biology

Introduction to Cell Biology-Where we're going:

- **WHAT is cell biology**
- **WHY study cell biology?**
- **Properties of cells**
- **Prokaryotic and eukaryotic cell types**
- **Model organisms**
- **Viruses and other a cellular infectious agents**
- **WHAT is Cell Biology? It's about Cells!**
- **Structure: nuclei, mitochondria, cytoskeleton, etc.**
- **Function: Energy transformations, movement, signalling, getting the right protein to the right place, etc.**
- **WHY STUDY Cell Bio?**

Higher activities can be reduced to cellular functions: movement, thinking, illness, effects of pollutants, reproduction (some would go far more).

Biology:

Is the scientific study of life. Biology is the science that studies living organisms and how they interact with one another and their environment.

- Bio = life
- ology = the study of
- Biology is the science that studies life

Properties of Life

1. To understand living organisms, biologists develop possible explanations, known as hypotheses, about phenomena they observe in nature. These hypotheses are then subjected to rigorous tests, and changed or rejected as appropriate.
2. Because all living organisms, diverse though they are, descended from a single common ancestor, there is a great unity in the characteristics of living organisms.

3. Shared characteristics define life: Living organisms are built of cells, reproduce, grow and develop, capture energy from their environment, sense stimuli in their environment and respond to them, show a high level of organization, and evolve.
4. A biological hierarchy encompasses all components of living organisms and their environments, from molecules to cells, tissues, organs and organ systems, to individual organisms, populations, species, communities, ecosystems, and biomes, and finally the biosphere.
5. More than 3.5 billion years ago, life arose from nonlife. How this happened remains a matter of intense interest and research.

All living organisms

•are built of cells

•reproduce them using the hereditary material DNA

•grow and develop

•capture energy from their environment

•sense their environment and respond to it

•show a high level of organization

• evolve

- Living organisms:
  - are composed of cells (Cellular Organization)
  - are complex and ordered (Ordered Complexity)
  - respond to their environment (Sensitivity)
  - can Grow, Develop and Reproduce
  - obtain and use energy (Energy Utilization)
  - maintain internal balance (Homeostasis)
  - allow for Evolutionary Adaptation
- The definitions of life are adapting with the field
  - where do viruses fit in?

Energy Flow through Biological Systems

■ Energy flows through biological systems from **producers**, such as **plants**, that create **chemical energy** in the form of **sugars** and **starches** from **sunlight**, to **consumers**, such as **animals**, that eat **plants** or other organisms whose energy ultimately derives from plants. ***Shared Characteristics Life***

What Is Evolution?

Generally, the word *evolution* means change, and the *process* of biological evolution is derived from this definition. That is, **biological evolution** is **a change in the features** of individuals in a biological population that occurs over the course of generations .understanding **how species originate** and why they have the characteristics they exhibit. The **theory of evolution** can thus be stated: All organisms present on Earth today are descendants of **a single common ancestor**, and all organisms represent **the product of millions of years of evolution.**

The Nature of Science:

- Scientists use a systematic approach to gain understanding of the natural world:
  - Observation
  - Hypothesis formation
  - Prediction
  - Experimentation
  - Conclusion

Charles Darwin:

- Evolution: Modification of a species over generations
  - "descent with modification"
- Natural Selection: Individuals with superior physical or behavioral characteristics are more likely to survive and reproduce than those without such characteristics

The Biological Classification

Many of these **classification systems** grouped organisms by **similarities in habitat**, **diet**, or **behavior**; some of these classifications placed humans with the **great apes**, others did not. Into the classification debate stepped **Carolus Linnaeus**, a Swedish physician and botanist. Linnaeus gave all species of organisms **a two-part**, or ***binomial,*** name in Latin, which was **the common language of science at the time**. These Latin names typically contained information about the species' traits—for instance, ***Acer saccarhum*** is Latin for "**maple tree** that produces sugar," the tree commonly known as the sugar maple, while ***Acer rubrum*** is Latin for "red maple."

In addition to the binomial naming system, Linnaeus developed a new way to organize living organisms according to **shared physical similarities**. His classification system was arranged hierarchically—organisms that shared many traits were placed in the same narrow classification, while those that **shared fewer**, **broader traits**, were placed in more comprehensive categories.

The hierarchy took the following form, from broadest to narrowest groupings:

Kingdom

Phylum (or Division)

Class

Order

Genus

Species

Thus, for example, **all organisms that were able to move** under their own power, at least for part of their lives and relied on other organisms for food were placed in the **Kingdom Animalia**. Within that kingdom, all organisms with **backbones** (or another skeletal structure called **a *notochord***) were placed in **the same phylum**, **Chordata**, and all chordates that possess fur and **produce milk** for their offspring were placed in the Class **Mammalia, the mammals**. Humans are Mammals, as are **dogs**, **lions**, **dolphins**, and **monkeys**. The scientific name of **a species** contains information about its classification as well—for instance, humans, ***Homo sapiens***, belong to the **genus *Homo***.

Other scientists quickly adopted the logical and orderly Linnaean system of classification, and it became the standard practice for organizing biological diversity. Later scientists added a new level, **family**, **placed between order and genus**. Even more recently, biologists have added **"sub**" and "**super**" levels between these categories as well—such as **superfamily** between family and order.

Post-Darwin Evolution Evidence:

- Fossil record
  - Intermediate Organisms
- Mechanisms of heredity
  - Early criticism of Darwin's ideas were resolved by Mendel's theories for genetic inheritance
- Comparative anatomy
- - Homologous structures have same evolutionary origin, but different structure and function.
- - Analogous structures have similar structure and function, but different evolutionary origin.

Post-Darwin Evolution Evidence:

- **Molecular Evidence**

- - Our increased understanding of DNA and protein structures has led to the development of more accurate phylogenetic trees.

The Origin of Life

The origin of the first living cell is an active research question in biology. There are two scientific hypotheses regarding the source of this first organism:

Hypothesis 1:

The common ancestor arose on **another planet** and was **imported to Earth**.

Hypothesis 2:

The common ancestor arose on Earth through natural processes from **nonliving materials**. This theory includes:

1.No biological processes assembled the **simple molecules** that **were present early** in the history of the solar system into **more complex molecules**.

2. These molecules then **assembled** themselves into **chains** that could store information and/or drive **chemical reactions**.

3. Collections of these complex molecules were assembled into **a self-replicating "cell,"** with a membrane and energy source. **This cell fed on other complex molecules.**

Biological Terminology

Natural Selection:

Natural selection Process by which individuals with **certain traits** have greater survival and reproduction than individuals who **lack these traits**, resulting in an increase in the frequency of successful alleles and a decrease in the frequency of unsuccessful ones.

Habitat Place where an organism lives.

Invertebrates Animals without backbones.

Morphology Appearance or outward physical characteristics.

Morphological species concept Definition of species that relies on differences in physical characteristics among them.

Organelle Subcellular structure that performs a specific job.

Parasites Organisms that feed on other living organisms.

Pathogens Disease-causing organisms.

Pollution Human-caused threat to biodiversity involving the release of poisons, excess nutrients, and other wastes into the environment.

Photosynthesis Process by which plants, along with algae and some bacteria, transform light energy to chemical energy.

Predator Organism that eats other organisms.

Species A group of individuals that regularly breed together and are generally distinct from other species in appearance or behavior. In Linnaeus' classification system, a group in which members have the greatest resemblance.

Zygote Single cell resulting from the fusion of gametes (egg and sperm).

Extinction— the complete loss of the Species. The loss of biological diversity through species extinction

Summary

• All humans belong to the same biological species, ***Homo sapiens***.

• **Species** are groups of individuals that can **interbreed and produce** fertile offspring.

• Species are reproductively isolated from each other, thus separating the gene pools of species so that **changes in the allele frequency of a gene occur within a species**.

• Reproductive isolation is maintained by **prezygotic** or **postzygotic factors**.

• **Speciation occurs when populations of a species become isolated from each other**. These populations diverge from each other, and reproductive isolation between the populations evolves.

• Biological **races** are populations of **a single species that have diverged from each other**.

• The fossil record provides evidence that the **modern human** species is **approximately 200,000 years old**, which is not much time for human races to have.

• **Modern human groups** do not show evidence that they have been isolated from each other: **There are no alleles** that are unique to a particular "race," and populations that are **similar in skin color do not demonstrate other genetic evidence of relationship, including similar allele frequencies for a number of genes**.

• Genetic evidence indicates **that human groups have been mixing for thousands of years**.

• Similarities among human populations may evolve as a result of natural selection. The **sickle-cell allele** is more common in populations where **malaria incidence is high**, and **light skin** is more common in areas where the **UV-light level is low**; both adaptations are a result of **natural selection** in these environments.

• **Human populations may show differences due to genetic drift.**

• Assortative mating or sexual selection may create differences among human populations.

• **Race in the human species is a social construct** that is based on **shared history** and **self-identity**