2nd lecture/1st grade/ 1st semester / Biology

Biology of life:

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**.

Properties of Life

In its broadest sense, *biology is the study of living things—the science of life.* Living things come in an astounding variety of shapes and forms, and biologists study life in many different ways. They live with **gorillas**, collect fossils, and listen to **whales**. They isolate viruses, grow mushrooms, and examine the structure of fruit flies. They read the messages encoded in the long molecules of heredity and count how many times a **hummingbird's** wings beat each second. What makes

1- Order:

All organisms consist of one or more cells with highly ordered structures: atoms make up molecules, which construct cellular organelles, which are contained within cells. This hierarchical organization continues at higher levels in multicellular organisms and among organisms.

2- Sensitivity:

All organisms respond to stimuli. Plants grow toward a source of light, and your pupils dilate when you walk into a dark-room.

3- Growth, development, and reproduction:

All organisms are capable of growing and reproducing, and they all possess hereditary molecules that are passed to their offspring, ensuring that the offspring are of the same species. Although crystals also "grow," their growth does not involve hereditary molecules.

something "alive"? Anyone could deduce that a galloping **horse** is alive and **a car** is not, but *why?* We cannot say, "If it moves, it's alive," because a car can move, and gelatin can wiggle in a bowl. They certainly are not alive. What characteristics *do* define life?

All living organisms share five basic characteristics:

4- Homeostasis.

All organisms **maintain** relatively **constant internal conditions**, **different from their environment**, a process called homeostasis.

5- Natural Selection

Darwin was thoroughly familiar with variation in domesticated animals and began *On the Origin of Species* with a detailed discussion of pigeon breeding. He knew that breeders selected certain varieties of pigeons and other animals, such as dogs, to produce certain characteristics, a process Darwin called **artificial selection .** Once this had been done, the animals would breed true for **the characteristics that had been selected**. Darwin had also observed that the differences purposely developed between **domesticated races** or **breeds** were often greater than those that separated **wild species**. Domestic pigeon breeds, for example, show much **greater variety** than all of the hundreds of wild species of pigeons found throughout the world. Such relationships suggested to Darwin that **evolutionary change could occur in nature** too.

Surely if pigeon breeders could foster such **variation** by "artificial selection," **nature** could do the same, playing the breeder's role in **selecting the next generation**—a process Darwin called **natural selection.** Darwin's theory thus **incorporates** the hypothesis of **evolution**, the process of natural selection, and the mass of new evidence for both evolution and natural selection that Darwin compiled. Thus, Darwin's theory provides a simple and **direct explanation** of **biological diversity**, or why animals are different in **different places**: because **habitats** differ in their requirements and **opportunities**, the organisms with **characteristics favored locally**

Evolution after Darwin :More Evidence

More than a century has elapsed since Darwin's death in 1882. During this period, the **evidence supporting** his theory has **grown progressively stronger**. There have also been many significant advances in our understanding of **how evolution works**. Although these advances have **not altered** the basic structure of Darwin's theory, they have taught us a great deal more about the **mechanisms** by which evolution occurs. We will briefly explore some of this evidence , we will return to the theory of evolution and examine the evidence in more detail.

1- The Fossil Record

Darwin predicted that the fossil record would yield **intermediate links** between the **great groups of organisms**, for example, between **fishes** and the **amphibians** thought to have arisen from them, and between **reptiles** and **birds**. We now know the fossil record to a degree that was unthinkable

in the nineteenth century. Recent discoveries of **microscopic fossils** have extended the known history of life on earth back to about **3.5 billion** years ago.

The discovery of other fossils has supported Darwin's **predictions** and has shed light on how organisms have, over this **enormous time span**, **evolved from the simple to the complex**. For **vertebrate animals** especially, the fossil record is rich and exhibits a graded series of changes in form, with the evolutionary parade visible for all to see.

2- The Age of the Earth

In Darwin's day, some physicists argued that the earth was only a few thousand years old. This bothered Darwin, because the evolution of all living things from some single original ancestor would have required a great deal more time. Using evidence obtained by studying the rates of radioactive decay, we now know that the physicists of Darwin's time were wrong, very wrong: the earth was formed about **4.5 billion years ago**.

3- The Mechanism of Heredity

Theories of heredity in Darwin's day seemed to rule out the possibility of genetic variation in nature, a critical requirement of Darwin's theory. Genetics was established as a science only at the start of the **twentieth century**, 40 years after the publication of Darwin's *On the Origin of Species.* When scientists began to understand the laws of inheritance, the heredity problem with Darwin's theory vanished. **Genetics accounts** in a neat and orderly way for the production of **new variations in organisms.**

4- Comparative Anatomy

Comparative studies of animals have provided **strong evidence** for Darwin's theory. In many different types of vertebrates, for example, the same **bones** are present, indicating their **evolutionary past**. Thus, the forelimbs shown are all constructed from the same **basic array** of bones, modified in one way in the **wing of a bat**, in another way in the fin of a porpoise, and in yet another way in the **leg of a horse**. The bones are said to be **homologous** in the different vertebrates; that is, they have the **same evolutionary origin**, but they now **differ in structure and function**. This contrasts with analogous structures, such as the **wings of birds** and **butterflies,** which have **similar structure** and **function** but different **evolutionary origins**.

The second half is devoted to an examination of organisms, the **products of evolution**. It is estimated that at least **5 million** different kinds of **plants**, **animals**, and microorganisms exist, and their diversity is *incredible.*

One of the central theories of biology is Darwin's theory that evolution occurs by natural selection. It states that certain individuals have **heritable traits** that **allow** them to produce more offspring in a given kind of environment than other individuals **lacking those traits**. Consequently, those traits will increase in **frequency through time**.

Levels of Organization

1. Cellular Level

Atoms molecules organelles cells

2. Organismal Level

Tissues organs organ systems

3. Population Level

Population species biological community

4. Ecosystem Level

Biological community + physical habitat (soil, water, atmosphere(

The Biosphere

The entire planet thought of as an ecosystem

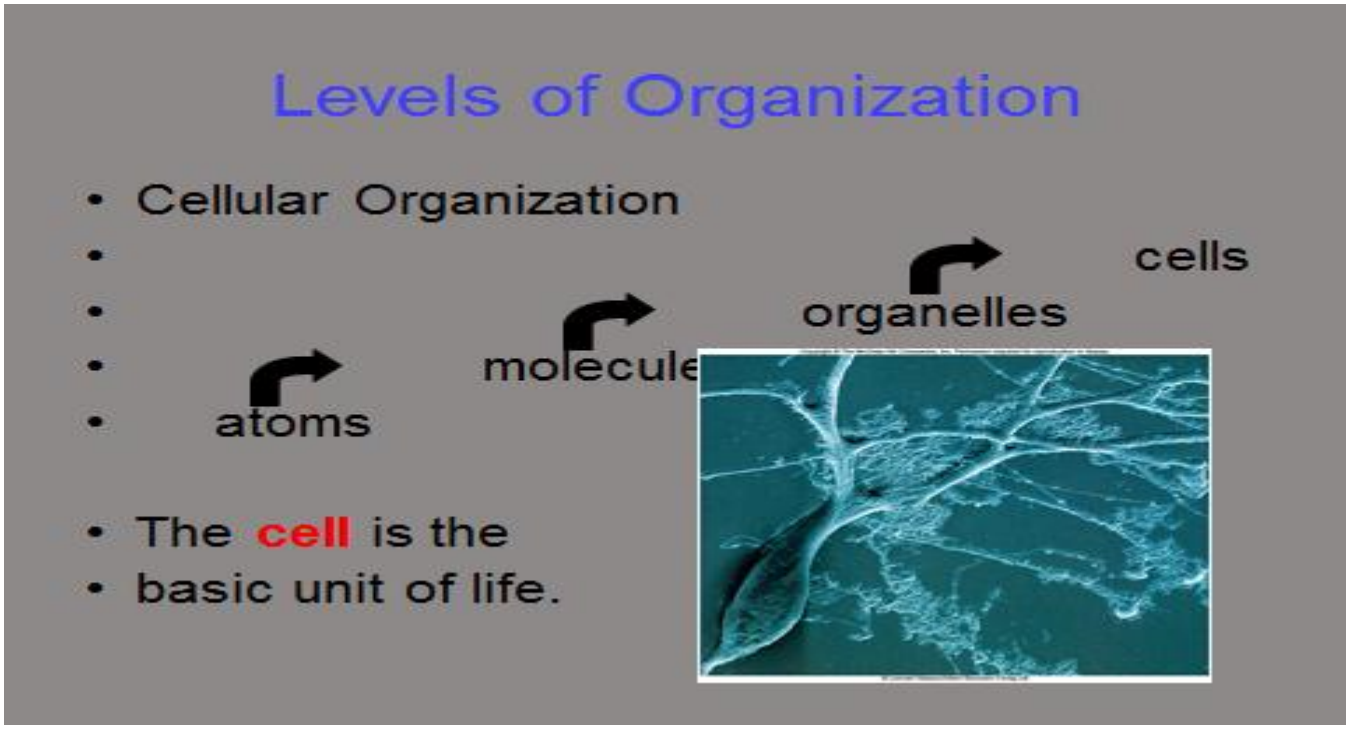

Fig. 1.1-1

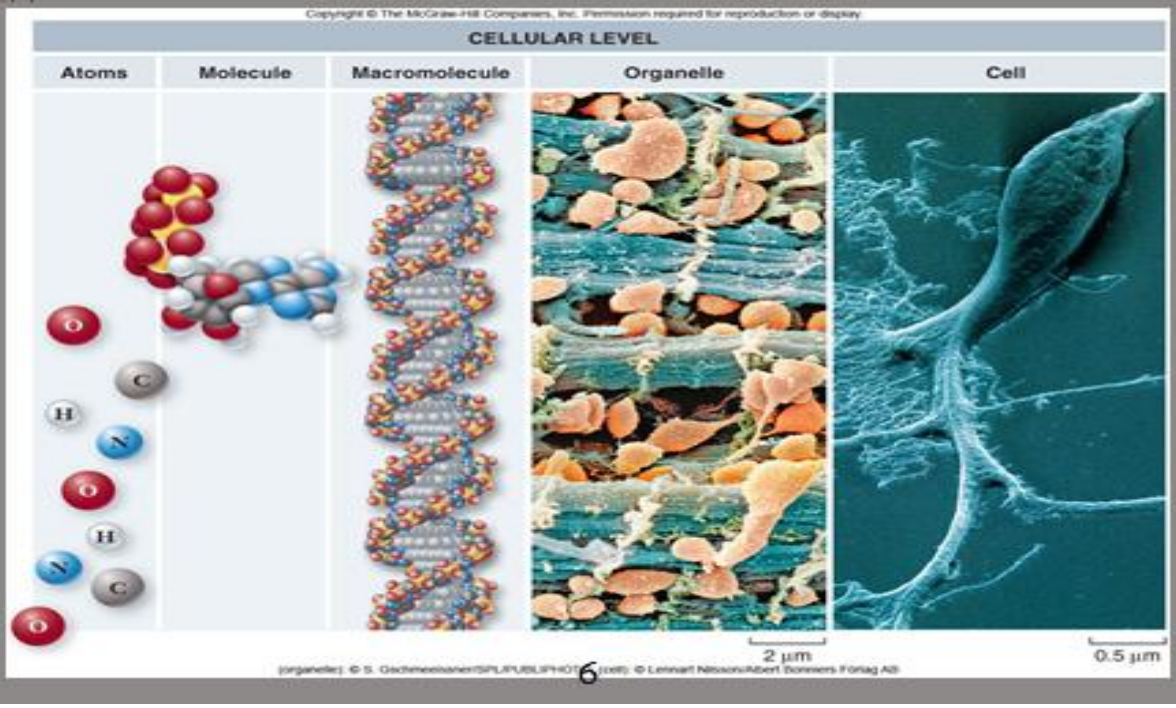

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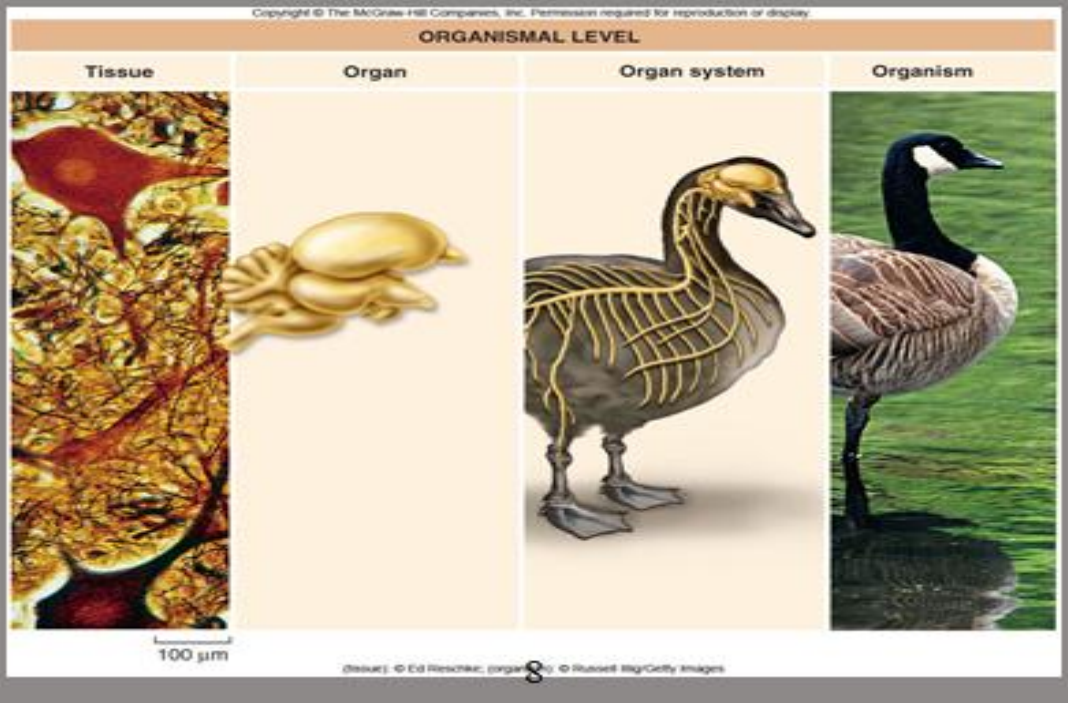
Fig. 1.1-2



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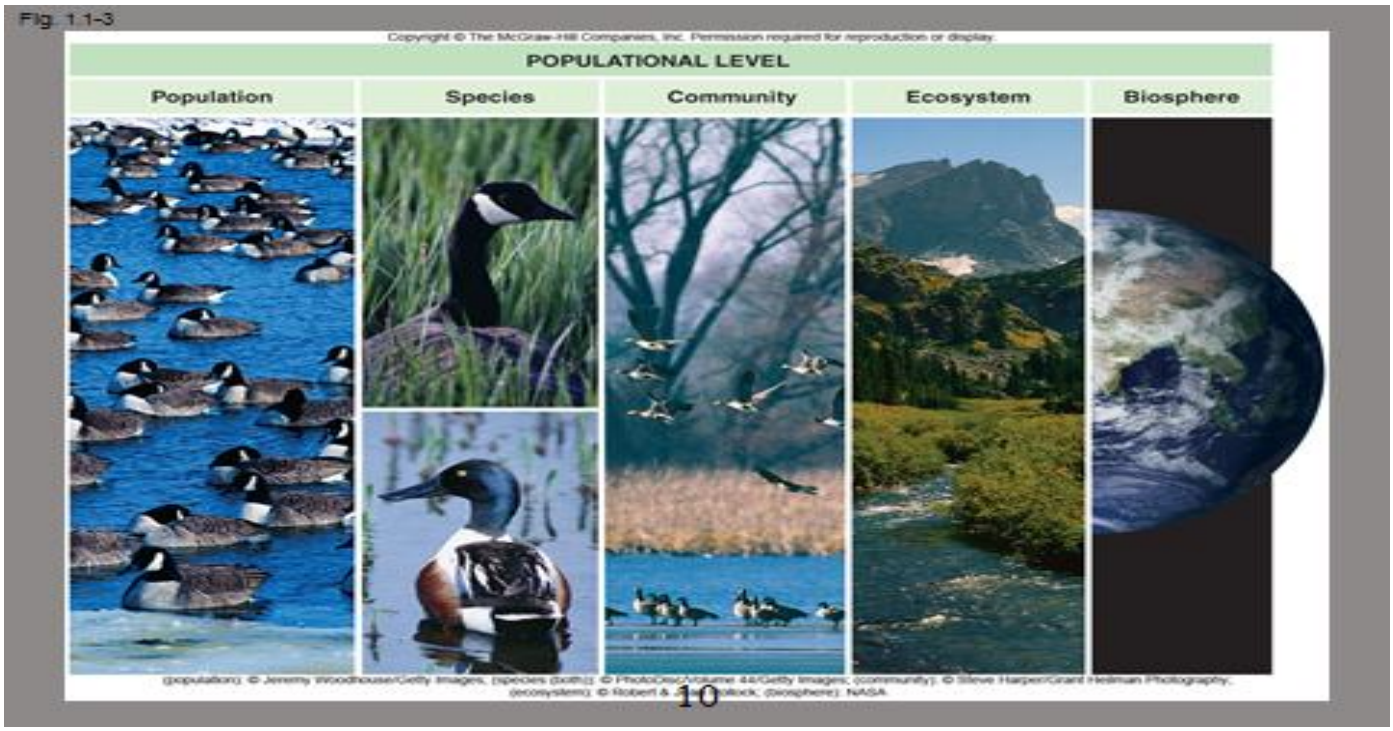


Cell theory

The cell theory describes the organization of living systems

All living organisms are made of cells, and all living cells come from preexisting cells

Molecular basis of inheritance

The molecular basis of inheritance explains the continuity of life

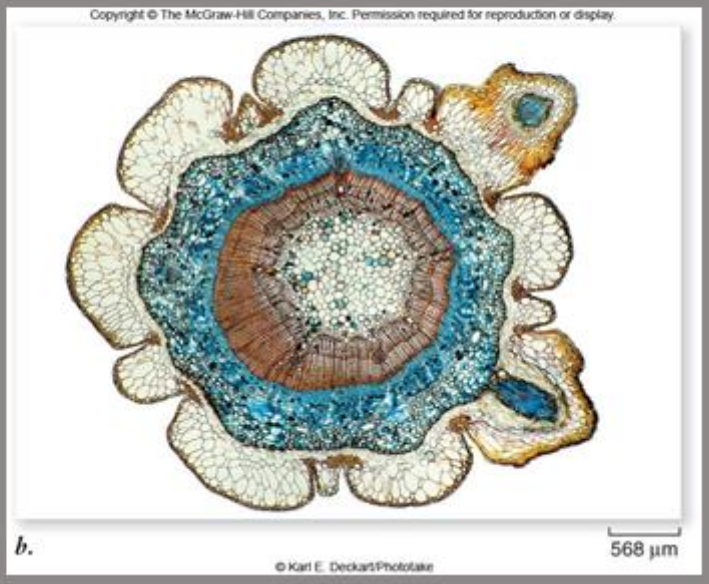
DNA encodes genes which control living organisms and are passed from one generation to the next

The DNA code is similar for all organisms (The Central Dogma)

Levels of Organization:

- Each level of organization builds on the level below it but often demonstrates new features
- Emergent properties: new properties present at one level that are not seen in the previous level
- New properties emerging may be greater than the sum of the the parts

Multi-Cellular Organisms



Single Celled Organisms

Unifying Themes in Biology

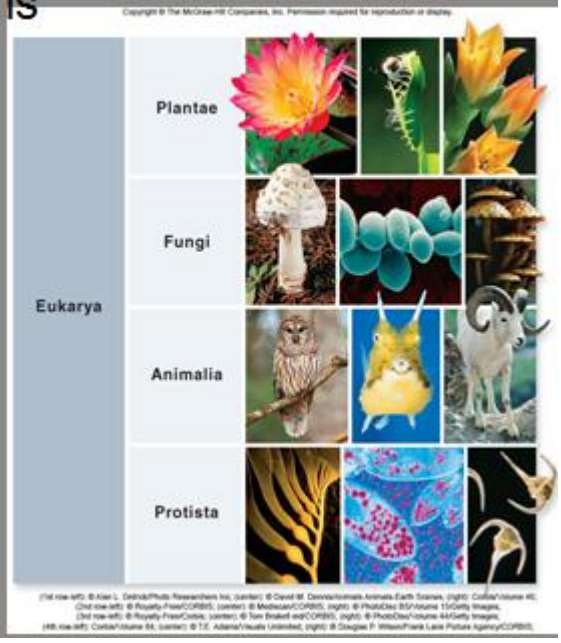
- **Structure and Function**
- The proper function of a molecule is dependent on its structure
- The structure of a molecule can often tell us about its function
- Four major classes of Biomolecules
    1. Nucleic Acids
    2. Amino Acids
    3. Lipids
    4. Carbohydrates
- **Evolutionary Change**

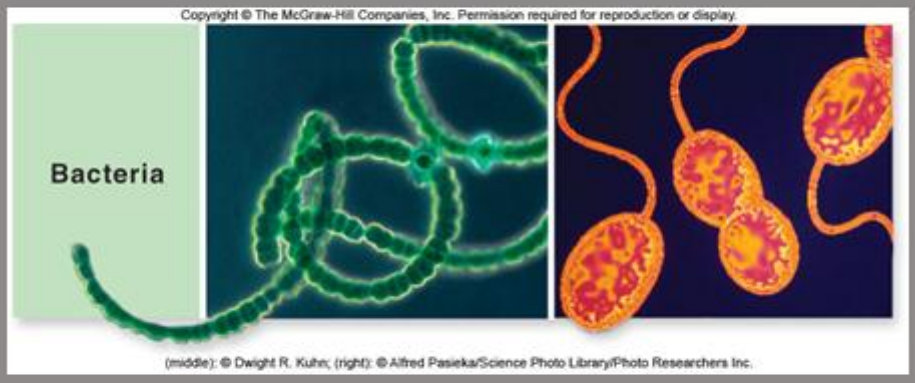
- The diversity of life arises by evolutionary change leading to the present biodiversity we see
- Biology attempts to classify life's great diversity based on these unifying themes
- Currently all living things are classified into 3 Domains subdivided into Kingdoms (more on taxonomy to come)
- This process is always changing

The Diversity of Life

Three Domains:
1. Eukarya
2. Archaea
3. Bacteria

Domain Eukarya is Divided into four Kingdoms:
1. Plantae
2. Fungi
3. Animalia
4. Protista

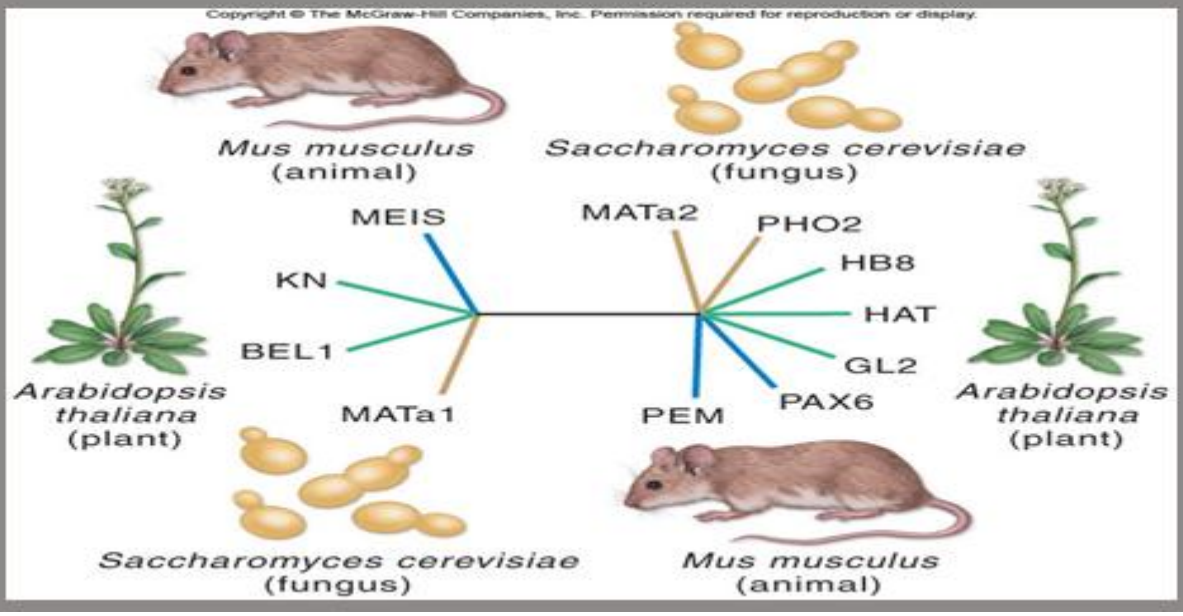




Evolutionary Conservation

- Evolutionary conservation explains the unity of living systems
- The underlying unity of biochemistry and genetics argues that all life has evolved from the same origin event
- Critical characteristics of early organisms are conserved and passed on to future generations

Homeodomains



- Cells are information-processing systems
- Every cell in an organism carries the same genetic information
- The control of gene expression allows cells to differentiate into different cell and tissue types
- Cells also process information received from the environment and respond to maintain homeostasis
- Emergent properties
- New properties are present at one level of organization that are not seen in the previous level
- The whole is greater than the sum of its parts