Lecture notes on General Biology for first level students in Faculty of Pharmacy and Biotechnology, Delta University of Science and Technology – Autumn 2012
Chapter 1

Characteristics and classification of living organisms
Biology is the study of living things. It deals with what all living things can do, how they do it and why they do it. In biology, there is always a relationship between the structure of an organism, its function and its adaptation to its function or environment.

An individual living thing, such as an animal or a plant, is called an organism. The term ‘living organism’ is usually used to describe something which displays all the characteristics of living things.

**Characteristics of living things**

There are seven activities which make organisms different from non-living things:

1. **Nutrition**: Living things take in materials from their surroundings that they use for growth or to provide energy. Nutrition is the process by which organisms obtain energy and raw materials from nutrients such as proteins, carbohydrates and fats.

2. **Respiration**: Respiration is the release of energy from food substances in all living cells. Living things break down food within their cells to release energy.

3. **Movement**: All organisms are able to move. Some, including most animals, are able to move their whole body from place to place, and this is called locomotion. But even seemingly non-moving organisms, such as plants, are able to move parts of themselves. If you look at some living plant cells under a microscope, you may be able to see the tiny structures within each cell moving around.

4. **Excretion**: All living things excrete. As a result of the many chemical reactions occurring in cells, they have to get rid of waste products which might poison the cells. Excretion is defined as the removal of toxic materials, the waste products of metabolism and substances in excess from the body of an organism.

5. **Growth**: Growth is seen in all living things. It involves using food to produce new cells. The permanent increase in cell number and size is called growth.

6. **Reproduction**: All living organisms have the ability to produce offspring of the same kind.

7. **Sensitivity**: All living things are able to sense and respond to stimuli around them such as light, temperature, water, gravity and chemical substances.

Learn these characteristics of living organisms. They form the basis of the study of Biology.
Classification of living organisms

Classification can be defined as grouping organisms according to their features similarities. The science of classifying organisms is called Taxonomy. All organisms in the living world are classified and named according to an international system of criteria. The rules of classification apply only to formal scientific names, not to common names.

The groups are arranged from the largest group of organisms to the smallest with an example for classification of human:

- **Domain**: Eukaryote
- **Kingdom**: Animalia
- **Phylum** (plural phyla): Chordata
- **Class**: Mammalian
- **Order**: Primate
- **Family**: Hominidae
- **Genus** (plural genera): Homo
- **Species**: sapiens

The domain is the broadest category, while species is the most specific category available. About 1.8 million species have been given scientific names. Thousands more are added to the list every year. Tropical forests and deep ocean areas very likely hold the highest number of still unknown species.

**Domains:**
The domains are organized based on the difference between eukaryotes and prokaryotes. The three domains are as follows:

- **Archea (Archeabacteria)**: consists of archeabacteria, bacteria which live in extreme environments. The kingdom Archaea belongs to this domain.
- **Eubacteria**: consists of more typical bacteria found in everyday life. The kingdom Eubacteria belongs to this domain.
- **Eukaryote**: encompasses most of the world's visible living things. The kingdoms Protista, Fungi, Plantae and Animalia fall under this category.
Kingdoms:
Under the three domains are six kingdoms in taxonomy:

§ **Animalia:** is comprised of multi-celled organisms which develop from an embryo resulting from the fertilization of an egg by a much smaller sperm. Animals also share the characteristic that must ingest or eat other living or decayed organic matter as food to live.

§ **Plantae:** is composed of multi-celled organisms that grow from embryos. Most plants engage in photosynthesis (use of energy of sunlight by the plant to produce carbohydrates and gaseous oxygen from water and carbon dioxide). Plants generally have a rigid cell wall composed of cellulose. They are non-motile but some produce motile cells.

§ **Protista:** is the catch-all kingdom for everything that does not fit into the other four. Since protists are quite irregular, this kingdom is the least understood and the genetic similarities between organisms in this kingdom are largely unknown. For example, some protists can exhibit properties of both animals and plants, it is also comprised of some large organisms such as giant kelps that can grow as much as 10 meters.

§ **Fungi:** is comprised of non-motile cells that have cell walls made of chitin (the same hard stuff that the outer bodies of insects are made of) and not cellulose. Mushrooms and molds belong in this kingdom. Originally, they were part of the plant kingdom but were recategorized when they were discovered not to photosynthesize. They digest other living things outside their bodies by releasing enzymes and then absorbing the product.

§ **Eubacteria (Monera):** are bacteria, made up of small cells, which differ in appearance from the organisms in the above kingdoms. They lack a nucleus and cell organelles.

§ **Archae (or Archaebacteria):** are bacteria which live in extreme environments, such as salt lakes or hot acidic springs. These bacteria are in their own category as detailed studies have shown that they have unique properties and features (ex. unusual lipids that are not found in any other organism) which differ them from other bacteria and which allow them to live where they live.
Kingdom Animalia

Properties of Animals:
The Animal Kingdom contains a wide-range of organisms which share common properties which go to define animals as a distinct group of life-forms:

§ **Complex Eukaryotic Cells**: Made up of highly-organized eukaryotic cells gradually differentiate into various tissues which ultimately provide specialized structure and function to the adult animal.

§ **Tissue Specializations**: Animals are multi-cellular; various tissue and organ systems are constructed to provide the specializations needed for day-to-day survival.

§ **Animals are Aerobic**: Aerobic metabolism is the means upon which animals breakdown food-stuffs and acquire ATP energy needed to drive all of their functions.

§ **Sexual reproduction**: The survival of animal species is accomplished through sexual reproduction.

§ **Mobility**: this property has allowed animals to be distributed throughout the land as well as marine habitats around the world. Moreover, this property of motion is highly dependent upon the development of a stimulable skeletal-muscular system.

§ **Land and Sea Habitats**: Most of the early, evolutionary forms of animals were aquatic; however over evolutionary time, several animals groups adapted to and colonized the land masses.

Classifications of Animals:
Within the Animal Kingdom there are approximately 35 Phyla; each phylum shares particular structural and functional properties which together separate it from other phyla. Below are ten of the most common animal phyla:

§ **Porifera**: These are the salt-water sponges; there are approximately 8,000 separate species existing today.

§ **Cnidaria**: This group is composed of jellyfish, and other lower aquatic animals; approximately 15,000 species exist today

§ **Platyhelminthes**: These are the flatworms which inhabit both marine and freshwater habitats; over 15,000 species exist today.

§ **Nematodes**: This phylum consists mainly of about 80,000 known parasitic worms.
Rotifers: This group consists of about 1,800 highly-mobile freshwater invertebrate animals.

Mollusca: This major group consists of snails, clams, squid, and octopus; there are over 110,000 known species.

Annelida: About 15,000 individual segmented worms comprise this phylum; the common earthworm is an example.

Arthropoda: This very large group consists of insects; it is estimated that there are over 1 million species of insects existing today.

Echinodermata: These are the marine starfish; about 6,000 species exist today.

Chordata: This is a group of animals which are classified on the basis of possessing 3 common embryological features – dorsal nerve cord, supportive structure called the notocord, and pharyngeal gill pouches.
**Phylum Chordata**

Although not the largest phylum, Chordata contains the most familiar species, including humans. Their main feature, what they are named after, is the notochord, which is a rod that supports the nerve cord. The nerve cord is also present in all species. This is a bundle of nerve fibers which connect the brain with the muscles and organs, and is through which messages from the brain are sent. There are 3 subphyla:

§ **Cephalochordata:** These animals are fish-like in appearance, but are invertebrates with a notochord, and a nerve cord right above it. They lack bones, a brain, eyes and most other organs associated with the brain. There are 25 species.

§ **Tunicata (Urochordata):** This is a large subphylum of unusual invertebrates that do not look like anything much more than a strange underwater worm or mushroom. They start off life as tadpole-like larvae with notochords and all the rest. This stage lasts only a short time, after which they anchor to the seabed and live a sedentary life. The adults lack the notochord. They have a highly-developed internal structure. Tunicates are named for their protective covering, known as a tunic. This tunic is made up of cellulose, which is very rare in animals.

§ **Vertebrata:** This is the largest subphylum with the more well-known animals, including humans. Every animal with a backbone is present in this subphylum. The notochord is developed at an early age, and is replaced with vertebrate. All vertebrates have a skeleton of either bone or cartilage. Their brain is protected by a boney cranium, and consists of three parts. They all have well-developed hearts with 2-4 chambers and have a closed circulatory system.
Vertebrata

There are seven classes within the subphylum vertebrata.

§ **Agnatha**: Class Agnatha consists of an ancient group of animals similar to fish but with some very noticeable differences. The agnathans lack jaws and paired fins. Agnathans lack an internal skeleton of bone but cartilage.

§ **Chondrichthyes**: Sharks, skates and rays make up Chondrichthyes, or "cartilaginous fish". Members of Chondrichthyes all lack true bone and have a skeleton made of cartilage. Only their teeth, and sometimes their vertebrae, are calcified; this calcified cartilage has a different structure from that of true bone.

§ **Osteichthyes**: Class Osteichthyes (the bony fish) is the largest class of vertebrates with over 20,000 species. The total numbers of fishes exceed that of all other kinds of vertebrates combined. Bony fish have a skeleton much stiffer than the cartilaginous fish because it is reinforced by calcium salts.

§ **Amphibia**: The word Amphibian is derived from two Greek words, *amphi* (double) and *bios* (life). This "double life" refers to the two phases in the life cycle of most amphibians, an aquatic larval stage and a terrestrial adult stage. Amphibians are ectothermic, which means they need an "outside" source of heat to generate adequate body heat.

§ **Reptilia**: The name "reptile" is generally applied to any of a group of ectothermic vertebrates in the Class Reptilia. Some reptiles look superficially similar to some amphibians. However, reptiles are dry-skinned, not slimy. They are covered in scales or a shell to prevent rapid water loss.

§ **Aves**: Birds belong to the Class Aves. Birds are the only animals on earth that have feathers and every animal on earth that has feathers is a bird. Other characteristics of birds include: forelimbs modified into wings, lack of teeth, a four chambered heart and eggs with hard shells.

§ **Mammalia**: They represent only a small portion (about 8.5%) of the known vertebrates. All mammals share three characteristics not found in other animals: 3 middle ear bones, have hair and the production of milk by modified sweat glands called mammary glands.
Binomial nomenclature

When writing a scientific name, the genus name is written first and starts with a capital letter, and the species name is written second and starts with a small letter. The scientific name ought to be printed in italics when typed and underlined separately when handwritten. The scientific name can be also abbreviated, where the genus is shortened to only its first letter followed by a period. For example, humans have the binomial name *Homo sapiens* (*Homo sapiens*) or *H. sapiens*. The genus name is generally a noun, while the species modifier is an adjective. Thus, *Homo sapiens* means “human knowing”.

The generally accepted criterion for defining a species is that organisms of the same species interbreed under natural conditions to yield fertile offspring. Individuals of different species normally do not mate. If they are forced to mate, the mating is either unsuccessful or the offspring are sterile. For example, a horse (*Equus caballus*) can be mated to a donkey (*Equus assinus*), and the result will be a mule. However, mules are sterile and cannot reproduce. Thus, the horse and donkey are classified as different species. A quarterhorse and a thoroughbred can mate and produce a fertile offspring. Therefore, both are classified as the same species: *Equus caballus*.

For humans, there is only one living species: *Homo sapiens*. However, in past ages other species, such as *Homo erectus*, may have coexisted with *Homo sapiens*. *Homo erectus* is considered a separate species because presumably it could not mate with *Homo sapiens*. 