Classification and Kingdoms

D. CLASSIFICATION SCHEME

We have to take into account variability, relationships, and evolutionary relatedness to classify organisms into various categories. The largest categories are called kingdoms ad the smallest are species.

Binomial, meaning two names, refers to the way scientists label living things. The two names come from the genus and species of the classification system.

This system was developed by Karl Von Linne, who latinized his own name to Carl Linneus (1701-1778). He is responsible for creating categories within categories. He chose to use Latin because of two reasons: 1) Latin is not commonly spoken anywhere outside of a few academic halls or in religious ceremonies and not likely to change 2) Latin forms the roots of many words in a number of languages. In a monumental feat, Linneus single handedly named and classified many of the earth’s organisms. Since Linneus’ time, the rules for assigning names are rigidly enforced by international commissions.

Here are the categories for classifying organisms from the highest to the lowest level. Each level is called a taxon.

Categories: How to remember them:

Kingdom King Kings

Phylum Philip Play

Class Came Chess

Order Over On

Family From Fat

Genus Greece Guys’

Species Singing Stomachs

These are just names applied to groups of organisms that are thought to be related to one other.

Taxonomy has two main objectives.

1. To sort out closely related organisms and assign them to separate species and to name newly discoveredspecies.
2. To organize species into higher taxonomic categories.

1. PHYLOGENY

Phylogen is the evolutionary history of a species or a group of related species.

* + - 1. Evolutionary Systematics

Biologists wanted taxonomies to be not only convenient and useful but also to accurately reflect the phylogenetic relationship among organisms. These taxonomies are hypotheses about evolutionary histories. Some of these hypotheses can be tested and revised if necessary. The study of evolutionary relationships is known as evolutionary systematics.

* + - 1. Monophyletic

A classification scheme that accurately reflects evolutionary history is termed monophyletic. This means

that at each level, all members of the taxon should be the descendants of a common ancestor.

Monophyletic classification is difficult to achieve for two reasons.

* + - 1. It is difficult to know completely the evolutionary histories of organisms.
      2. Convenience and utility may be more important than an accurate reflection of phylogeny. We usually see that a taxon contains members that have descended from more than one common ancestor (polyphyletic taxon).

3. Homology and Phylogeny

Organisms are grouped in a process based on similarities in structure and other phenotypic characteristics. Superficial similarities are not always useful in deciding the taxon for the organism.

A big question in evolutionary systematics concerns the origin of similarities or differences between two organisms. Does the similarity reflect inheritance from a common ancestor, or does it reflect an adaptation to similar environments by organisms that do not share a common ancestor? Does a difference between two organisms represent different phylogenetic histories or does it reflect the adaptation of closely related organisms to different environments?

Similarities that have a common origin but do not necessarily the same function are termed homologous. Structures that have a similar function, but have different evolutionary backgrounds are said to be analogous.

1. TAXONOMIC METHODS AND TOOLS

Several steps for the traditional taxonomic method.

* + - * 1. An organism is assigned a taxon based on the outward similarities to other organisms in the taxon.
        2. The similarities are tested for homologies. Fossil evidence is examined whenever possible.
        3. Various stages in the lifecycle and the patterns of embryonic development are also compared.

When constructing a taxon in the traditional way, two factors need to be considered.

Some factors produce evidence of genealogy (branching patterns that show the evolutionary history of the organism).

The taxon should reflect the degree to which the organisms have diverged since they began to travel in different evolutionary paths. Traditional taxons contain information about the sequence in which branching occurred and the extent of the biological changes.

Problem: Not all similarities are due to a common ancestor, some are due to convergent evolution. However, the more complex two similar structures, the more improbable it is that they came from two separate ancestors.

1. OTHER TOOLS OF TAXONOMISTS: MOLECULAR BIOLOGY

* 1. Amino Acid Sequences

Compare the amino acid sequences of the same protein in different organisms. The greater the number of

amino acid sequence differences, the more distant their evolutionary relationship. The smaller the amount of differences, the closer the relationship.

Some biologists suggest that a change in an amino acid represents a functional difference in the molecule. Other biologists say that amino acid changes occur at random and that they do not represent the result of the selection process, such changes simply mark the passage of time. Instead of functional differences, changes in amino acid sequences are a molecular clock. This clock can be used to determine the time at which groups diverged.

* 1. Nucleotide Sequences/DNA Observations

Since it is now possible to sequence nucleotides, the comparison of homologous proteins has been largely abandoned. Nucleotide sequencing is more sensitive and easier to do than comparing amino acids.

The nucleotide sequences of different species are placed into a computer and compared. Taxonomic relationships can be determined with there comparisons.

* + 1. DNA-DNA Hybridization

This is usd to compare the DNA strands of different species. It is an important tool in conjunction with other methods.

* + 1. Restriction Mapping

A process which obtains restriction fragments (RFLP) with restriction endonucleases and compares this with the restriction fragments of other species. The mitochondrial DNA (mtDNA) of several species can be compared in this way.

1. Molecular Clocks

Proteins evolve at different rates, but for a given protein the rate seems to be pretty constant. If homologous proteins are examined and compared, the number of amino acid differences is proportional to the amount of time that has elapsed since the branching of the populations.

DNA comparisons are more promising than protein comparisons.

Molecular clocks are calibrated by graphing the number of amino acid and/or DNA base pair differences against time. This is done for a series of evolutionary branch points from the knowh fossil record. If no clear fossil evidence is present, the graph then estimates the time of species divergence.

The consistent rate of protein and DNA changes implies a large number of neutral mutations. This is a controversial pint among scientists who use the molecular clock.

1. Alternative Methodologies (Schools of Taxonomy)

* 1. Numerical Phenetics

This is based only on a species’ observable characteristics. These characteristics are dividedi into

‘unit characteristics’. These unit characteristics are assigned a value, and these values are compared by a computer. Homology/ Analogy is not considered. Phenetics suggests that the problems with this method are resolved if enough characteristics are compared.

* 1. Cladistics

This is based on phylogeny. Cladistics suggest that the branching of one lineage from another in the course of evolution is the one event that can be determined objectively.

The goal of cladistics is to construct a holophyletic taxa. The holophyletic taxa must contain ALL of the descendants from the common ancestor plus the ancestor.

1. BACK TO KINGDOMS

In the beginning of taxonomy (naming things) there were two kingdoms; either something was an animal or a plant. From there scientists devised a three kingdom system – plants, animals, and protests. Currentrly, scientists use a five kingdom system.

* 1. Moneran: Prokaryontes: bacteria and cyanobacteria

* 1. Protista: Eukaryotic: various simple, single celled eukaryotes including protozoa (formerly animals) and chlorophyta (formerly plants).

* 1. Fungi: Eukaryotic

* 1. Plants: Eukaryotic, nonvascular and vascular

* 1. Animal: Eukaryotic, multicelluar from sponges to humans

Unit VII

Viruses / Protists / Fungi

1. Viruses

1. PHYSICAL CHARACTERISTICS

A large virus is 300 nm in diameter; the smallest is 20 nm in diameter. Viruses can cause disease (e.g. AIDS, Herpes, Chicken pox, the common cold and the flu) and they can also cause permanent inheritable changes in the cell/

1. Properties

A virus is a piece of double stranded DNA, single stranded DNA, or PNA surrounded by a protecting protein coat called a capsid. All viruses are classified by he type of nucleic acid (DNA or RNA) contained in the capsid. The smallest virus contains 4 genes, and the largest virus has several hundred genes.

Viruses cause diseases or cancer. For example, the HIV virus causes the disease AIDS and the Epstein-Burr Virus causes the disease Mononucleosis.

1. HOW DOES A VIRUS INFECT A CELL?

Viruses are oblogate ontracellular parasites. They have no enzymes for metabolism and they have no ribosomes to produce proteins. Viruses must be transported form one organism to another, because they cannot move by themselves. Viruses remain inactive until they arrive on an attachment site of the correct cell. A virus can only attack a specific cell with the correct receptor site. For example, the HIV virus only attacks the T4 cells of the immune system.

* 1. Attachment

Virus lands on the correct cell with a specific receptor site. The capsid fits into the receptor on the cell. There is a limited range of host cells to which a virus can attach. Receptors on the surface of the virus fit in a lock and key fashion to receptors found on the surface of cells.

* 1. Penetration

The virus can enter the cell. Once this happens, enzymes in the cell destroy thee capsid and the nucleic acid (RNA or DNA) is freed. Many viruses inject the DNA or RNA into the cell, leaving the capsid on the outside.

1. MRNA

Most RNA acts as mRNA to produce proteins. Other RNA, use reverse transcriptase (also in the capsid) to produce DNA form the RNA is inside the cell the virus can take one of two life styles, lytic or lysogenic.

Either way, the virus diverts the host cell’s resources to produce new rival parts. After the parts are produced, they are assembled by themselves (often spontaneously) into new viruses. This process is called self-assembly.

* 1. Lytic

The viral DNA incorporates into the cell’s DNA. The cell then makes the part of thee virus. The virus is put together by the cell. When there are too many viruses in the cell, either the cell bursts, releasing the viruses, or the viruses exit the cell one by one. The released viruses search for the appropriate cells. A cold virus is an example of this type of virus. These are virulent viruses.

* 1. Lysogenic

The viral DNA incorporates into the cell’s DNA and remains dormant. At any time, thee viral DNA may become lyctic. The AIDS virus is an example of this type of virus. These are called temperate viruses.

The virus can also cause drastic changes in thee DNA of the cell so than the cell becomes a tumor cell. There are two types of tumors.

* + 1. Benign: Harmless, confine to a local area.
    2. Malignant: These tumors are the ones that spread through out thee body and can kill an organism.

1. DEFENSES

There are no drugs that you can take that will cure you from a virus infection. There are drugs that can lessen symptoms, but they cannot cure. The body has three ways to combat the virus.

* 1. Phagocytes

This is the first line of defense. The phagocytes surround and destroy the virus by eating the virus or the infected cell.

* 1. Antibodies

Antibodies are proteins that react to a specific type of virus. Antibodies are produced and the body mounts an immune response; the antibodies flood the blood stream and target the invading organism. Vaccines cause a person to build specific antibodies to a virus that causes a specific disease.

* 1. Interferon

Interferon is a protein produced by the cell. It prevents the virus from reproducing in three ways.

* + 1. Prevents the virus from attaching to the cell’s attachment site.
    2. Prevents the virus from injecting the viral DNA.
    3. Prevents the viral DNA from taking over the host’s cell machinery.

II. KINGDOM: PROTISTA

A. CHARACTERISTICS OF PROTISTS

1. Unicellular or simple colonial.
2. Eukaryotic.
3. May have diverse nutritive modes including photosynthesis, ingestion, and absorption.
4. May reproduce sexually or asexually.
5. May have motility by the eukaryotic cilia or undulipodia or by other means (pseudopods) or may be nonmotile.

III. KINGDOM: FUNGI

A. INTRODUCTION

Fungi are heterotrophs which secrete digestive enzymes into their surroundings, and take in the products after the food has been digested.

In this mode, the fungi are known as saprophytes or saprobes (live on dead matter). Those that aren’t saprophyte are parasites. Most biologists believe that the closest living relatives of fungi are the colorless swimming protists known as chytrids.

Most fungi are multicellular. Some produce highly elaborate reproductive structures.

Fungi are decomposers which help with the cycling of important nutrients. Fungi are also used commercially in such products as cheese, antibiotics, bread and beer.

You will notice that when we talk about fungi, that many of their names end in mycota or myscetes. Myketos is

Greek for fungus, the root word is also the source for the term mycelium – the body of many fungi. They

mycelium is made up of tread-like structures known as hyphae. Septate hyphae are tubular cells with one nucleus per cell. Coencocytic hyphae have no cell wall separating the nuclei, so the hypha consists of a continuous cytoplasmic mass.

Cell walls are composed of chitin. The mycelium is the feeding structure that secretes the digestive enzymes and absorbs the products. The mycelium is usually the result of germination and growth from one spore. Growth occurs at the tips of hyphae. Parasitic fungi often have specialized hyphae called haustoria, which have nutrient absorbing tips that penetrate the tissues of the host. The rest of the hyphae remain outside the host cell membrane.

Many fungi develop erect spore producing organs, sporangia, which make tiny spores by the millions. Sporangia are made on specialized hyphae called sporangiophores. The spores are everywhere and are a means of asexual reproduction. Spores are small and able to survive long periods of drought and extreme temperatures. Often sporangia are raised above the mycelium by the sporangiophores. The spores are caught up and transported by air currents. The bright colors and powdery textures associated with many types of molds are the colors and textures of spores and sporangia. Fungi also reproduce sexually – often in complex lifestyles. In fact, the nuclei of hyphae and spores are almost always haploid.

F. SYMBIOSIS AND FUNGI

1. Lichens

There are 25,000 types of lichens. Lichens are formed by a symbiotic relationship between an algae (or canobacterium) and a fungus. They are important soil builders. Lichens erode rock surfaces and harbor bits of organic matter in their crusty bodies. Lichens can live in harsh conditions such as the tundra without many nutrients.

Lichens may be found on rocks, trees, or soil. They reproduce asexually by fragmentation.

1. Mycorrihizae

These are the symbiotic relationships between zygomycetes and the roots of vascular plants. In some mychorrihizal associations, endomychorrihizae, the fungal hyphae extend into the root cells, forming coils, swellings or bridges. The hyphae also extend into the surrounding soil. About 80% of vascular plants have endomycorrihizal associations.