UNIT 2
BIODIVERSITY

Chapter 4

Patterns of Life

Biology 2201

Characteristics of Life

- Generally speaking we all know what is living and what is non-living
  - A butterfly is alive, while a rock is not
  - A tree is living, while a building is non-living
- Rather than defining what "life" is, biologists tend to describe "what makes something living"
- What are the characteristics that are shared by all living things?

Thinking Lab

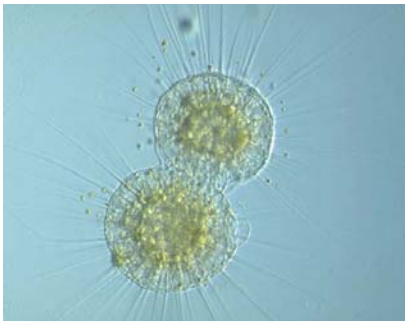
- In pairs, examine the pictures on pages 102 – 103. Brainstorm a list of characteristics that enable you to separate living from non-living
- Make a list of 6 more living and non-living things (3 of each) and trade with another group to test the reliability of you characteristics
- Modify your list as needed

6 Characteristics of Living Things

- Organized systems made up of one or more cells
  - Cells make up tissues, tissues make up organs, organs make up systems. Non-living things do not have this level of complexity
- Metabolize matter and energy
  - Chemical reactions require a source of energy – food

6 Characteristics of Living Things

- Interact with their environment and are homeostatic
  - "stay the same" in an environment even though they are exchanging molecules / water from their surroundings
- Grow and Develop
  - Unicellular living things grow, and divide. Multicellular living things grow, develop through the union of eggs and sperm, followed by cell divisions



6 Characteristics of Living Things

- Reproduce themselves
  - Only living things can make other living things like themselves. Genetic information being passed on to offspring
- Adapt to their surroundings
  - Have physics feature that make them well suited to the environment in which they live – behaviours for obtaining food, waste transport, motility, reproduction and communications

Road to 6 Kingdom Classification

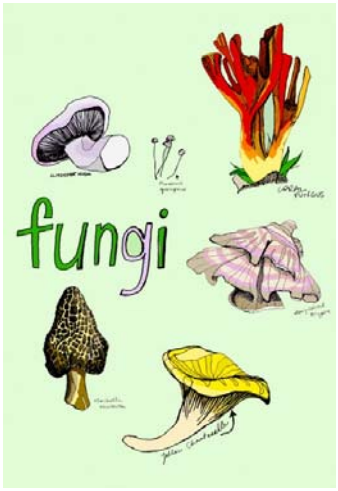
- We often tend to organize things based on physical characteristics
  - Music, clothing, books
  - The groupings reflect the patterns we see in the world around us
- Aristotle first grouped over 1000 organisms into 2 large kingdoms, then subdivided each into smaller groups
- 1. Kingdom Animalia
  - Grouped based on movement:
    - on land
    - in the air
    - in water
- 2. Kingdom Plantae
  - Grouped based on physical characteristics
    - Reproductive structures
    - Types of external tissues

Road to 6 Kingdoms

- 3. Kingdom Protista
  - Discovery of micro-organisms forced scientists to reconsider Aristotle's system of classification
  - Some organisms move like animals, but photosynthesize like plants

Road to 6 Kingdoms

- 4. Kingdom Fungi
  - Were originally included in the plant kingdom
  - Were placed in their own kingdom because they do not photosynthesize, and absorb nutrients from their environment



Road to 6 Kingdoms

5. Kingdom Bacteria

- Entirely made up of prokaryotic cells (lacking a nucleus and membrane-bound organelles)
- Obtain energy from a wide range of environments, but thrive between 10 and 40 degrees celcius
- Also called: Monera, eubacteria (true bacteria)

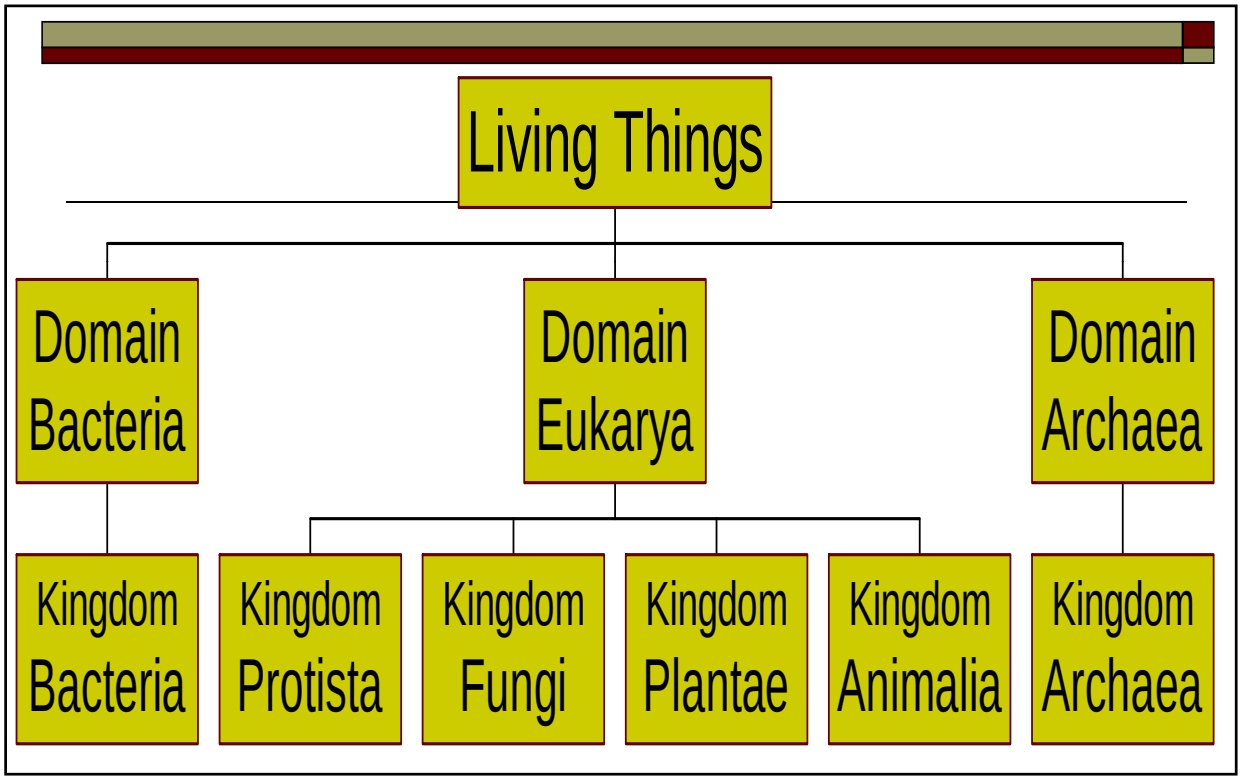
6. Kingdom Archaea

- Also made up of prokaryotic cells, but with specialized structures allowing them to live in extreme environments
  - Hot vents, acidic lakes, high pressure, low oxygen, etc.
- Also called: archaebacteria

The Three Domains

- Each of the kingdoms belongs to one of the three domains
- They represent how organisms evolved
  - See fig. 4.5 pg. 107

1. Domain Bacteria
   - Kingdom Bacteria
   - Earliest living organisms, 1000's of species exist today
2. Domain Archaea
   - Kingdom archaea
   - Evolved later, through a series of changes in bacteria
3. Domain Eukarya
   - Kingdoms protista, plantae, animalia and fungi
   - Early protists branched away from bacteria, giving rise to all the other kingdoms



Naming and Classifying Organisms

- There are well over 2 million different types of organisms known.
- Biologists place the organisms into groups based on their characteristics.
- By classifying, biologists can organize living things into groups.
- Taxonomy
  - The branch of Biology that deals with the naming and placing of all organisms into groups.
  - The system of naming we use today was created over 300 years ago by Carolus Linneaus
- The Linnean system is very simple to use and became popular as a result

Naming Organisms

- Many of the names are based on the Latin or Greek since that is what was used when the naming system was created.
- Scientists are required to give new latin *scientific names* when they discover new species
- The names often reflect the characteristics of the organisms, or in some cases honour the discovering scientist

Hierarchy of Groups

- Each kingdom is subdivided into smaller and smaller groups called **taxa** (one taxon)
- Kingdoms are the largest taxa, containing 1000's of species
- Species are the smallest taxa, containing only one type of organism
- The Taxa
  - Domain
  - Kingdom
  - Phylum (plural – Phyla)
  - Order
  - Family
  - Genus (plura – genera)
  - Species
- Each taxon may have subtaxa

Hierarchical Classification – The Pneumonic

Domain	**Do**ctor
Kingdom	**King**
Phylum	**Phyl**lip
Order	**Order**ed the
Family	**Family**
Genus	**Gen**ius to
Species	**Spe**ak

- Each organism is classified based on physical characteristics and DNA relationships
- The Species level contains organisms that are similar enough that they can reproduce

Domestic Dog

- Kingdom Animalia
- Phylum Chordata
- Class Mammalia
- Order Carnivora
- Family Canidae
- Genus Canis
- Species familaris
  - Different breeds may exist

Humans

- Kingdom Animalia
- Phylum Chordata
- Class Mammalia
- Order Primates
- Family Hominidae
- Genus Homo
- Species Sapien Sapien

Binomial Nomenclature

- Binomial = 2 terms
- Nomenclature = naming
- System of naming species using a two-term name
  - First term is the genus name
  - Second term is species name
- Rules for naming
  - The genus name is capitalized
  - The second name is the species and is entirely lower-case
  - The name must be either in *italics* or have each term separately underlined

Binomial Nomenclature Examples

CORRECT WAY

- *Canis familiaris* – house dog

  OR
- Canis lupus – Wolf
- Many species may be in the same genus because they are related, in this case dog-like animals

WRONG WAY

- Canis Familiaris
- *canis lupus*
- Canis latrans - Coyote
- *Canis lupus*

Common Names

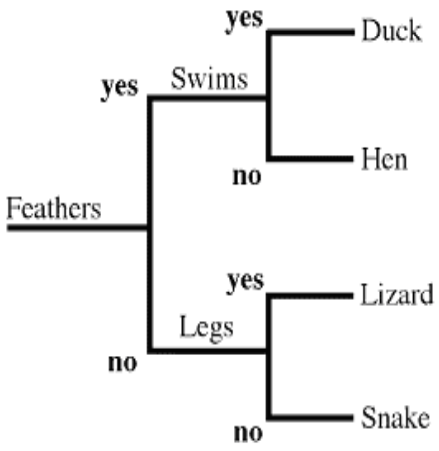
- In addition to scientific names organisms may also be given common names.
- Common names can cause confusion
- Why do you suppose this is?
- Example – Pg 112
  A. Shellfish
  B. Starfish
  C. Jellyfish
  D. Crayfish
  E. Catfish
- Why are these names misleading?

Benefit of Universal Naming

- A universal system of naming allows us to avoid the confusion associated with common names, and tells us something about evolutionary relationships.

Dichotomous Keys

- A tool used by biologists to identify unknown organisms
- Consists of a series of paired comparisons of characteristics used to sort organism into smaller and smaller groups

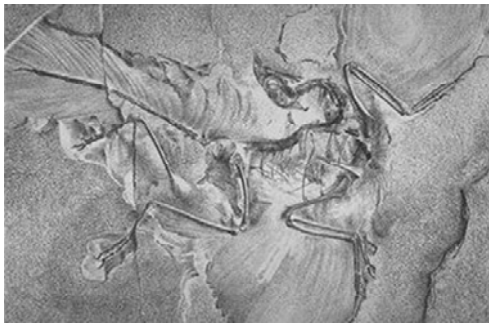


Today's Classification Schemes

- Taxonomists (scientists who name organisms) use a variety of information to classify or group organisms
- The goal of taxonomy is to determine the evolutionary history of organisms
  - This is done by comparing physical characteristics of modern species with past species
- Scientists utilize many techniques to ensure that organisms are classified correctly
- Using these techniques many species have been re-classified after being incorrectly so in the past

Evidence: Fossil Record

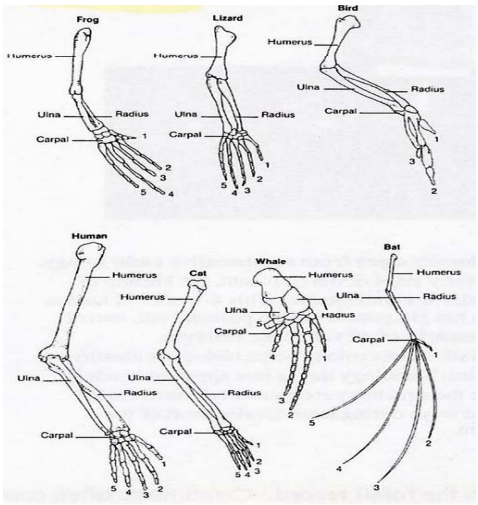
- Using radioactive carbon-14 dating, the age of a fossil can be determined
  - C-14 decays at a known rate, the amount remaining in a fossil can be used to calculate the age
- This evidence shows that major taxa are not as different from each other as they appear



Archaeopteryx shares features with both birds and reptiles. The organism is believed by many to be a modern descendant of birds – That is to say the intermediate between dinosaurs and birds

Evidence: Anatomy

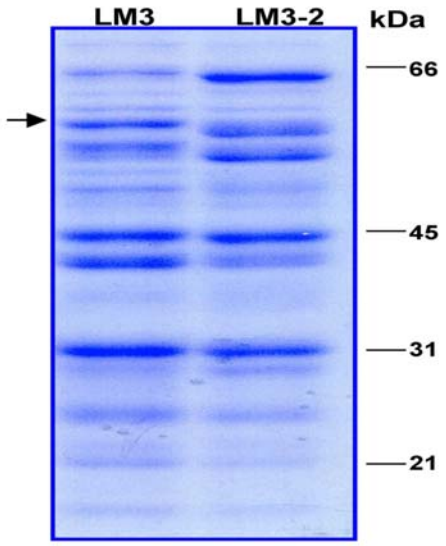
- Comparisons are made between the structures of different organisms
- Bone structures are similar in many species, even though their sizes and proportions have been modified for different modes of transportation



See Fig. 4.9 – pg 114

Evidence: Biochemical

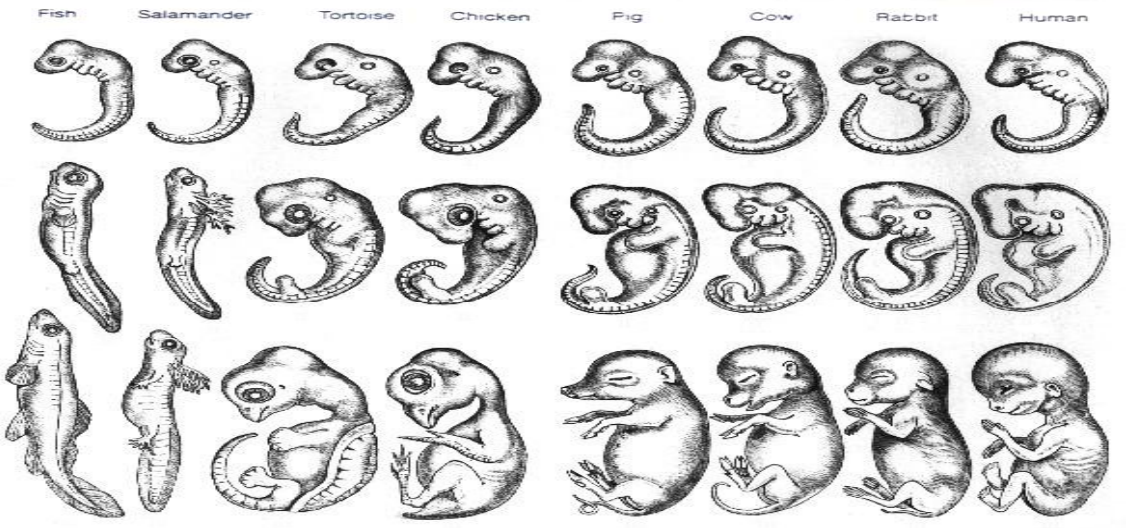
- Many genes are simply instructions for making proteins
- By comparing these genes and finding similarities means that different species may be related since they have the same proteins
- Many species have been reclassified based on their biochemistry
  - Guinea pigs
  - Horseshoe crabs



Evidence: Embryology

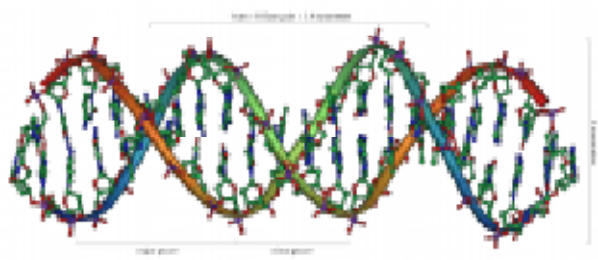
- Comparisons of early embryological development between different species provides evidence as to how closely related they are
- Earnest Haeckel drew embryos of different species for comparison

Haekel's Embryo Drawings



Evidence: DNA / RNA Analysis

- Mixing single strands of DNA from two different species to determine percentage of relationship
- The greater the bonding between complimentary base pairs, the more closely the two are related
- This is done using DNA from the mitochondria because it is passed down from mother to offspring (from the egg)



98% of human – chimp DNA bonds while only 93% of human-macaque monkey DNA bonds

To which species are we more closely related?

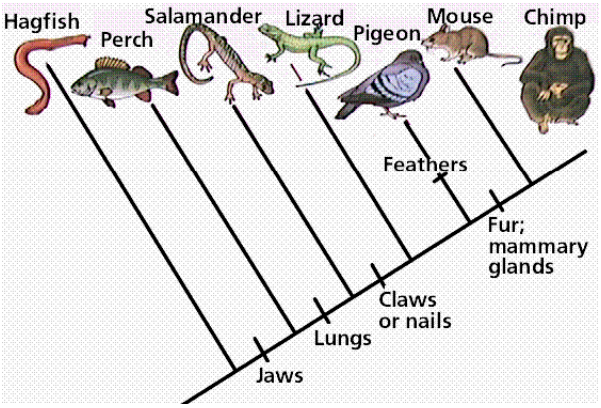
Phylogeny & Cladistics

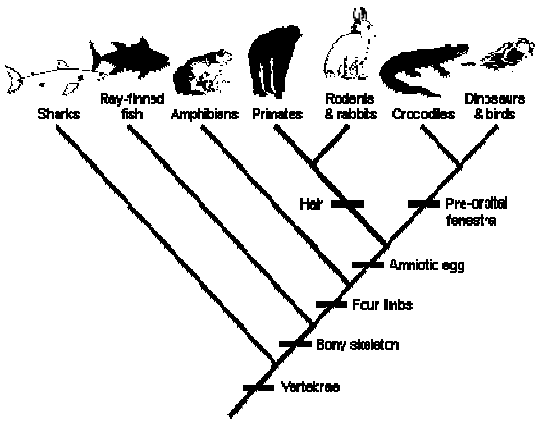
- **Phylogeny –** The whole evolutionary history of a species or other taxonomic group. (Figure 4.14 pg. 116).
  - At the base of the tree is the oldest ancestor
  - Forks in branches represent divergences of new species
  - The top of the tree represents the most recent time, so from the base to the top of a branch is a progression through time.

- **Cladistics –** A classification scheme based on phylogeny and the idea that any one group of related organisms was derived from a common ancestor

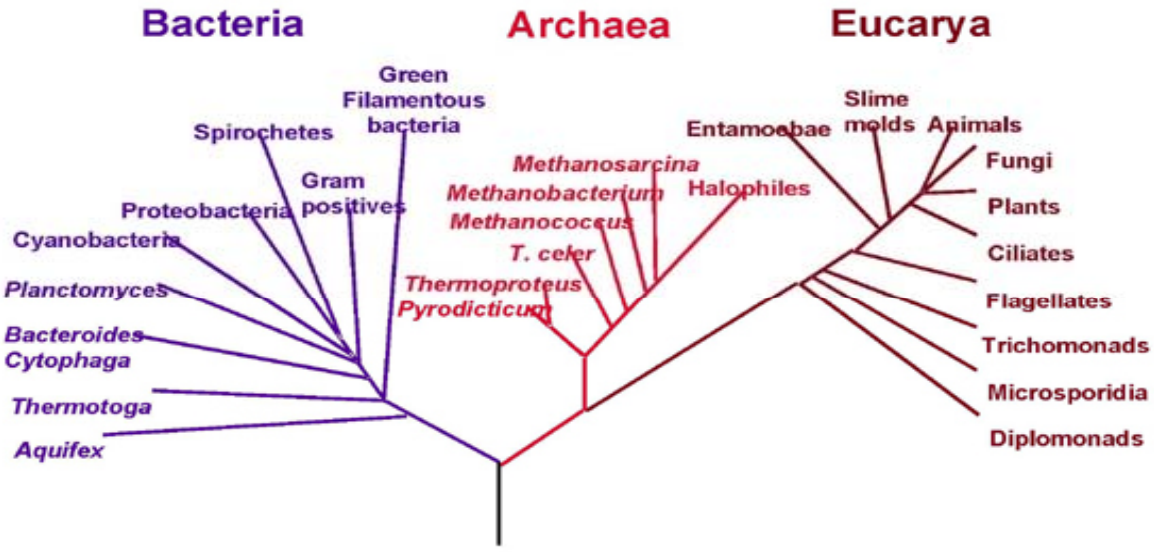
Phylogenetic Trees

Cladogram – A diagram similar to a phylogenetic tree that does not take into account the time of a divergence.



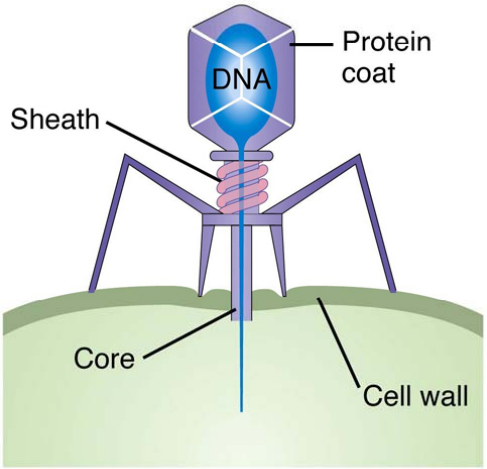


Phylogenetic Tree of Life



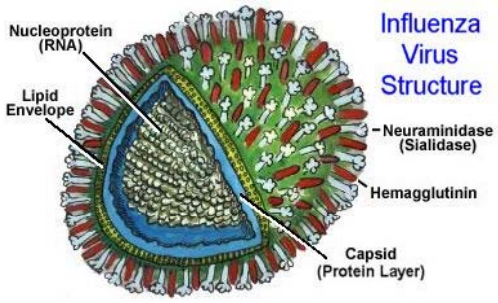
Viruses

- Non-living particles of DNA/ RNA encased in a protein capsid. The capsid helps to protect the virus from the host cell's defensive enzymes, and enables the virus to be more host-specific



Why Viruses are non-living

1. No cell structures
2. No cytoplasm, organelles or cell membranes
3. No cellular respiration



Lytic Cycle (Viral Replication)

A. **ATTACHMENT –** The virus particle must first attach itself to a host cell, generally to a specific receptor site on the cell membrane.

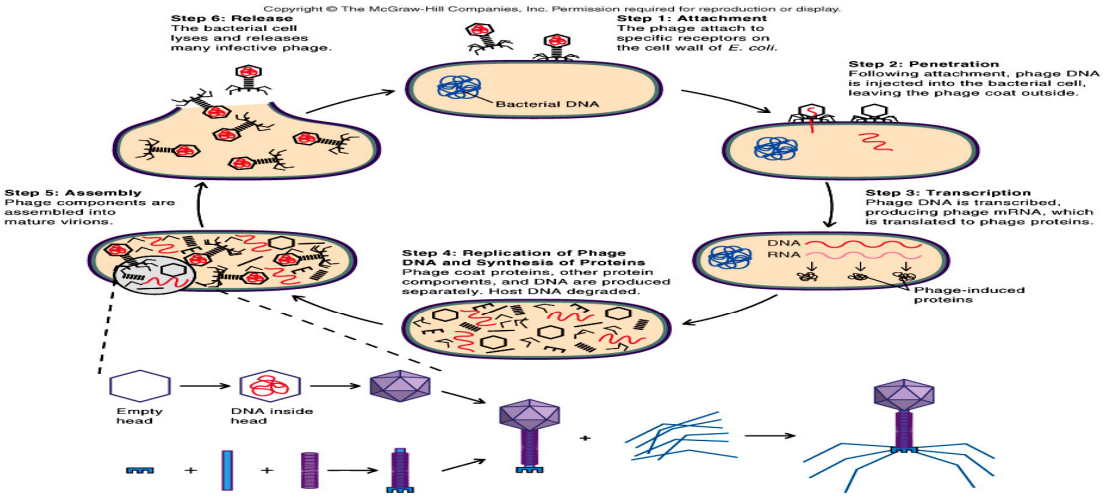
B. **ENTRY –** 2 ways this can happen: Injection of the DNA/RNA into the host cell (T4 virus) OR if the virus in an envelop, it will attach to the cell membrane, and the cell will engulf it, forming a vacuole, which it will break out of releasing DNA/RNA

C. **REPLICATION –** (lytic cycle – cycle of viral replication) The host cell's metabolism replicates (copies) the viral DNA/ RNA

D. **ASSEMBLY -** New virus particles are assembled inside the host cell

E. **LYSIS AND RELEASE -** The host cell breaks (lyses) open releasing the new virus particles

Lytic Cycle Diagram



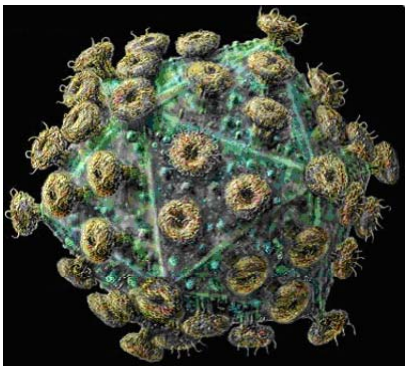
See page 123, figure 4.21 in textbook

Lysogenic Cycle

- **Lysogenic cycle –** Genetic material from the capsid is released into the host cell. The viral DNA becomes part of the host cell's chromosome as a provirus. The provirus remains inactive but is replicated with the host cell DNA. The newly replicated viral DNA may then be used in the assembly of new virus particles, continuing on in the lytic cycle.
- EXAMPLE: Cold Sores – caused by the herpes simplex virus. The sores appear when the virus is destroying cells, and disappear when the virus is in the provirus stage.
- **Virus may remain *dormant* in the provirus phase for years – meaning viral outbreaks may be very rare even though the person carries the virus.**

Retroviruses

- **Retroviruses**
  - Viruses, such as the AIDS, human immunodeficiency virus (HIV)
  - Are able to transcribe a single strand of RNA into double-stranded DNA using an enzyme called reverse transcriptase
  - This DNA is incorporated into host genome, and replicated each time the host cell divides
  - This forms new virus particles, which repeat the process
- Process described in Fig. 4.22, page 124



HIV AIDS Virus Particle
http://www.hhmi.org/biointeractive/disease/animations.html

MORE ON VIRUSES

- T4 viruses may be used by genetic engineers to copy genes that they are using for their research. (Fig. 4.23, page 125)
- DNA/ RNA may be either single stranded or double stranded, and either linear or circular.
- 70% of all viruses are known to be RNA virus, and since RNA replication frequently involves errors, there is a high rate of mutation in RNA viruses