Goal 3

Bio.3.1 Explain how traits are determined by the structure and function of DNA.

Bio.3.2 Understand how the environment, and/or the interaction of alleles, influences the expression of genetic traits.

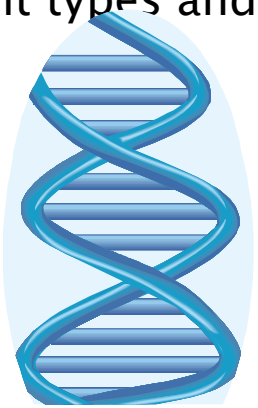
Bio.3.3 Understand the application of DNA technology.

Bio.3.4 Explain the theory of evolution by natural selection as a mechanism for how species change over time.

Bio.3.5 Analyze how classification systems are developed upon speciation.

DNA

- The structure of DNA is a double helix or “twisted ladder” structure.
- The sides are composed of alternating phosphate-sugar groups.
- The “rungs of the DNA ladder” are composed of complementary nitrogenous base pairs (always adenine, A, to thymine, T, and cytosine, C, to guanine, G) joined by weak hydrogen bonds.
- The sequence of nucleotides in DNA codes for proteins, which is central key to cell function and life.
- Replication occurs during the S phase of the cell cycle and allows daughter cells to have an exact copy of parental DNA.
- Cells respond to their environments by producing different types and amounts of protein.



DNA

- Advantages of the overproduction of proteins at the incorrect times: Injury Repair
- Disadvantages of the overproduction, underproduction or production of proteins at the incorrect times:

Protein Synthesis

Process of protein synthesis:

Transcription that produces an RNA copy of DNA, which is further modified into the three types of RNA

mRNA travels to the ribosome (rRNA)

Translation – tRNA supplies appropriate amino acids

- Amino acids are linked by peptide bonds to form polypeptides.
- Polypeptide chains form protein molecules.
- Proteins can be structural (forming a part of the cell materials) or functional (hormones, enzymes, or chemicals involved in cell chemistry).

Protein synthesis

- Interpret a codon chart to determine the amino acid sequence produced by a particular sequence of bases.

First Letter	Second Letter				Third Letter
	U	C	A	G	
U	phenylalanine	serine	tyrosine	cysteine	U
	phenylalanine	serine	tyrosine	cysteine	C
	leucine	serine	stop	stop	A
	leucine	serine	stop	tryptophan	G
C	leucine	proline	histidine	arginine	U
	leucine	proline	histidine	arginine	C
	leucine	proline	glutamine	arginine	A
	leucine	proline	glutamine	arginine	G
A	isoleucine	threonine	asparagine	serine	U
	isoleucine	threonine	asparagine	serine	C
	isoleucine	threonine	lysine	arginine	A
	(start) methionine	threonine	lysine	arginine	G
G	valine	alanine	aspartate	glycine	U
	valine	alanine	aspartate	glycine	C
	valine	alanine	glutamate	glycine	A
	valine	alanine	glutamate	glycine	G

Mutations

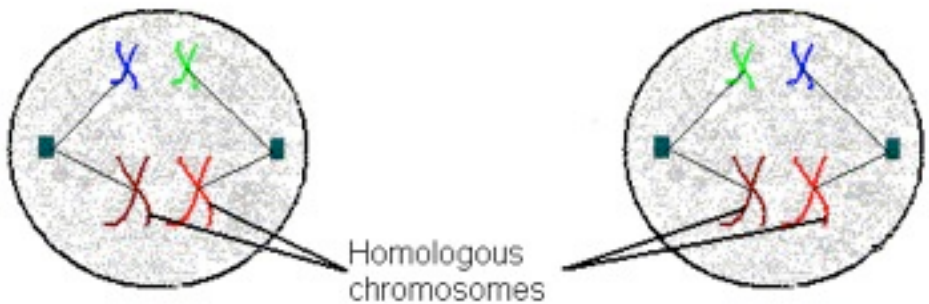
- Mutations are changes in DNA coding and can be deletions, additions, or substitutions.
- Mutations can be random and spontaneous or caused by radiation and/or chemical exposure.
- Describe how mutations change amino acid sequence, protein function, phenotype.
- Only mutations in sex cells (egg and sperm) or in the gamete produced from the primary sex cells

Meiosis

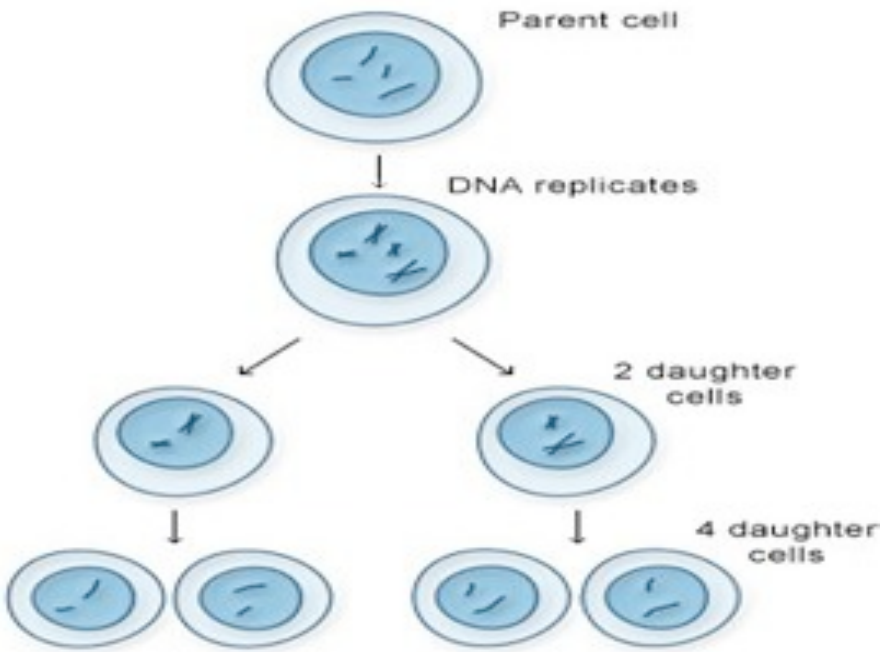
- • Genes are on separate chromosome which allows them to be shuffled in meiosis..
- • The process of meiosis leads to independent assortment and ultimately to greater genetic diversity.
- • Genetic variation in sexually reproducing organisms including
  - Crossing over
  - Random assortment of chromosomes
  - Gene mutation
  - Nondisjunction: failure of chromosomes to separate
  - Fertilization: combination of 2 set of genes.

Random Assortment

- Meiosis is the cell division which takes place to form sex cells (sperm and egg cells).
- In the first metaphase the chromosomes line up in pairs along the equator.
- The random assortment basically means they can line up in any order before they are pulled to either ends of th



Meiosis


Parent cell
DNA replicates
2 daughter cells
4 daughter cells

Mitosis vs. Meiosis

- Asexual Reproduction
- One cell division
- 2 identical cells produced
- Makes body(somatic) cells
- Goes from diploid to diploid
- Chromosome number stays the same.

Mitosis

- Sexual Reproduction
- Two cell divisions
- 4 cells produced
- Makes gametes
- Goes from diploid to haploid (2n to 1n)
- Chromosome number reduced.

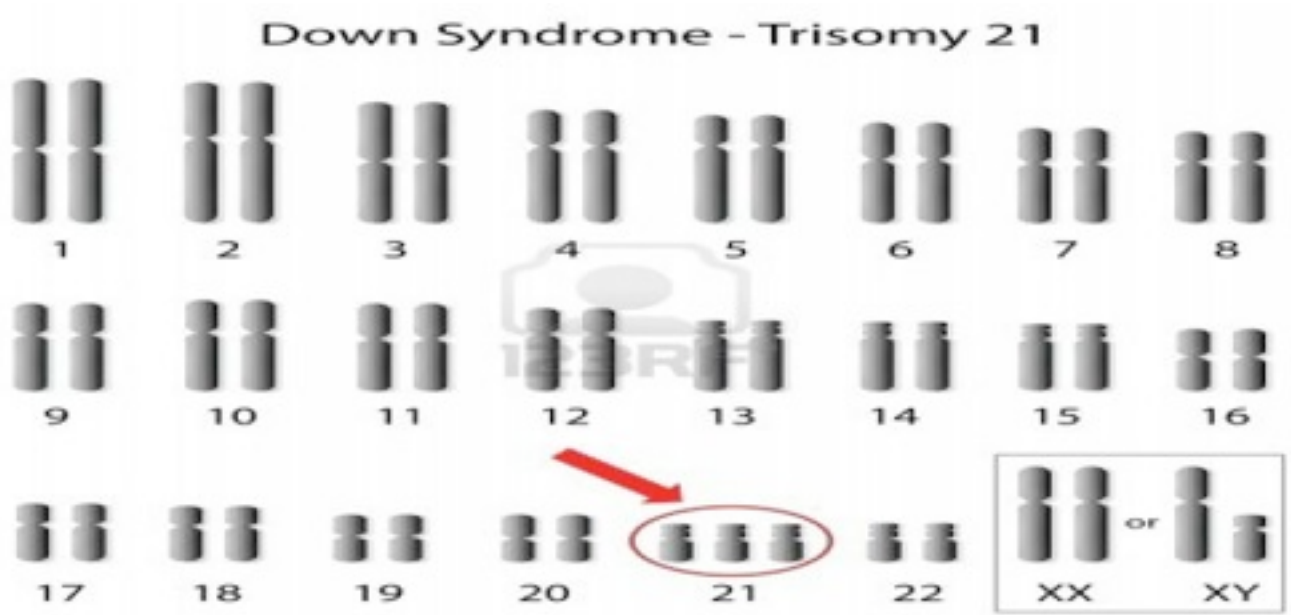
Meiosis

Genetics

- Determine parental genotypes based on offspring ratios. Example: B= brown, b= white If 3 out of the 4 offspring are Brown, what would the parents be?
- Co-dominance: Traits are equally expressed. Example: roan cow or blood types
- Incomplete dominance: Blending of traits ; Example: four o'clock flower
- Polygenic traits are controlled by more than one pair of genes and that this pattern of inheritance is identified by the presence of a

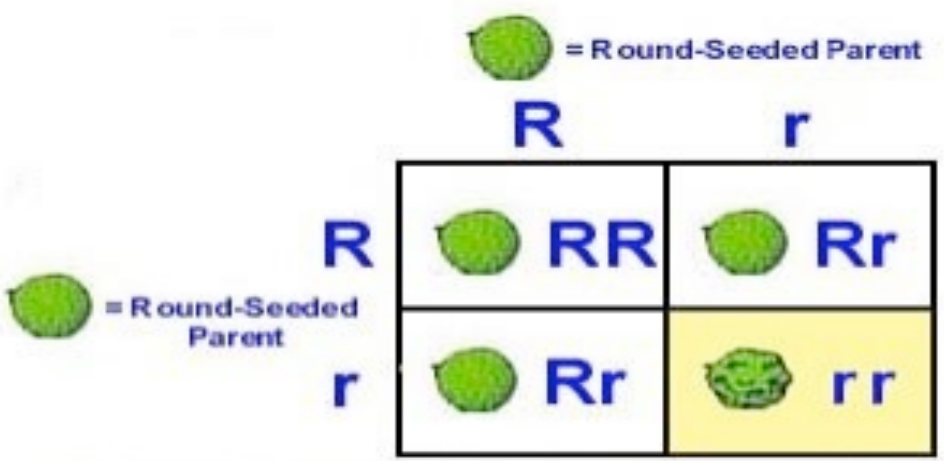
Karyotype

- Look at the 23rd set of chromosomes to see if male or female. If they are the same, it is a female.



Punnett Square

- What is the genotypic(RR:Rr:rr) ratio of the square below?



Punnett Square Showing a Cross of a Heterozygous Round-Seeded Pea with a Heterozygous Round-Seeded Pea Yielding 1/4 Wrinkled-Seeded Offspring

Genetics

- Autosomal inheritance patterns:
  - Sickle cell anemia (incomplete dominance)
  - Cystic fibrosis (recessive heredity)
  - Huntington's disease (dominant heredity).

Sickle Cell

A=normal, a=sickle

AA= normal but can get malaria

Aa= carrier; doesn't have the symptoms of sickle cell anemia and cannot get malaria.

aa= Has sickle cell anemia

If a male with Huntingon's marries a female without it, what would be the chance of their child having it?

Blood Types: Codominant and

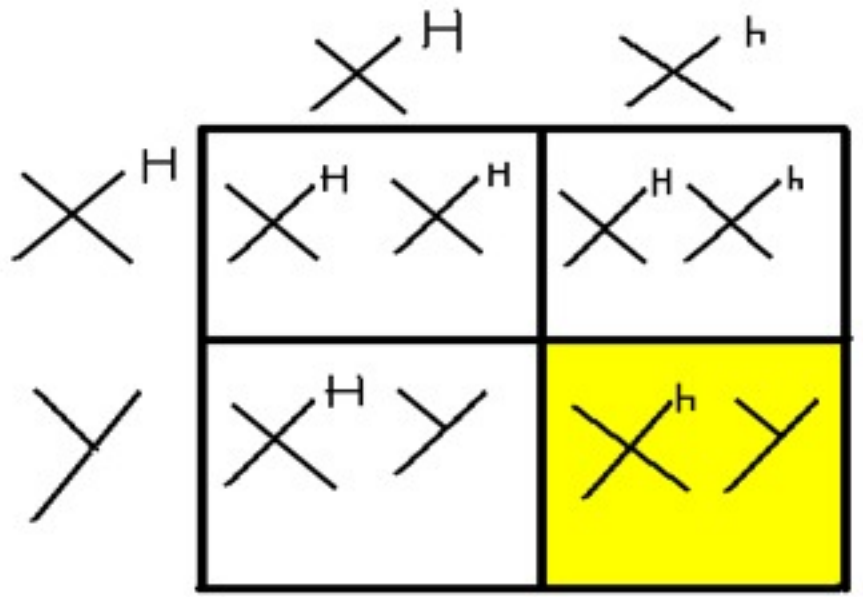
- Solve and interpret codominant crosses involving multiple alleles including blood typing problems.

Blood type	Genotype
A	I^AI^A , I^Ai
B	I^BI^B, I^B i
AB	I^AI^B
O	ii

Can a mom with A blood type and a dad with B blood type have a baby with O blood type?

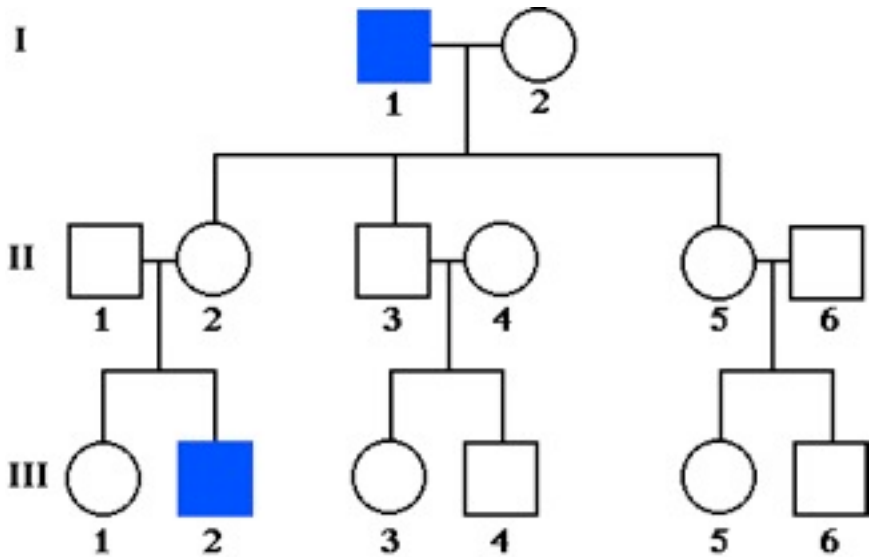
Sex- Linked Crosses

- Color-blindness and hemophilia
- Males are more likely to express a sex-linked trait.
- Sex Linked traits are usually recessive and



Pedigrees

- Males: Squares
- Females: Circles



Pedigree 7. X-linked recessive inheritance.

In this pedigree only number 1 and 2 have the disease. What is the genotype of person II 2?

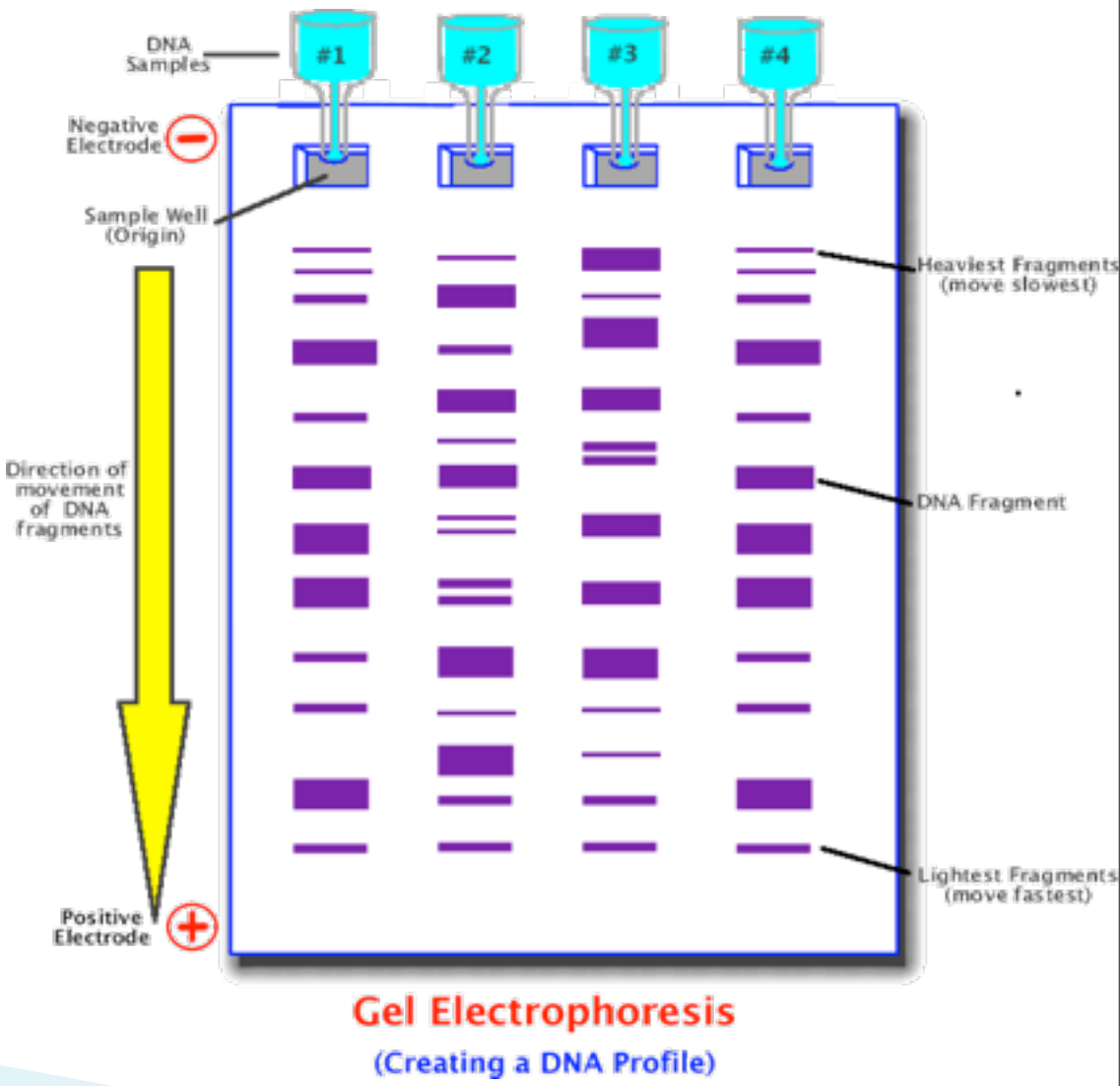
Relationship between environmental factors and expression of a particular genetic trait.

- lung/mouth cancer – tobacco use
- • skin cancer – vitamin D, folic acid and sun exposure
- • diabetes – diet/exercise and genetic interaction
- • PKU – diet
- • heart disease – diet/exercise and genetic

Gel electrophoresis

The general steps of gel electrophoresis –

- use restrictions enzymes to cut DNA into different sized fragments
- run those fragments on gels with longer



Transgenic and transformation

- Transgenic organisms (plants, animals, & bacteria) are used in agriculture and industry
  - pharmaceutical applications such as the production of human insulin.
- The steps in bacterial transformation
  - insertion of a gene into a bacterial plasmid,
  - getting bacteria to take in the plasmid

Ethical Issues

- Identify the reasons for establishing the Human Genome Project.
  - Identify the sequence of DNA on a human's chromosome.
  - The project is useful in determining whether individuals may carry genes for genetic conditions and in developing gene therapy.
- • Gene therapy: Using viral factors to transfer the correct gene to a patient
  - Used to treat: Severe Combined Immunodeficiency and Cystic Fibrosis
- • Critique the ethical issues and implications of

Evidence of evolution

- Hypothesized early atmosphere and experiments that suggest how the first “cells” may have evolved and how early conditions affected the type of organism that developed
  - Oparin’s hypothesis: organic soup model; tested by Miller
- Steps of evolution
  - first anaerobic and prokaryotic
  - then photosynthetic
  - then eukaryotic
  - then multicellular
- Fossil evidence informs our understanding of the evolution of species and what can be inferred from this evidence.
- • Biochemical (molecular) similarities tell us what organisms have similar ancestors.

Natural selection

- Cause and effect model for the process of natural selection:
  - Species have the potential to increase in numbers exponentially.
  - Populations are genetically variable due to mutations and genetic recombination.
  - There is a finite supply of resources required for life.
  - Changing environments select for specific genetic phenotypes.
  - Those organisms with favorable adaptations survive, reproduce and pass on their alleles.
  - The accumulation and change in favored alleles leads to changes in species over time.

Geographic isolation can cause speciation.

Resistance

- Develop a cause and effect model for the role of disease agents in natural selection including evolutionary selection of resistance to antibiotics and pesticides in various species, passive/active immunity, antivirals and vaccines.

Resistance

1. Passive immunity: transfer of immunity from one organism to another.
    1. Mother to child
    2. Vaccines: dead or live viruses injected into an animal
    3. Body recognizes pathogens and is ready to kill it.

2. Active immunity: A type of immunity or resistance developed in an organism by its own production of antibodies in response to an exposure to an antigen, a pathogen or to a vaccine.

3. [illegible]rals and vaccines.

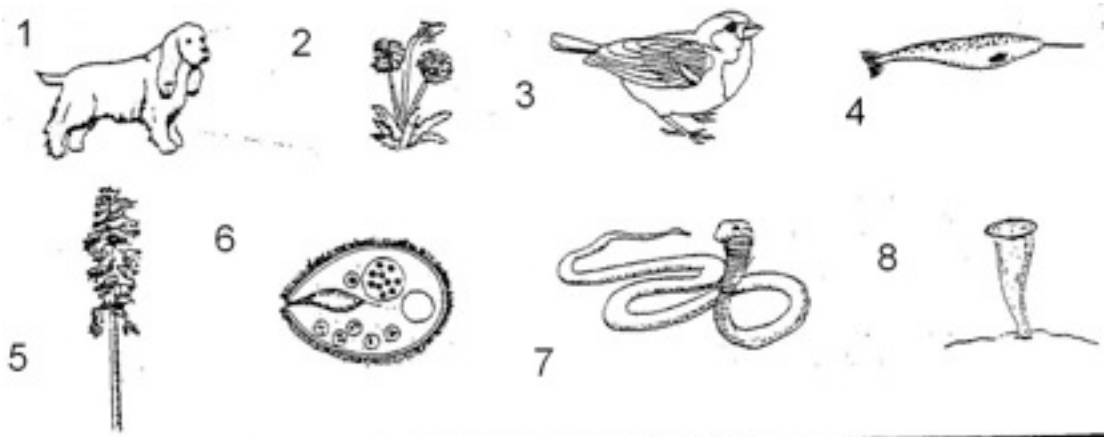
Classification

- Classification is constantly changing based on new knowledge generated by research on evolutionary relationships and the history of classification system.
- Currently Seven levels: kingdom, phylum, class, order, family, genus, species
- Currently 3 domains and 6 kingdoms:

Classification

What is the name of organism #6?

Always start with 1a for each organism.



1a. organism with two or four functional legs . . . go to **2**
1b. organism without two or four legs . . . . . go to **3**

2a. organism without wings . . . . . *Canis familliaris* . . . . . .dog

2b. organism with wings . . . . . *Passer domesticus* . . . . . .house sparrow
3a. organism is unicellular . . . . . go to **4**
3b. organism is multicellular . . . . . go to **5**

4a. organism swims freely in water . . . . . *Balantidium* sp. . . . . .balantidium

4b. organism anchored to substrate . . . . . *Stentor* sp. . . . . .stentor
5a. organism is heterotrophic . . . . . go to **6**
5b. organism is autotrophic . . . . . go to **7**

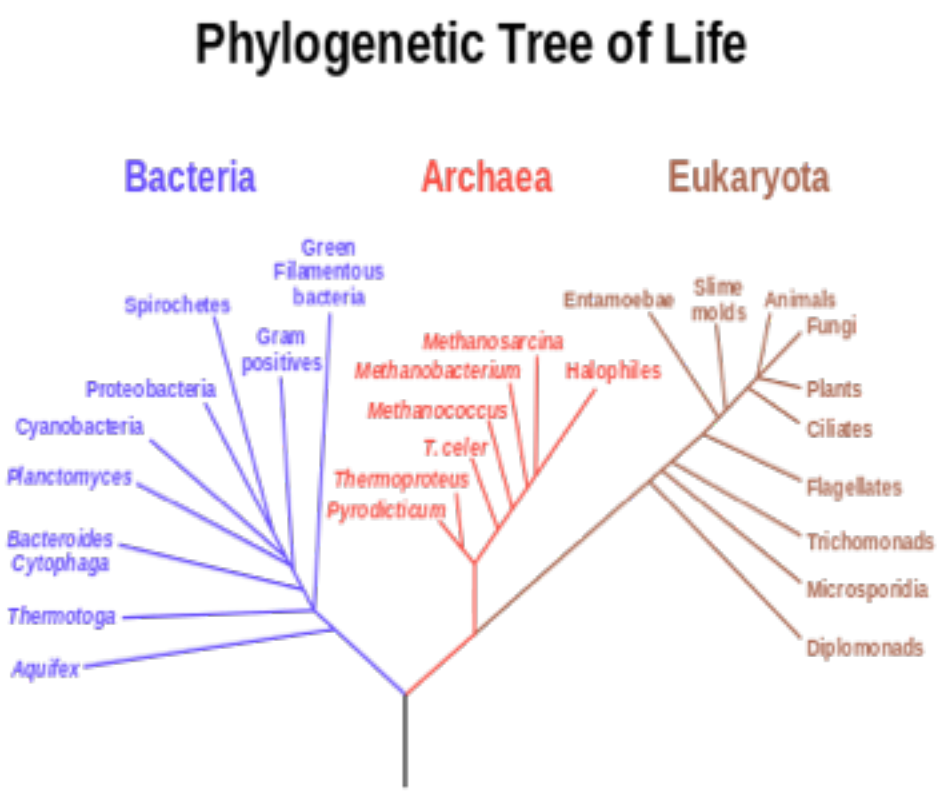
6a. organism lives in oceans . . . . . *Monodon monoceros* . . . . .narwhal

6b. organism lives on land . . . . . *Ophiophagus hannah* . . . .king cobra

7a. organism is a tree . . . . . *Pinus ponderosa* . . . . . .ponderosa pine

7b. organism is an herb . . . . . *Taraxicum officinale* . . . . .dandelion

Phylogenetic Tree



Use the tree to find relationships and evolution.

Are fungi more closely related to an animal or to a slime mold?