

## AP Summer Assignments 2020

Welcome to AP Biology! I'm excited you have decided to take this course. Please find below the assignments for this summer. You will be tested during the first week of class on Part I and Part II. **ALL assignments** are due on the first day of class. **I recommend that you study your quiz questions from Part I and Part II for your test when you return to school in August.**

**Please join the 2020-2021 AP Biology Google Classroom to submit your summer assignment.**

**Class code: d2gus3y**

### Part I: Introduction to Biochemistry

**Follow each link to watch the video and answer the questions that correspond.**

<https://www.youtube.com/watch?v=QMRU7PUNusA>

1. Living matter is made up of many different elements, but 96% of all living matter is comprised of just a few. Which element below is part of this 96%?

- A. iodine
- B. phosphorus
- C. iron
- D. nitrogen

2. Which of the following statements best describes trace elements?

- A. Trace elements are found in very small quantities in cells but still play a critical role in the functioning of living organisms.
- B. Trace elements are only found in some living organisms, but not all of them.
- C. Trace elements are present in living organisms in small amounts and have no special role in the function of cells.
- D. Trace elements are elements that are found in small quantities in nature and living organisms uptake them to improve the condition of the environment.

<https://www.youtube.com/watch?v=bzaVL4jYmGA>

3. Water has unique properties that allow it to support life. Which of the following best describes this?

- A. Water is a non-polar molecule because oxygen and hydrogen share electrons equally, which allows for hydrogen bonding.
- B. Water is a polar molecule because oxygen and hydrogen form polar covalent bonds, which allows for hydrogen bonding.
- C. Water covalently bonds with other water molecules, which is the strongest form of bonds.
- D. Water forms ionic bonds with other water molecules, which allows it to break bonds easily.

4. Which statement best describes hydrogen bonding?

- A. a covalent bond that occurs when an negatively charged oxygen donates an electron to a positively charged hydrogen
- B. an ionic bond that occurs when a hydrogen shares its lone electron with an oxygen or nitrogen
- C. an attractive force between the partial positive charge on a hydrogen and a partial negative charge on an oxygen or nitrogen
- D. an attractive force between the partial negative charge on a hydrogen and a partial positive charge on an oxygen or nitrogen

<https://www.youtube.com/watch?v=kGrYheDLiuk>

**CORRECTION TO CONTENT** (at approximately 4:25 in video)

**cis-** meaning "on this side" - molecules in the *cis*- configuration have substitutions on the same side of the double bond. This gives them a **bent** structure.

**trans-** meaning "on the other side" - molecules in the *trans*- configuration have substitutions on opposite sides. This gives the hydrocarbon an almost **linear** structure.

5. Carbon can form up to four covalent bonds because --

- A. It has four valence electrons.
- B. It is a polar molecule.
- C. it bonds to hydrogens, which are small.
- D. it has a greater electronegativity than most other elements.

6. Isomers have the \_\_\_\_ chemical formula, \_\_\_\_ chemical structures and \_\_\_\_ biological functions.

- A. different, different, same
- B. same, different, different
- C. same, different, same
- D. different, same, same

<https://www.youtube.com/watch?v=ieToMWPAPt8>

7. Which functional group is used in stabilizing three-dimensional structures of proteins by forming covalent bonds?

- A. sulfhydryl
- B. amino
- C. carboxylic acid
- D. carbonyl

8. Which of the following is the correct functional group for alcohols?

- A. -COOH
- B. -CH<sub>3</sub>
- C. -OH
- D. -SH

9. Major components of organic compounds such as fats, phospholipids and fossil fuels consist of hydrocarbons.

Hydrocarbons are molecules that are made of

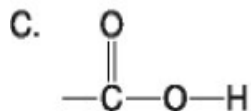
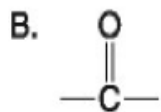
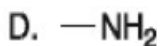
- A. hydrogen and carbon atoms.
- B. hydrogen, oxygen and carbon atoms.
- C. water molecules and carbon atoms.
- D. hydrogen, carbon and nitrogen atoms.

10. All living organisms have common organic compounds that perform many of life's functions. All organic compounds are made of atoms and elements. Which of the following is the most complete list of elements common to all organic life?

- A. helium, calcium, carbon and potassium
- B. hydrogen, carbon, oxygen, phosphorus and nitrogen
- C. hydrogen and carbon
- D. potassium, hydrogen, calcium and phosphorus

**Use the following information for the next 2 questions.**

11. Functional groups are specific groups of atoms that retain their chemical behavior regardless of the size of the molecule to which they are attached. They play critical roles in the chemistry of the cell. Use the diagrams below to answer the questions that follow.



12. Which of the functional groups above would be found in an ethanol molecule?

- A. A
- B. B
- C. C
- D. D
- E. E

13. Which group is a carboxyl functional group?

- A. A
- B. B
- C. C
- D. D
- E. E

14. Enantiomers are possible because carbon can form 4 bonds. Which of the following best describes enantiomers?

- A. compounds with the same covalent partnerships that differ in spatial arrangements of atoms
- B. compounds that are mirror images of each other
- C. compounds that have the same molecular formula but differ in the covalent arrangement of atoms
- D. compounds that have a different formula but the same covalent arrangement

15. Lipids are considered \_\_\_\_ because they do not interact with water. Carbohydrates and salts are considered \_\_\_\_ because they do interact with water.

- A. polar covalent, ionic
- B. nonpolar, hydrophobic
- C. hydrophobic, hydrophilic
- D. polar, nonpolar

<https://www.youtube.com/watch?v=HBmSYkHcdVs>

16. How can certain animals extract energy and nutrients from cellulose?

- A. cellulose is made from alpha glucose monomers and they have the enzyme to break it down
- B. cellulose is made from beta glucose monomers and they have a symbiotic relationship with bacteria to break it down
- C. cellulose is not digestible for an organism, it is only insoluble fiber
- D. cellulose is a protein made up of amino acids which are used to make proteins for the cell

17. Which of the following is a monosaccharide?

- A. glutamic acid
- B. tyrosine
- C. glucose
- D. adenosine

<https://www.youtube.com/watch?v=RBpl3UlyXas>

18. One unifying property of lipids is

- A. They have double bonds between carbon.
- B. They are steroids and are used for communication.
- C. They are hydrophobic and nonpolar.
- D. They are hydrophilic and polar.

19. Nucleotides are joined together in a phosphodiester bond by

- A. hydrolysis.
- B. oxidation-reduction.
- C. combustion.
- D. dehydration synthesis.

<https://www.youtube.com/watch?v=X0pPNdXpIO4>

20. The primary structure of a protein is

- A. the hydrogen bonds formed between amino and carboxyl groups.
- B. the sequence of amino acids as dictated by the gene.
- C. the association of several polypeptide chains forming an active protein.
- D. the R-group interactions giving the polypeptide a specific 3D structure.

21. What is the quaternary structure of a protein?

- A. the sequence of amino acids
- B. the initial folding into alpha helices or beta sheets
- C. the folding of one amino acid chain into a functional protein
- D. the interaction between multiple subunits to form one functional protein

22. Inside cells, small organic molecules are joined together to form larger molecules. Which of these correctly pairs a monomer to the polymer it can form?

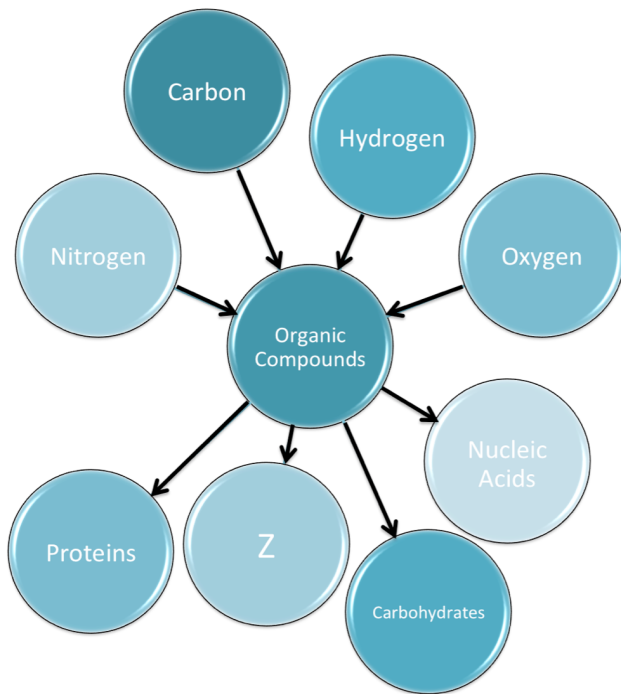
- A. glucose - starch
- B. amino acid - nucleic acid
- C. phospholipid - fatty acid
- D. ribosome - protein

23. Lactose, a sugar in milk, is composed of one glucose molecule and is linked to one galactose molecule. how is lactose classified?

- A. as a pentose
- B. as an enzyme
- C. as a monosaccharide
- D. as a disaccharide

24. Check the boxes next to all of the TRUE statements about enzymes.

- A. Enzymes are proteins.
- B. Enzymes are made of polypeptide chains.
- C. Enzymes have generic shapes to allow for the use with many different substrates.
- D. Enzymes are not reusable, they are destroyed after they bind to the substrate.
- E. Enzymes lower the amount of energy that is needed in order for a reaction to occur.

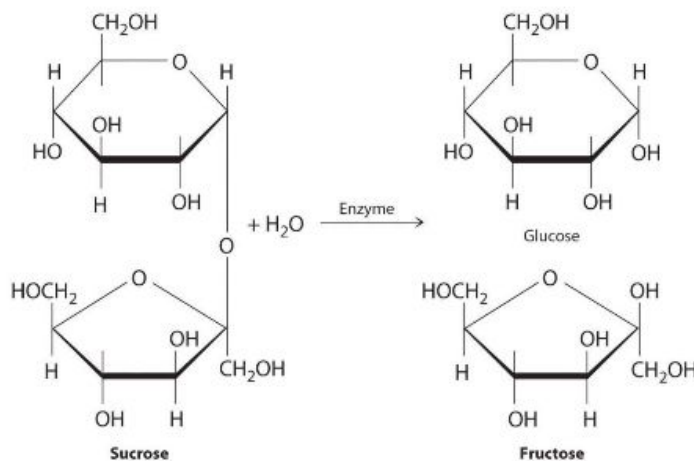


25. What substance could be represented by the letter Z in the diagram above?

- A. water
- B. nucleotide
- C. lipid
- D. amino acid

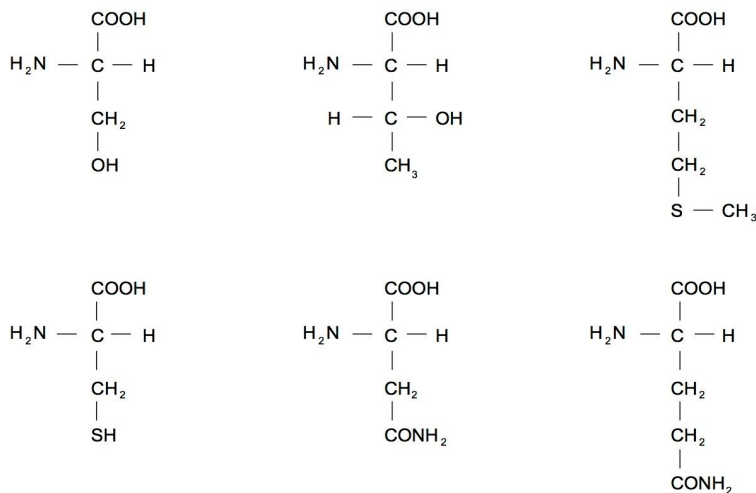
26. Proteins consist of polypeptides folded in a specific formation. Amino acids are the monomers of proteins. The organic molecules of amino acids have both carboxyl and amino groups. The center carbon is known as the alpha carbon. Four different components attach to the alpha carbon including the R group. The different R groups make up the 20 different amino acids. The physical and chemical properties of each different R group give the unique characteristics of the particular protein. All of the following molecules below contain amino acids except...

- A. enzymes.
- B. antibodies.
- C. keratin.
- D. steroids.



27. In the illustration to the left, what type of reaction is shown for this process?

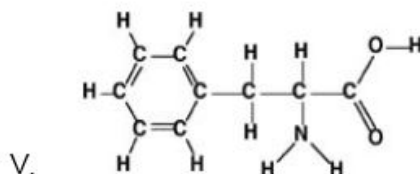
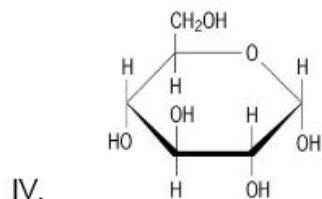
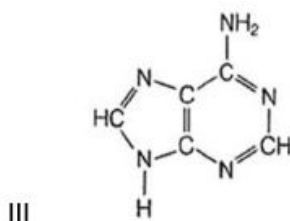
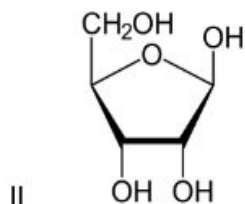
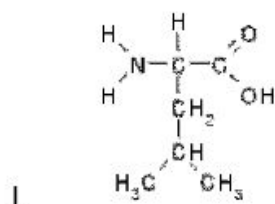
- A. hydrolysis
- B. dehydration synthesis
- C. absorption
- D. digestion



28. A sample of amino acids is shown above. The number and arrangement of the functional groups in the amino acids help give each molecule its unique properties. Which of the following describes the properties of the functional groups contained in the amino acid?

- A. The amine group acts as a base and the carboxyl group acts as an acid.
- B. The amine group makes it polar and the carboxyl group causes a release of energy.
- C. The amine group acts as an acid and the carboxyl group acts as a base.
- D. The amine group stabilizes the molecule and the carboxyl group makes it polar.

Use the diagrams to answer questions 29 and 30.



29. Which of the following molecules utilize a peptide bond to form a dipeptide molecule?

- A. I and II
- B. II and IV
- C. III and V
- D. I and V

30. Which of these correctly illustrates the building blocks of a starch molecule?

- A. III only
- B. IV only
- C. II and IV
- D. I and V

Refer to the passage and the chart below to answer questions 31 and 32.

Proteins from different areas in the digestive system are collected during an investigation; each is isolated and placed in a separate beaker containing water. The undisturbed solutions are incubated at 38 degrees C for three hours. After the incubation period, the contents of each beaker are analyzed and the results are recorded in the table below.

Location	Substance in Beaker	Results after 3 hours
stomach	mucus	large polypeptide
stomach	pepsin	smaller polypeptide
duodenum	trypsin	tripeptides
duodenum	chymotrypsin	4-peptide fragments

31. Which of the following substances exhibits no enzymatic activity?

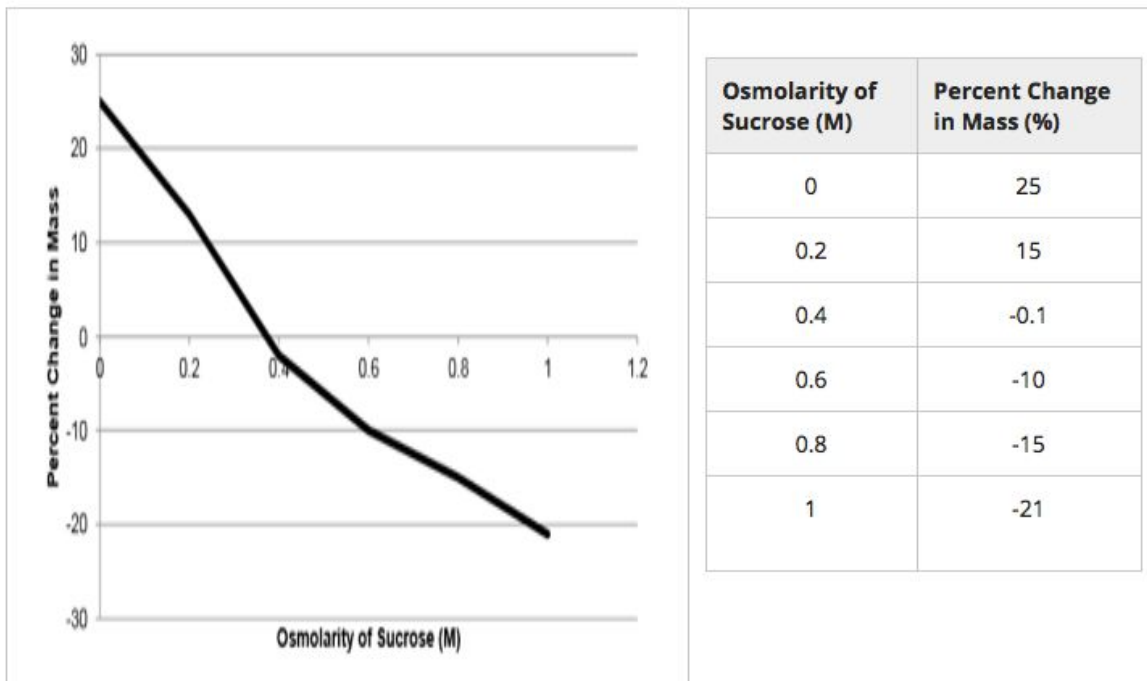
- A. chymotrypsin
- B. mucus
- C. pepsin
- D. trypsin

32. Which of the following best explains how a polypeptide can be broken down into amino acids?

- A. The covalent bonds between the carboxyl group and amino group of 2 amino acids release water.
- B. Water surrounds the polypeptide resulting in changes to the surface of the protein.
- C. As a peptide bond breaks in polypeptide, a hydrogen ion is added to one section and a hydroxyl group is added to the other section.
- D. Water stabilizes the ions that result from the breaking of the peptide bond enabling the water to surround the ions in an orderly fashion.

**Use the information below to answer question 33.**

Carrots measuring 2 cm in length were massed and placed into a series of beakers containing sucrose solutions of increasing osmolarity at room temperature. The carrots were allowed to sit in the sucrose solutions for 24 hours. After 24 hours, the carrots were removed from the solution, blotted dry, and massed again. Data were collected and a percentage change in mass was calculated. The data were then plotted on a graph, shown below.



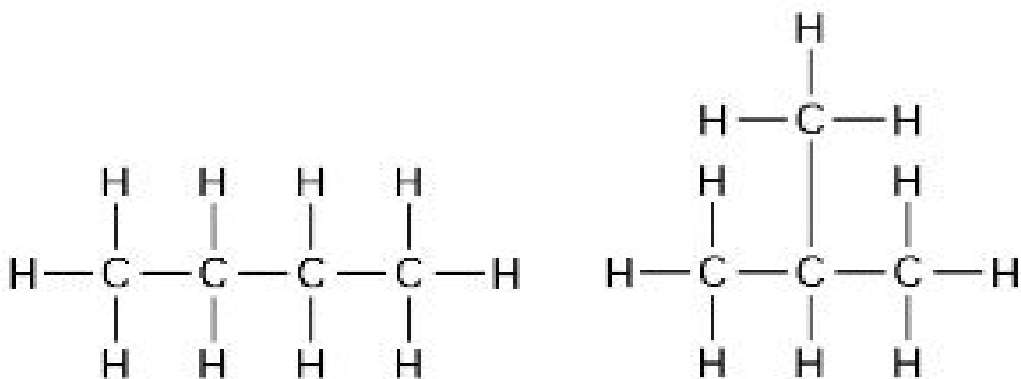
33. Which of the following conclusions can be reached by interpreting the data shown above?

- A. Active transport of sucrose was occurring in the carrot cells at around 0.4M sucrose.
- B. There is more sucrose in the environment around the carrots after 0.4M sucrose, and this caused sucrose to move into the carrot cells.
- C. The carrots were gaining water when they were placed into the 0.6M sucrose solution.
- D. There was no net movement of water into or out of the carrot cells at around 0.38M sucrose.



34. Patients who await organ transplants are often kept waiting because they do not have a donor who is a match. What component of the donor's cell membranes must match that of the recipient's in order to have a compatible organ for transplant?

- A. integral proteins
- B. channel proteins
- C. glycoproteins
- D. phospholipids



35. Molecules with multiple carbons can form up to four bonds per carbon. If carbon is double bonded, the structure is going to be three dimensional. This three dimensional shape determines the function. The two molecules shown above are best described as...

- A. optical isomers.
- B. enantiomers.
- C. structural isomers.
- D. cis-trans isomers.

**Use the following information to answer question 36.**

A student was conducting an experiment on the effect of salt solutions of increasing osmolarity on the behavior of *Amoeba*. The student was able to observe *Amoeba* in culture and recorded these data.

Osmolarity of Salt Solution (mM)	Contractions per Minute
0	125
0.1	100
0.2	89
0.3	71
0.4	56
0.5	37

36. Which of the following research questions was the student likely attempting to answer when performing the experiment?

- A. Does increasing osmolarity increase the rate of active transport of water out of Amoeba cells?
- B. Does increasing osmolarity decrease the rate of active transport of water out of Amoeba cells?
- C. Does increasing osmolarity increase the rate of passive transport of water out of Amoeba cells?
- D. Does increasing osmolarity decrease the rate of passive transport of water out of Amoeba cells?

**Use the information and the table below to answer questions 37-39.**

A biologist studies the organelles located in four human cells. The presence (+) or absence (-) of an organelle is indicated in the table below. A blank does not signify the presence or absence of an organelle; it only refers to its lack of importance when comparing it to the other cells.

Cell	Golgi Complex	Lysosome	Mitochondria	Rough ER	Nucleus
A		++	+		+
B			-		-
C		++			+
D	+		+	++	+

37. Which cell is most likely to be found in the cardiac muscle of the heart?

- A. cell A
- B. cell B
- C. cell C
- D. cell D

38. Which of the following cells would be constituents of blood?

- A. cell A only
- B. cell B only
- C. cells B and C
- D. cells C and D

39. Which cell would most likely produce and secrete proteins?

- A. cell A
- B. cell B
- C. cell C
- D. cell D

## Important Vocabulary Terms from Part I:

**Acid-** hydrogen donors; acids increase the hydrogen ion concentration in solution

**Adhesion-** the attraction between water molecules and other molecules

**Alpha (  $\alpha$  ) helix-** secondary protein structure resulting from stabilizing hydrogen bonds in the protein backbone; shaped like a coil or helix

**Amino acids-** a compound consisting of an amino group, a carboxyl group, and a side chain; the building blocks of protein

**Base-** hydrogen acceptors; bases decrease the hydrogen ion concentration in solution

**Beta (  $\beta$  ) pleated sheet-** a secondary protein re-structure resulting from stabilizing hydrogen bonds in the protein backbone; shaped like a sheet with some twists

**Biological molecules-** any molecule produced by living organisms; includes four macromolecules: protein, lipids, polysaccharides, and nucleic acids

**C-terminus-** the side of a peptide chain/protein that ends in a carboxyl group

**Carbohydrates-** a compound consisting of carbon, hydrogen, and oxygen

**Cellulose-** a polysaccharide consisting of C<sub>6</sub>H<sub>10</sub>O<sub>5</sub> units bonded together; found in the cell walls of plants

**Chaperones-** a type of protein that assists in the folding of other molecules

**Chitin-** polymer consisting of C<sub>8</sub>H<sub>13</sub>O<sub>5</sub>N units; found in cell walls of fungi, crustacean shells, and other places.

**Cis-** in cis/trans isomerism, cis refers to the case when the substituent groups are oriented on the same side

**Cohesion-** intermolecular forces between water molecules caused by the polar nature of water; responsible for surface tension

**Dehydration synthesis-** refers in organic chemistry in which two molecules are bound together and an H<sub>2</sub>O is removed from the compound

**Denaturation-** a process in which the secondary and tertiary structures of a protein fall apart due to a change in conditions; this can be a pH out of normal conditions, extreme temperatures, or other factors

**Deoxyribonucleic acid-** DNA- consists of a nucleic base, a deoxyribose (sugar), and a phosphate group. Acts as genetic information storage

**Disaccharides-** sugars consisting of two monosaccharides bonded together

**Electronegativity-** describes the ability of an atom or functional group to attract electrons

**Enantiomer-** a case of stereoisomerism in which two molecules form mirror images of each other

**Ester linkage-** the bond between a fatty acid and a glycerol that forms a lipid

**Evaporative cooling-** reduction of temperature that results from evaporation of liquid; as the liquid evaporates, it removes heat from the surface on which the evaporation is occurring

**Functional group-** group of atoms that provides a specific function to a carbon skeleton

**Geometric isomer-** isomer that differs in the placement of groups around a double bond; cis/trans isomerism

**Glycogen-** polysaccharide used as a way to store carbohydrates. Forms glucose on hydrolysis

**Glycosidic bond-** bond formed by a dehydration reaction between two monosaccharides

**Hydration shell-** refers to a specific "solvation shell" case; water acts as a solvent and dissolves a solute. When this happens, the solute becomes surrounded by water molecules and these water molecules form a "hydration shell"

**Hydrocarbon-** a molecule consisting of only hydrogens and carbons

**Hydrolysis-** "water cutting"; reaction in which water is added to break a bond

**Hydrophilic-** "water loving"- polar or charged molecules that interact well with water

**Hydrophobic-** "water fearing" - nonpolar uncharged molecules that do not interact well with water

**Lipids-** class of macromolecules including fats and steroids; Generally nonpolar and insoluble in water

**Messenger RNA-** mRNA- RNA that is sent to ribosomes for translation in order to produce proteins

**MicroRNA-** miRNA- small noncoding RNA segments that have a role in gene regulation (interrupting other mRNA messages)

**Molarity-** unit of concentration; moles solvent/liters solution

**Monomers-** a molecule that can act as a unit that bonds to other monomers to form a larger molecule called a polymer

**Monosaccharides-** a basic carbohydrate unit; a carbohydrate monomer

**N-terminus-** the side of a peptide chain/protein that ends in an amino group

**Nucleotide-** monomer of a nucleic acid; consists of a pentose sugar, a nitrogenous base, and one or more phosphate groups

**Omega fatty acids-** type of polyunsaturated fat that is required by the body; the numbering of the carbon omega starts from the methyl end (end farthest from carboxylic end)

**Organic molecule-** any molecule containing carbon

**Peptide bond-** bond formed between two amino acids by a dehydration reaction

**pH-** a number that refers to the acidity of a solution; 7 is neutral, lower than 7 is acidic, higher than 7 is basic

**Phospholipids-** major constituent of membranes; two fatty acids and a phosphate containing group attached to a glycerol backbone

**Phosphodiester linkage-** covalent bonds between phosphate group and carbon rings that join together a polynucleotide

**Polar covalent bond-** type of covalent bond in which the electrons are shared unequally; this results in a partially positive side and a partially negative side

**Polymers-** a molecule made up of smaller monomer units

**Polysaccharides-** a carbohydrate polymer made of many smaller carbohydrates

**Primary structure-** refers to the order and composition of amino acids in a peptide chain

**Proteins-** biological macromolecule composed of amino acids

**Purine-** type of nitrogenous base in DNA and RNA (adenine and guanine)

**Pyrimidine-** type of nitrogenous base in DNA and RNA (cytosine, thymine, and uracil)

**Quaternary structure-** refers to the association of discrete polypeptide subunits in a protein

**R-groups-** a side chain attached to an amino acid; the R group determines the identity of the amino acid and may give the amino acid additional properties (positive/negative charge or acid/base activity)

**Ribonucleic acid-** RNA- a single strand of nucleic acids that have several different functions within the cell. All the different functions are carried out by specific types of RNA and are named according to their functions.

**Ribosomal RNA- rRNA-** RNA used to ensure proper alignment of mRNA and ribosomes during translation; catalyzes formation of peptide linkage

**Saturated fatty acids-** a fatty acid that has no double bonds along the hydrocarbon chain; this means the number of hydrogen atoms attached to the carbon backbone is maximized or “saturated”

**Secondary structure-** refers to shapes formed by hydrogen bonding along the peptide chain; forms alpha helices and beta-pleated sheets

**Solute-** the dissolved part of a solution; the smaller part

**Solution-** a uniform mixture composed of one phase; consists of solvent and solutes

**Solvent-** a substance that can dissolve other substances

**Starch-** storage carbohydrate in plants

**Steroids-** type of lipid composed of four fused hydrocarbon rings in a planar structure

**Structural isomer-** molecules that have same chemical formula but different arrangement; different "structure"

**Substituted hydrocarbon-** a molecule consisting of hydrogens, carbons, and another atom or functional group replacing a hydrogen

**Surface tension-** created by attractive cohesive forces between molecules of a liquid; prevents molecules from separating at the surface

**Tertiary structure-** refers to the overall 3D structure of a protein and how it folds

**Trans-** in cis/trans isomerism, trans refers to the case when the substituent groups are oriented on opposite sides

**Transfer RNA- tRNA-** RNA that carries amino acids to the site of protein synthesis on the ribosome

**Triglycerides-** a fat molecule; three fatty acids linked to a glycerol

**Unsaturated fatty acids-** a fatty acid that has one or more double bonds on the hydrocarbon chain

**Waxes-** lipid made of a long chain fatty acid that is esterified to a long chain alcohol; serves as a protective coat on leaves, fur, and feathers

**Part II: Evolution is defined as a change in the genetic makeup of a population over time. To better understand this big idea you will be asked to analyze, evaluate, and manipulate data.**

40. Peter and Jessica already have three children, 2 boys and 1 girl. They are hoping for another girl. As their doctor, you think they should know about the likelihood of that possibility. If they decide to have another child, what is the probability it will be a girl?

- A.  $1/4$
- B.  $2/4$
- C.  $3/4$
- D.  $4/4$

41. Cerumen, or earwax has been classified into two types. Wet type is dominant and the dry type is recessive. Assume a study was conducted of individuals with genotypes *Ss* who mated with other individuals with the same genotype. Based on [Mendelian genetics](#) what proportion of the offspring was expected to have wet earwax?

- A.  $1/4$
- B.  $2/4$
- C.  $3/4$
- D.  $4/4$

42. When the earwax data was collected, it was noted that a smaller proportion of the offspring had wet earwax than expected. Approximately  $2/3$  of the offspring showed this phenotype. What could be a likely explanation of the deviation from that mendelian ratio?

- A. Too small of a sample to achieve the mendelian ratio
- B. Nondisjunction occurs in meiosis
- C. The *E* allele is lethal in the homozygous form.
- D. The effects of *E* allele were masked.

43. A mosquito, whose diploid number is 6, would be expected to produce gametes that have what number of chromosomes?

- A. 2
- B. 3
- C. 6
- D. 12

44. Researchers are trying to figure out the mode of inheritance for a new disease. They have observed that affected males and normal females produce normal sons and affected daughters. The affected daughters have a 50% chance of having an affected child even when they mate with a normal male. What mode of inheritance do these characteristics suggest?

- A. Autosomal Dominance
- B. Autosomal Recessive
- C. Incomplete dominance
- D. Codominance
- E. X linked Dominant
- F. X linked Recessive
- G. Y linked Dominant
- H. Y linked Recessive

45. Sickle cell disease (SCD) is caused by a recessive version of the hemoglobin gene. In the US, SCD occurs in about 0.2% of the newborn babies. In some African countries, 4% of newborn babies have sickle cell. Out of a random sample of 10,000 newborn babies in the US, how many would you expect to be homozygous for the normal, dominant hemoglobin genotype assuming Hardy Weinberg equilibrium?

- A. 9140
- B. 914
- C. 200
- D. 20

### Gene Expression

46. What are the three components of a nucleotide?

- A. ribose
- B. phosphate
- C. deoxyribose
- D. nitrogen base
- E. glucose

47. Which of the following statements is NOT TRUE?

- A. All DNA codes for protein
- B. All DNA is replicated through semiconservative replication
- C. One DNA strand is connected to the other through two hydrogen bonds between the nitrogen bases
- D. The two strands of DNA are antiparallel

48. Which of the following IS TRUE of eukaryotic chromosomes:

- A. Like bacterial chromosomes, it consists of double stranded DNA
- B. Like bacterial chromosomes they involve protein
- C. As DNA becomes more highly packaged it is more available for transcription
- D. There are four levels of packaging DNA which changes over the course of a cell's life

### Gene Expression

49. Which of the following is not true of RNA processing?

- A. Exons are cut out before mRNA leaves the nucleus
- B. Nucleotides may be added at both ends of the RNA
- C. Ribozymes may function in RNA splicing
- D. RNA splicing is catalyzed by RNA polymerase

For more of a review of the central dogma and gene expression visit the following resources:

[VIDEO](#) about Gene Expression by Genome BC

[VIDEO](#) about Mutations by the Amoeba Sisters



## Protein Structure

50. Which of the following statements is true? Circle all that apply?
- A. The primary structure of a protein is a linear arrangement of amino acids.
  - B. Multiple protein components are connected in secondary structure.
  - C. Peptide bonds are linkages between monomers of proteins
  - D. Peptide bonds cannot rotate freely.
  - E. Protein conformation is lost by dehydration synthesis

## Basics of Transcription

51. What is a gene?
- A. Set of instructions for a protein
  - B. Set of factors attached to DNA
  - C. Set of instructions that determine where transcription starts
  - D. Basic unit of heredity
52. During the process of transcription the message of a gene is copied into another molecule called:
- A. DNA
  - B. mRNA
  - C. Protein
53. In order for the message of the gene to be copied onto a molecule that can leave the nucleus which of the following is necessary?
- A. Free nucleotides
  - B. Ribosomes
  - C. Enzyme to unzip DNA and assemble the messenger molecule
  - D. DNA
54. What are some of the differences between DNA and RNA?
- A. Shape
  - B. Length
  - C. Nitrogen Base
  - D. Sugar
  - E. Made of nucleotides

## Details of Transcription

Here's a more advanced look at transcription: [Video](#) from Cold Spring Harbor Laboratory  
[Amoeba Sisters Protein Synthesis](#)

55. What is the central dogma of biology?
- A. DNA->Protein
  - B. DNA->RNA->Protein
  - C. RNA->DNA->Protein

56. In most cases where transcription factors assemble?
- A. In advance of the gene
  - B. At the end of the gene
  - C. In the promoter region
  - D. In the terminator region
57. What enzyme is used to copy RNA?
- A. RNA Polymerase
  - B. DNA Polymerase
  - C. DNA Helicase
58. Which of the statements below are correct?
- A. The enzyme of transcription reads the DNA template strand in a 3' to 5' direction.
  - B. The enzyme of transcription reads the DNA template strand in a 5' to 3' direction.
  - C. The enzyme of transcription can read the DNA template strand in both directions.
59. What is the name of the strand that is read to produce mRNA?
- A. Coding strand
  - B. Template strand
  - C. DNA
60. Where in the cell does translation take place?
- A. In the ribosome
  - B. In the nucleus
  - C. In the cytoplasm
61. Transfer molecules (tRNA) bring what to the ribosome?
- A. mRNA
  - B. DNA
  - C. Amino Acids
  - D. Nucleotides
  - E. Proteins
62. Each amino acid is affiliated with its own:
- A. tRNA
  - B. DNA
  - C. mRNA
  - D. ribosome
63. How does each transfer molecule (tRNA) know what sequence to assemble the amino acids?
- A. DNA
  - B. mRNA
  - C. charge
  - D. sequence doesn't matter

64. 3 nucleotides on the mRNA correspond to \_\_\_\_\_ nucleotide(s) on the tRNA:

- A. 1
- B. 2
- C. 3
- D. 4

65. The protein is made up of:

- A. nucleotides
- B. amino acids
- C. monosaccharides
- D. glycerol

66. True or false: Ribosomes make only one type of protein.

- A. True
- B. False

67. True or false: mRNA makes only one type of protein.

- A. True
- B. False

### **Translation in more detail**

Here's some more detail about translation. Watch this [video](#) from Cold Spring Harbor Laboratory.

68. True or False: Each cell contains only one ribosome

- A. True
- B. False

69. The Ribosome is made of \_\_\_\_\_ subunits

- A. 1
- B. 2
- C. 3

70. The mRNA is made up of three letter groups called:

---

71. The three letter group on each tRNA is called:

---

72. If there is an anticodon/codon mismatch, the tRNA would not make it to which site?

---

73. The ribosome continues along the mRNA until:

- A. Start Codon
- B. Stop Codon
- C. Entire mRNA is read
- D. 20 amino acids have been assembled

74. The amino acid chain folds into the 3D shape as a result of:

- A. The charge of amino acids
- B. The ribosome
- C. Enzymes that create bonds between different sections of the polypeptide
- D. The sequence of amino acids

### Introduction to cladograms

<https://www.youtube.com/watch?v=ouZ9zEkxGWg>

Imagine you are Linneaus Jr. and are anxious to follow in your great-great-great-grandfather's footsteps. You aim to classify these organisms you have recently learned more about. See the information below about each organism.

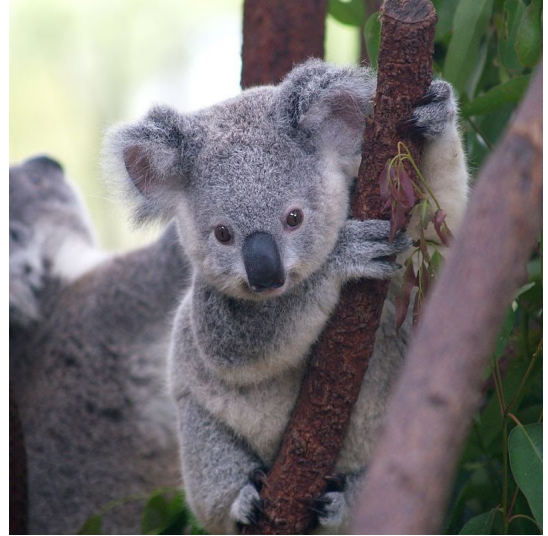


The Box Turtle is a vertebrate native to North America. Their average life span is about 50 years. Once they reach sexual maturity between 7-10 years old females will lay a clutch of 1-7 eggs in a nest that is left unguarded.

The echidna, or spiny anteater, is found in Australia and New Guinea. This vertebrate is part of the monotreme order of egg-laying mammals. They lay one egg at a time in a pouch. After ten days, a young echidna, known as a puggle is born. It will stay in the pouch for two to three months. Fun Fact: Knuckles, from the video game series Sonic the Hedgehog is an echidna.

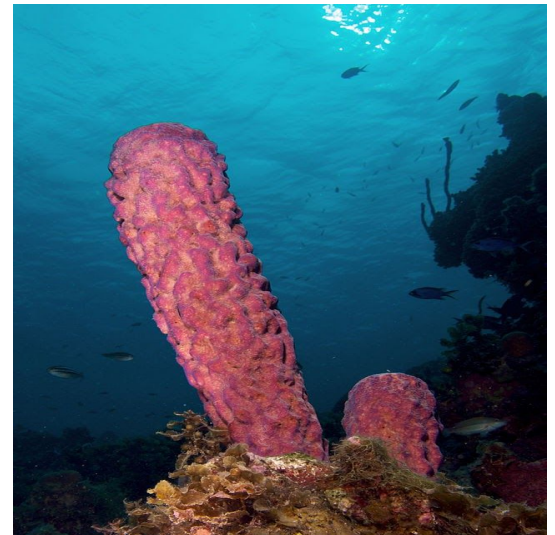


The koala, a marsupial native to Australia is more closely related to wombats than to bears. Found happily munching eucalyptus leaves they live a sedentary life. Being a marsupial, they give birth to underdeveloped young that then develop in their mothers' pouches for several months. As adults these vertebrates have few natural predators, including dingos and large pythons.



Platyhelminthes, or flatworms, are simple soft-bodied invertebrates. They have no body cavity or specialized circulatory and respiratory organs which limits their size. They can be found in water or in humid terrestrial environments. This group of organisms includes parasites such as tapeworms.

Sponges, while they do not have nervous systems, are animals found in salt water environments. They are immobile and get a large number of their resources from the water that passes through and over them. Cells within their bodies can move so they can remold their shape.



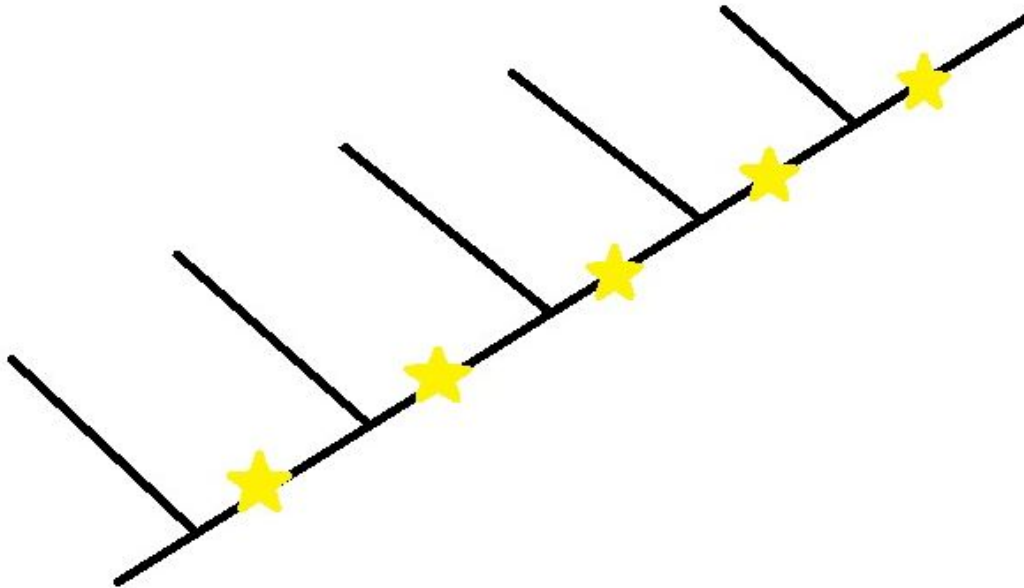
A zebra's coat pattern is unique to the individuals. These vertebrates tend to live in herds and can be found in a variety of habitats, such as grasslands, savannahs, woodlands, mountains, and coastal hills. Female zebras give live birth to one foal at a time and can give birth as frequently as every twelve months. Unfortunately zebra populations have been greatly reduced due to hunting. Fun Fact: A strain of clostridium bacteria found in Zebra feces, can convert nearly any form of cellulose into butanol fuel.

75. Create a cladogram based on physical/observable characteristics:

Zebra  
Koala  
Planaria  
Sponge

Box Turtle  
Echidna  
Bilateral Symmetry  
Hair

Placenta  
Live Birth  
Vertebrate



#### Using the cladogram

76. According to the cladogram created above, which of the following are more closely related?

- A. Turtle and Echidna
- B. Echidna and Koala
- C. Koala and Zebra
- D. Sponge and Planaria

#### Using molecular evidence to create a cladogram

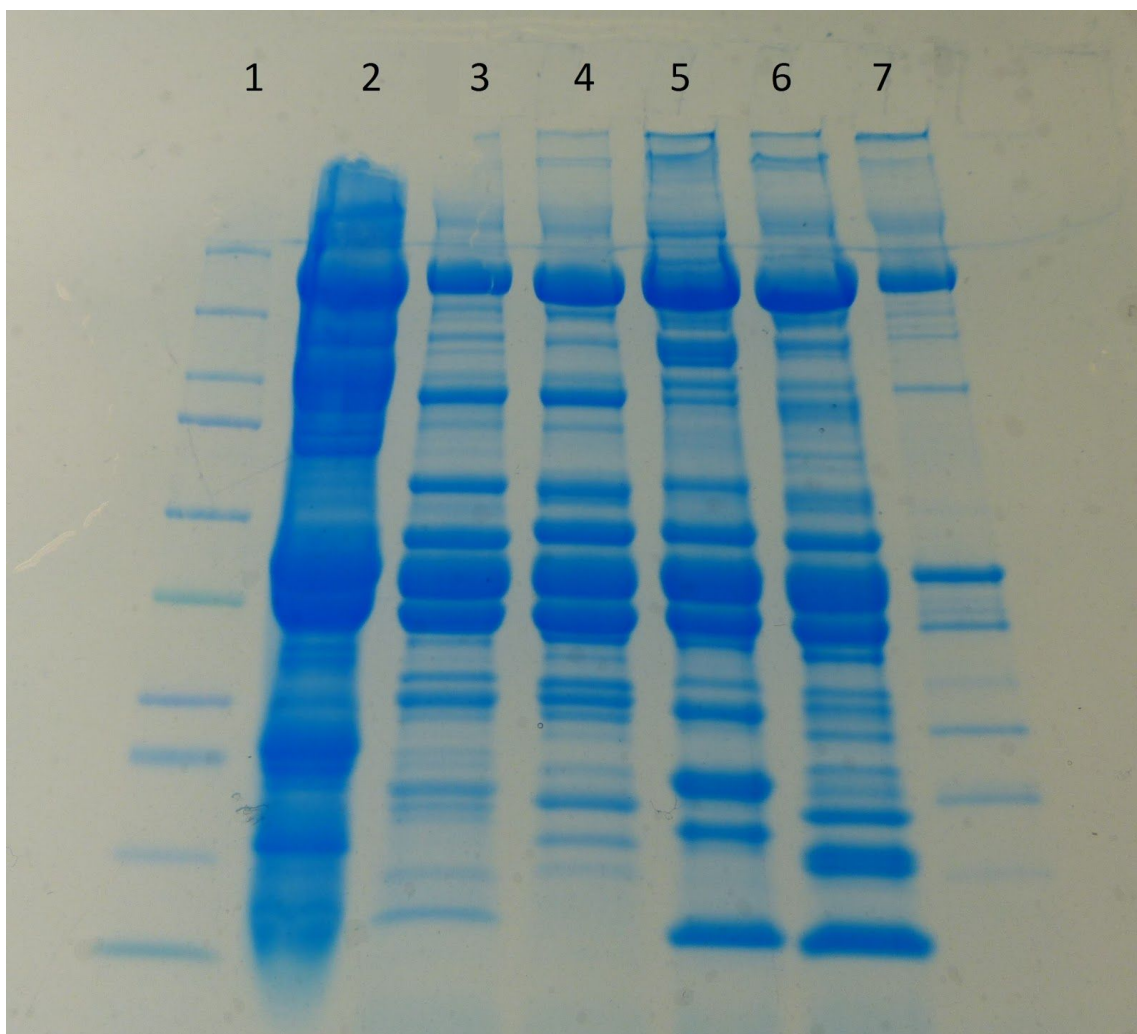
##### Protein Evidence for Common Ancestry

Pictured below is the results of a protein gel.

A mix of proteins extracted from muscle tissue of different organisms were added to each lane. The proteins moved through the polyacrylamide gel at different rates according to size. Larger proteins are towards the top, smaller proteins are towards the bottom. Proteins of the same size run the same distance in the gel. All the proteins in the gel were denatured and coated with negative charge. After running the proteins in the gel, the proteins were stained resulting in this blue banding pattern on the gel.

Two standards, used to help identify and classify the proteins in the mix, were also loaded into the gel.





**Lane 1:** Kaleidoscope standard which is a molecular rule of sorts. It has known proteins of specific sizes so each band represents a protein of a particular weight. From the top the bands represent proteins of sizes (in kD): 250, 150, 100, 75, 50, 37, 25, 20, 15, 10

**Lanes 2-6:** Samples from different organisms' muscle tissue

**Lane 7:** A myosin and actin standard. The two dark bands you see in this lane are myosin and actin common proteins in muscle fibers.

### Interpreting the gel

77. Based on the protein gel above and the 5 organisms tested, which sample likely branched off at the earliest point in time?

- A. Organism in Lane 2
- B. Organism in Lane 3
- C. Organism in Lane 4
- D. Organism in Lane 5
- E. Organism in Lane 6

The kaleidoscope standard can be used as a ruler and the proteins in the gel can be identified by size based on the distance they travel in the gel. A table has been created comparing the proteins identified in the gel above between each of the organisms tested. The numbers in the table represent the number of bands, or proteins, that those two organisms have in common.

	Organism 2	Organism 3	Organism 4	Organism 5	Organism 6
Organism 2	6	4	2	5	1
Organism 3		7	8	4	4
Organism 4			10	10	12
Organism 5				11	10
Organism 6					14

### Interpreting Molecular data

78. Which of the organisms above are most closely related?

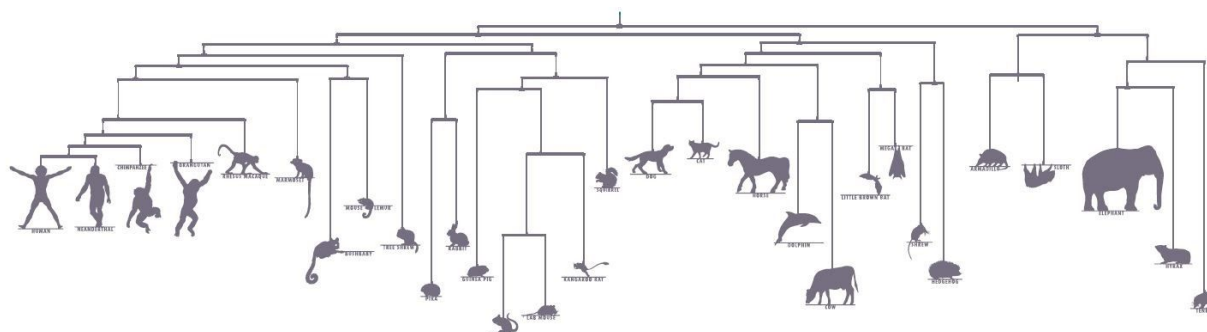
- A. Organism 2 and Organism 3
- B. Organism 4 and Organism 6
- C. Organism 5 and Organism 6
- D. Organism 5 and Organism 4
- E. Organism 3 and Organism 5

79. Draw a cladogram depicting the evolutionary relationships among all five organisms tested according to the protein similarities as revealed through polyacrylamide gel electrophoresis. Explain why you organized the organisms in the cladogram in that particular way.

Note: There are multiple interpretations of this data.

### Interpreting the phylogenetic mobile

80. According to this figure, which pair of organisms shares the most recent common ancestor? Circle the part of the diagram that represents that ancestor.





## **Entrez: Getting some background on a gene**

### **Finding out more about a gene**

You were watching the news and heard about a new case of bovine spongiform encephalopathy (BSE, or "mad cow disease"). You heard them mention that it was prion disease and wanted to know more.

That's when you headed to the Entrez Gene database. (<http://www.ncbi.nlm.nih.gov/gene/>)

You want to find out if this prion protein exists in humans.

81. Does this gene exist in humans?

- A. No
- B. Yes

82. What is the gene name?

83. What chromosome is it found on (Chromosome number only)

84. What is the function of this protein?

- A. membrane surface protein
- B. structural protein
- C. enzyme
- D. antibody
- E. protein hormone

85. What are some phenotypes associated with mutations in this gene?

- A. Alzheimer's
- B. Creutzfeldt-Jakob disease
- C. Huntington's disease
- D. fatal familial insomnia
- E. Gerstmann-Straussler disease
- F. Kuru

86. Locate the nucleotide sequence of this gene and enter the first 10 nucleotides of it here:

87. How many nucleotides make up this gene? (answer in base pairs number only)