

Biology 150: 1st in-class examination
Sept. 19, 2003

Name _____
Lab sec. (time) _____

Answer the questions in the space provided and you may also use the back of the page to complete your response. There are 31 questions worth a total of 50 points (plus a 2 point bonus question). The point value of individual questions appears in parentheses.

1. A single simple definition of life does not seem possible. In class we discussed seven characteristics of living things. List all seven of those characteristics. (3; minus 1 for each missed)
 - 1)
 - 2)
 - 3)
 - 4)
 - 5)
 - 6)
 - 7)
2. Define hypothesis (1)
3. One characteristic feature of the scientific method as it is actually used by scientists is that scientists, repeating and confirming the results of earlier experimenters, generate and attempt to answer new questions. In following up on the work of Charles Darwin with oat seedlings, what was the question that interested P. Boysen-Jensen and what was his hypothesis? (2)
4. Charles Darwin also proposed a mechanism by which biological evolution might occur. His mechanism contained three components or processes. Name or describe them. (3)
 - 1)
 - 2)
 - 3)

5. Define compound. How does it differ from mixture? (1)
6. The nuclei of atoms are composed of what two types of subatomic particles? (1)
7. Consider the Carbon atom. It has six protons. ^{12}C , ^{13}C ^{14}C occur in nature. In each case, the innermost electron shell is filled and the remaining electrons normally all reside in the next electron shell. Answer the questions below.
- 1) How many electrons occur in the carbon atom? (1)
 - 2) How many neutrons can occur in the carbon atom? (1)
 - 3) There are how many carbon isotopes? (1)
 - 4) How many bonds does carbon form? (1)
8. _____ chemical bonds are formed when electrons are lost and gained during interactions between atoms, while _____ bonds are formed when electrons are shared between atoms. (2)
9. Atoms that have lost or gained electrons are called _____. (1)
10. In the bond between an Oxygen atom and a Hydrogen atom, the electrons involved are more strongly associated with the _____ atom. Because of this unequal sharing of electrons this bond is an example of a _____ bond. (2)
11. Explain why surface tension occurs. (1)
12. Highly water soluble molecules are referred to as being _____, while relatively water insoluble molecules are referred to as being _____. (2)
13. What is capillarity and why does it happen? (1)

14. If a solution is pH 6: (2)
- 1) Is it acidic, basic or neutral?
 - 2) What is the $[H^+]$?
15. The balance between bicarbonate and carbonic acid is an example of a _____. (1)
16. All organic molecules always contain what 2 kinds of atoms? (1)
17. Biological molecules are often assembled by a process that releases water called _____. The reverse reaction is called _____. (2)
18. The three similar carbohydrates fructose, glucose, and galactose all have the same atomic composition of $C_6H_{12}O_6$, therefore they are _____ of each other. In particular glucose and galactose differ from each other only in the bond arrangements at one carbon and are therefore _____. (2)
19. Name one disaccharide and its component monomers. (1)
20. For the following polysaccharides name the component monomers: (3)
- 1) amylose
 - 2) cellulose
 - 3) chitin
21. Glucose, sucrose, and starch; which is a reducing sugar? (1)
22. Describe the difference between fats and oils. (1)
23. Describe the composition of a phospholipid molecule. (2)
24. Draw the arrangement of atoms (functional groups) around the central carbon of an amino acid. (1)

25. Describe three differences between DNA and RNA (3)
26. Adenine and guanine are both what type nitrogen containing base? (1)
27. DNA and RNA strands have 5' and 3' ends. Explain. (1)
28. To what does anti-parallel refer when talking about nucleic acids? (1)
29. Base-pairing occurs between which bases in DNA? (1)
30. Chemical reactions that will proceed (i.e. are energetically favorable) are called _____ reactions. (1).
31. Distinguish between endergonic and exergonic reactions. (1)

Bonus question.

There have been nine lectures so far in this course, how many did you attend? Note: perceived honesty gets you the points here. Any answer is acceptable unless I don't believe you (i.e. some of you I know haven't come to very many classes). (2)

16. A bag made with dialysis tubing (a selectively permeable membrane) contains 0.5 M sucrose. It is placed in a solution of 0.4 M sucrose. Will it gain or lose weight? (1)
17. Is the 0.4 M solution in the preceding question isotonic, hypertonic, or hypotonic? (1)
18. The first model of the cell membrane was proposed in the 1930's by J.F. Danielli and H. Davson. What was their model called and describe it (2)
19. Describe the Unit Membrane model of the cell membrane. (1)
20. The currently accepted model of cell membrane structure was proposed in 1972 by S. J. Singer and G. L. Nicolson, what is his model called? (1)
21. Describe and/or illustrate that model. (3)
22. Gated channels are of two basic types: _____ and _____ . (2)
23. The K^+/Na^+ pump generates an electrical gradient across animal cell membranes. How? (2)

24. Describe the function of a symport (a cooperative ion channel). (2)
25. How does an antiport differ from a symport? (1)
26. Name the 3 forms of endocytosis. (3)
27. What is the principle difference between eukaryotes and prokaryotes? (2)
28. Molecular traffic in and out of the cell nucleus is primarily through what structures? (1)
29. What is the function of the nucleolus? (1)
30. Besides the envelope and nucleoli, the cell nucleus contains _____ which is composed of almost equal parts _____ and _____. (2)
31. What are nucleosomes? (1)
32. What is the function of the rough endoplasmic reticulum (R. E. R.)? (1)

Bonus questions

- 1) Recently the recipients of the 2003 Nobel Prize for Chemistry were announced. The honorees included Peter Agre in recognition of his demonstration of the existence of water channels and Rod MacKinnon for his elucidation of the function of an aspect of channel function.
 - a) The channel he studied passes what entity? (1)
 - b) Describe what he determined about the function of this channel. (2)

Biology 150: 3rd in-class examination
November 5 , 2003

Name _____
Lab sec. or time _____

Answer the questions in the space provided and you may also use the back of the page to complete your response. There are 31 questions worth a total of 50 points (plus a couple of bonus questions). The point value of individual questions appears in parentheses.

1. Distinguish between cytoplasm, and cytosol. (1)
2. Distinguish between primary and secondary lysosomes. (2)
3. What distinguishes microbodies from other organelles? (1)
4. Mitochondria have 2 membranes. What is the space inside the inner membrane called? (1)
5. Chloroplasts also have 2 membranes. The space inside the inner chloroplast membrane is called _____ . The name of the sacs or vesicles that fill that space is _____ . (2)
6. Considerable evidence has amassed in support of the endosymbiosis hypothesis in the thirty years since it was first proposed. Give two examples of such evidence. (2)
7. Microfilaments consist of solid strands of _____ protein often in association with another protein, _____ which has ATPase activity. (2)
8. Microtubules are assembled by the polymerization of a dumbbell or peanut shaped protein called _____ . (1)
9. Describe the internal structure (arrangement of protein fibers) of a flagellum. How does it differ from that of a basal body? What type of protein fiber(s) is involved? (3)

10. What type of fiber(s) is responsible for muscle contraction? (1)

11. H, C, N, S, O, or P, which is the most electronegative? (1)

12. The gain of electrons from an electronegative substance to less electronegative substance is called _____ . (1)

13. In the first reactions of glycolysis, the intermediate products are energized by phosphorylation. What molecules donate those phosphates? (1)

14. How much net ATP synthesis results from the glycolysis alone of a single glucose molecule? (1)

15. In a yeast cell, also in the *absence of O₂*, what molecule(s) (and how many) will the original carbons of one glucose molecule eventually be converted to? (1)

16. Fermentation actually wastes most of the energy harvested in glycolysis. Explain. (2)

17. Describe the oxidation of pyruvic acid. What molecule(s) is produced? Where in the cell does this reaction occur? (3)

18. To begin the Kreb's cycle, citric acid is formed by the joining of an acetate (2 carbon) group to a four carbon molecule called _____. (1)

19. NADH, reduced in the Krebs cycle, is reconverted to NAD (oxidized) by reducing the first member of the _____ which consists of a series of proteins located in _____. Finally, the electrons are passed to _____, the terminal electron acceptor of aerobic respiration. (3)

20. If you were to measure the pH of the matrix (inner compartment) and of the inter-membrane space (outer compartment) during active aerobic respiration would the pH be the same or different? If different which would be lower? (1)
21. Aerobic respiration can use carbon from both protein and from triglycerides... that is what dieting is all about. Describe how (or where) a triglyceride molecule enters the pathway. (2)
22. Photosynthesis occurs entirely within what organelle in eukaryote cells? (1)
23. Describe the structure of a light harvesting complex. (2)
24. Name the two forms of the principle pigment of plant photosynthesis. (1)
25. Name two types of accessory pigments. (2)
26. What is the terminal electron acceptor of non-cyclic photophosphorylation? (1)
27. During non-cyclic photophosphorylation, electrons are first removed from molecules of _____, passed to the reaction center named _____ of photosystem _____. Following energization by light energy these electrons pass from one to another of a series of electron carrier molecules to reach the reaction center named _____ of photosystem _____. Following a second energization by light energy these electrons pass from one to another of another series of electron carrier molecules to reach the terminal electron acceptor _____. (6)
28. If you were to measure the pH of the stroma and of the lumen of the thylakoids during daylight would the pH be the same or different? If different which would be lower? (1)
29. In the dark reactions of photosynthesis, the initial reaction combines CO₂ with _____ to yield two molecules of phosphoglyceric acid (PGA). (1)

30. In a second phase of the dark reactions, phosphoglyceric acid is phosphorylated and reduced to yield _____. (1)
31. For much of the first half of the last century most biologists favored what molecule as the molecule of heredity? (1)

BONUS QUESTIONS:

- (1) Chemiosmosis was a term coined by what Noble laureate? (1)
- (2) Two scientists were primarily responsible for discovery of the dark reactions of photosynthesis. One of them, named _____, got the Nobel prize. The other, named _____, did not. (2)
- (3) Cyanide is fatal because it binds to a member of the mitochondrial electron transport chain and prevents that protein from being reduced. Explain how this will lead to death. (2)

5. What three scientists did get the Nobel prize for determining the structure of DNA? (1)
6. DNA replication is described as being semi-conservative. Why? (1)
7. DNA replication turns out to be a complex process. For E. coli DNA replication, describe replication on the lagging strand following the passage of the rep complex mentioning DNA polymerase I, DNA polymerase III, DNA ligase, single stranded binding proteins, primers, RNAPrimase, Okazaki fragments. (5)
8. Describe how misalignment deletions occur. Stretches of DNA sometimes contain more A-T base pairs than G-C base pairs and sometimes vice-versa. In which region are misalignment deletions more frequent and why? (3)
9. What are promoters? (2)
10. What enzyme complex performs transcription? (1)

11. What does the acronym "snurp" stand for? (1)
12. Processing of mRNA before it passes from the eukaryote nucleus into the cytosol involves cutting out and discarding portions called _____. The portions retained are called _____. In addition, the 5' end of the molecule is modified by _____ and the 3' end is modified by _____ (4)
13. Determination of the genetic code is arguably the major scientific accomplishment of which decade of the last century (i.e. 1930s, 1940s, 1950s, 1960s, 1970s, etc)? (1)
14. How many bases form a codon? Which base is the least important? (2)
15. The amino acid tryptophan appears only once in the genetic code. What is its codon (1)
16. How many codons code for Leucine in the genetic code? (1)
17. Assume the following sequence represents the 5' end of a mRNA:
methly-GGAAGGAGGUAACACAUGCCAGCGGGGAGUGCUGUAUUGGCCAUAGAUA....
- a) list the sequence of amino acids that would result (3)
- b) give the base sequence of the gene used to synthesize the original mRNA (3)
18. What are restriction enzymes? Where are they found and what do they have to do with sticky ends? (3)

19. You have completed your studies at MSU and, armed with your Biology degree, you have landed a job in a Biotech company that specializes in genetic engineering of crop plants to be disease resistant. Your first assignment in your new position is to prepare a DNA library of a type of wild sunflower known to be resistant to a sunflower fungus. Describe how you would prepare the DNA library(6)
20. Why has recombinant DNA technology involving plant species proceeded so much more rapidly than that involving animals? (2)

BONUS QUESTIONS:

1. Erwin Chargaff died just a few months ago having apparently spent the last forty years of his life immensely bitter that he was not awarded the Nobel prize. What was his major contribution to science? (1)
2. How many rRNA molecules occur in the large ribosomal subunit? (1)
3. What two scientists got the Noble Prize for determining the genetic code? (1)

Biology 150: Final examination
December 18, 2003

Name _____
Lab sec. or time _____

Answer the questions in the space provided and you may also use the back of the page to complete your response. There are 44 questions worth a total of 100 points (plus 5 possible bonus points). The point value of individual questions appears in parentheses.

1. What is meant by the term "operon"? Describe the structure of the lac operon indicating the relative position of the relevant components (4)
2. Explain how rising levels of tryptophan molecules in an *E. coli* bacterial cell a decrease in tryptophan synthesis through gene regulation. (4)
3. Explain the roles and relative locations of enhancers, transcription factors, and inducers in eukaryote gene regulation. (3)
4. Explain how control of the translation mechanism turns out to be an important part of gene regulation. (3)
5. How do the chromosomes of prokaryotes and eukaryotes differ? (1)
6. How many chromosomes does a haploid human cell contain? (1)

7. Interphase is divided into G_1 , G_2 , and S. What happens during each? What does "G" stand for? and in what order do the three occur? (4)

8. What is the first phase of mitosis called? Describe the events of that phase. (5)

9. Cytokinesis differs greatly between animals and plants. Briefly describe the process in each. (4)

10. In Meiosis: (3)
 - a) at what stage do homologous chromosomes separate?

 - b) at what stage do chromatids separate?

 - c) at what stage does the synaptonemal complex form?

11. Briefly describe the three types of life cycle found in living things. Indicate where mitosis and meiosis occurs, which cells are haploid, diploid, and gametes and what organisms are typified by each type of life cycle. (6)

12. What does Mendel's Law (or principle) of segregation state? (1)
13. Mendel's Law of Independent Assortment state? (1)
14. You are a geneticist working with fruit flies. You have a true breeding strain of flies with dark pigmentation of the thorax and another with tan thoraxes. You cross a male with a tan thorax with a female with a dark thoax and all the progeny have dark thoraxes. You then cross the F1 and the result is 317 dark thorax flies and 104 tan thorax flies. What do the results suggest to you? (2)
15. In a monohybrid cross between a heterozygous individual and homozygous recessive individual, what proportion of the progeny would be expected to display the dominant phenotype? (1)
16. What genotypes, and in what proportions, would be expected to result from a cross between AaBb and AaBb? What phenotype and in what proportions would be expected? (4)
17. Consider the Carbon atom. It has six protons. ^{12}C , ^{13}C ^{14}C occur in nature. In each case, the innermost electron shell is filled and the remaining electrons normally all reside in the next electron shell. Answer the questions below.
- a) How many electrons occur in the carbon atom? (1)
 - b) How many neutrons can occur in the carbon atom? (1)
 - c) There are how many carbon isotopes? (1)
 - d) How many bonds does carbon form? (1)

18. In the bond between an Oxygen atom and a Hydrogen atom, the electrons involved are more strongly associated with the _____ atom. Because of this unequal sharing of electrons this bond is an example of a _____ bond. (2)
19. Highly water soluble molecules are referred to as being _____, while relatively water insoluble molecules are referred to as being _____. (2)
20. If a solution is pH 6: (2)
- 1) Is it acidic, basic or neutral?
 - 2) What is the $[H^+]$?
21. Glucose, sucrose, and starch; which is a reducing sugar? (1)
22. Describe the composition of a phospholipid molecule. (2)
23. If the chemical equilibrium constant of a chemical reaction has a value of 1.5, is the reaction spontaneous? (1)
24. What happens to the activation energy for a reaction in the presence of an enzyme that catalyzes that reaction? (1)
25. What happens to the ΔG of a reaction in the presence of an enzyme that catalyzes that reaction? (1)
26. The discovery of cells depended on the invention of what scientific tool? (1)
27. Plant cells are bigger than animal cells. The diameter of animal cells is generally in what range? (1)
28. A bag made with dialysis tubing (a selectively permeable membrane) contains 0.5 M sucrose. It is placed in a solution of 0.4 M sucrose. Will it gain or lose weight? (1)
29. Is the 0.4 M solution in the preceding question isotonic, hypertonic, or hypotonic? (1)

30. The currently accepted model of cell membrane structure was proposed in 1972 by S. J. Singer and G. L. Nicolson, what is his model called? (1)
31. Describe and/or illustrate that model. (3)
32. The K^+/Na^+ pump generates an electrical gradient across animal cell membranes. How? (2)
33. What distinguishes microbodies from other organelles? (1)
34. Mitochondria have 2 membranes. What is the space inside the inner membrane called? (1)
35. Describe the internal structure (arrangement of protein fibers) of a flagellum. How does it differ from that of a basal body? What type of protein fiber(s) is involved? (3)
36. The gain of electrons from an electronegative substance to less electronegative substance is called _____ . (1)
37. In a yeast cell, also in the *absence of* O_2 , what molecule(s) (and how many) will the original carbons of one glucose molecule eventually be converted to? (1)

38. Fermentation actually wastes most of the energy harvested in glycolysis. Explain. (2)
39. Photosynthesis occurs entirely within what organelle in eukaryote cells? (1)
40. What is the terminal electron acceptor of non-cyclic photophosphorylation? (1)
41. For much of the first half of the last century most biologists favored what molecule as the molecule of heredity? (1)
42. In spite of the clear results of an experiment published by Avery, Macleod, and McCarty in 1944, most Biologists were not convinced of the apparent conclusion suggested by that work until the work of Alfred Hershey and Martha Chase appeared in 1952. Describe the experiment performed by Hershey and Chase and the conclusion that can be drawn from it. (4)
43. Processing of mRNA before it passes from the eukaryote nucleus into the cytosol involves cutting out and discarding portions called _____. The portions retained are called _____. In addition, the 5' end of the molecule is modified by _____ and the 3' end is modified by _____ (4)
44. You have completed your studies at MSU and, armed with your Biology degree, you have landed a job in a Biotech company that specializes in genetic engineering of crop plants to be disease resistant. Your first assignment in your new position is to prepare a DNA library of a type of wild sunflower know to be resistant to a sunflower fungus. Describe how you would prepare the DNA library(6)

BONUS QUESTIONS:

1. In 1906, shortly after the recognition of the importance of Mendel's experiments, R.C. Punnett examined the inheritance of two traits in sweet peas; flower color and pollen shape. Punnett found that when he crossed purple flowered plants with elongate pollen with red flowered plants with round pollen all of the F1 had purple flowers with elongate pollen. When he allowed the F1 to "self" he found a most of the plants of the resulting F2 had either purple flowers with long pollen or red flowers with round pollen in a ratio of close to 3:1.
 - a) What ratio did he expect to find in the F2? (1)

 - b) What phenomenon explains Punnett's unexpected results? (1)

 - c) In addition to the many purple flowered plants with elongate pollen and red flowered plants with round pollen, Punnett found a very small number of additional plants with either purple flowers and round pollen or red flowers with elongate pollen. What phenomenon explains the existence of these plants? (1)

2. During what decade (i.e. 1820s, 1830s, 1840s, 1850s, 1860s, 1870s, 1880s etc) did Gregor Mendel perform most of his pea breeding experiments? (1)