Part I: Questions from the first part of the course

True-false (mark A for true, B for false):

1. Features that all cells have in common include DNA, ribosomes, and a cell wall made of starch or glycogen.
2. The following chemical equation represents ATP hydrolysis, and it releases the energy required for the cell’s activities: \( \text{ATP} + \text{H}_2\text{O} \rightarrow \text{ADP} + \text{P}_i \).
3. Plants and other autotrophs make glucose in photosynthesis, so they don’t need respiration to make ATP.

Multiple choice / matching:

4. Why do phospholipids form a bilayer in water?
   a. Because each tail is much smaller than a water molecule.
   b. Because certain substances can pass through the membrane only if proteins are also present.
   c. Because each phospholipid molecule’s head is hydrophilic, and each tail is hydrophobic.
   d. Because otherwise the tails would break down by dehydration synthesis.
   e. All of the above are correct.

5. Pictured at right are the R groups for alanine and glutamic acid. How might a mutation that switched alanine for glutamic acid affect a protein?
   a. It wouldn’t change anything; proteins are too big for one amino acid change to have any effect.
   b. It would make a portion of the protein that normally curled inward (avoiding water) to curl outward (interacting with water).
   c. It would make a portion of the protein that normally curled outward (interacting with water) to curl inward (avoiding water).

6. The graph at right shows data from a study testing whether a new vaccine helps prevent rotavirus illness in babies. Which of the following statements is FALSE?
   a. Babies receiving the placebo got a “fake” vaccine without the active ingredient.
   b. The vaccine appears to be effective at reducing the incidence of severe rotavirus illness.
   c. The placebo actually causes rotavirus illness.
   d. The researchers were correct to use a bar graph (not a line graph) to present the data.
   e. Each bar represents the average incidence of rotavirus for multiple babies.

7. Water is required for life for all of the following reasons EXCEPT:
   a. Proteins fold into their correct shapes in part because of interactions of amino acid R groups with water.
   b. Many other molecules required for life dissolve in water, which occurs in all cells.
   c. Frozen water is less dense than liquid water, so it floats, protecting life living in oceans and lakes from being trapped in solid ice when the temperature falls below freezing.
   d. Water molecules stick together, which enables large plants to transport water from soil to their leaves.
   e. Water cannot evaporate at temperatures in which life is possible.
Fill in the table below, then answer questions 8-10:

<table>
<thead>
<tr>
<th>Molecule</th>
<th>Function</th>
<th>Type of monomer</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starch</td>
<td>Energy storage in plants</td>
<td>T</td>
<td>U</td>
</tr>
<tr>
<td>Oil</td>
<td>Energy storage in plants</td>
<td>N/A</td>
<td>V</td>
</tr>
<tr>
<td>Enzyme</td>
<td>W</td>
<td>X</td>
<td>Y</td>
</tr>
<tr>
<td>RNA</td>
<td>Z</td>
<td>Nucleotide</td>
<td>Nucleic acid</td>
</tr>
</tbody>
</table>

8. What goes in slots U, V, and Y of the above table?
   a. U = lipid; V = lipid; Y = carbohydrate
   b. U = protein; V = carbohydrate; Y = carbohydrate
   c. U = protein; V = lipid; Y = lipid
   d. U = carbohydrate; V = lipid; Y = protein
   e. U = lipid; V = lipid; Y = protein

9. What goes in slots W and Z of the above table?
   a. W: Determines what enters/leaves cells; Z: Passes genetic information from generation to generation
   b. W: Energy storage in animals; Z: Direct participant in ATP production
   c. W: Speeds chemical reactions in cells; Z: Direct participant in protein production
   d. W: Copies DNA in the cell’s nucleus; Z: Product of DNA replication in the cell’s nucleus
   e. W: Hormone that passes messages between cells; Z: Causes the mutations that drive evolution

10. What goes in slots T and X of the above table?

<table>
<thead>
<tr>
<th>Choice</th>
<th>Slot T</th>
<th>Slot X</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td><img src="image1.png" alt="Choice a" /></td>
<td><img src="image2.png" alt="Choice a" /></td>
</tr>
<tr>
<td>b.</td>
<td><img src="image3.png" alt="Choice b" /></td>
<td><img src="image4.png" alt="Choice b" /></td>
</tr>
<tr>
<td>c.</td>
<td><img src="image5.png" alt="Choice c" /></td>
<td><img src="image6.png" alt="Choice c" /></td>
</tr>
<tr>
<td>d.</td>
<td><img src="image7.png" alt="Choice d" /></td>
<td><img src="image8.png" alt="Choice d" /></td>
</tr>
</tbody>
</table>

11. Cesium (Cs) is an element with an atomic number of 55. Two radioactive isotopes of Cs form in nuclear reactors: $^{134}$Cs and $^{137}$Cs. How are these two isotopes different?
   a. The number of electrons; $^{134}$Cs has 3 more electrons than does $^{137}$Cs.
   b. The number of electrons; $^{134}$Cs has 3 fewer electrons than does $^{137}$Cs.
   c. The number of protons; $^{134}$Cs has 3 more protons than does $^{137}$Cs.
   d. The number of protons; $^{134}$Cs has 3 fewer electrons than does $^{137}$Cs.
   e. The number of neutrons; $^{134}$Cs has 3 fewer neutrons than does $^{137}$Cs.
12. To test the effectiveness of a new drug (Provenge) designed to treat advanced stage prostate cancer, researchers conducted a clinical trial. The subjects were 512 adult American male volunteers with advanced prostate cancer. Half were randomly assigned to take the drug and the other half were randomly assigned to take a placebo. Neither the subjects nor the doctors who evaluated them knew who was in which group. After three years, 32 percent of those who got Provenge were still alive, compared with only 23 percent of those who got the placebo. Which of the following is correct?
   a. The placebo is an example of a standardized variable, because all of the control males got it.
   b. If you were graphing the data, “Percent alive after 3 years” would go on the Y axis.
   c. “Adult,” “male,” “American,” “volunteer,” and “advanced prostate cancer” are all examples of controls.
   d. If you were graphing the data, only Provenge (but not the placebo) would go on the X axis.
   e. The experimental design would be improved by assigning Provenge to volunteers with the most advanced cases of cancer.

13. A cigarette lighter is not considered to be alive because it does not:
   a. use energy
   b. have parts organized in a specific way
   c. grow/develop/reproduce
   d. maintain homeostasis
   e. A cigarette lighter does not do c or d

14. Which of the following is an organic molecule that is abundant in cells?
   a. Water (H₂O)
   b. Oxygen (O₂)
   c. Glucose (C₆H₁₂O₆)
   d. a, b, and c
   e. Only a and b

15. OU’s Dr. Rich Broughton is famous among fish biologists for having figured out the evolutionary relationships among many of the world’s fish species. This work was featured in the OU Daily last week. One quote from the article is, “Broughton said he worked with about 20,000 nucleotides … for each of the 14,000 species.” That means that he was sequencing ____ to do his work.
   a. proteins
   b. carbohydrates
   c. fatty acids
   d. DNA
   e. All of the above are possible

16. Which of the two graphs below presents the data most appropriately?
   a. Graph A
   b. Graph B
   c. Both A and B are equally appropriate.

17. Arrange the items in the following list from smallest to largest. Which item is third on the list?

   cell’s nucleus, atom’s nucleus, chromosome, muscle tissue, heart

   a. cell’s nucleus
   b. atom’s nucleus
   c. chromosome
   d. muscle tissue
   e. heart

18. How many H₂O’s are produced in the reactions that build 12 fat molecules out of glycerol and fatty acids?
   a. 2
   b. 6
   c. 12
   d. 24
   e. 36
For the next two questions, mark your scantron as follows (choices may be used more than once or not at all):

Mark “a” if the first item is larger than the second
Mark “b” if the first item is smaller than the second
Mark “c” if the two items are the same size

19. Number of vacancies in the outermost shell of a boron atom (atomic number = 5) … number of vacancies in the outermost shell of an aluminum atom (atomic number = 13)

20. Tendency of molecule X to dissolve in water … tendency of molecule Y to dissolve in water [see the images in the box at right]

21. Which of the following elements would have the largest partial positive charge in a covalent bond with oxygen?

22. Which of the following is an example of a question that can be answered using science?
   a. Is harvesting stem cells from human embryos wrong?
   b. Is Pharrell Williams a good singer?
   c. Should we use DNA technology to correct genetic errors?
   d. Do angels intervene in human lives?
   e. When did the oldest rocks on Earth form?

23. The image at right shows a portion of:
   a. a chromosome.
   b. an atom’s nucleus.
   c. a protein.
   d. a cell membrane.
   e. a cellulose molecule.

24. Which of the following cell structures is incorrectly paired with its description and function?
   a. Golgi apparatus – external structure that enables a cell to move
   b. Rough endoplasmic reticulum – highly folded membrane studded with ribosomes that make proteins
   c. Cell wall – barrier that protects the cell membrane of typical plant cells, fungal cells, and bacterial cells
   d. Nucleus – internal compartment that contains a eukaryotic cell’s DNA
   e. Mitochondrion – internal compartment where a cell uses glucose and oxygen to produce ATP

25. Which arrow(s) in the drawing at right is/are actually pointing to hydrogen bonds?
   a. Arrow 1 only
   b. Arrow 2 only
   c. Arrows 1 and 2 only
   d. Arrows 3 and 4 only
   e. Arrows 1, 2, 3, and 4
Part II: Questions from the second part of the course

True-false (mark A for true, B for false):

26. The images at right correctly show the orientation of chromosomes during metaphase and anaphase of mitosis.
27. A gene that is 3000 nucleotides long encodes a protein that is 9000 amino acids long.
28. If researchers could make hamsters with genes that encode human proteins (say, to make them susceptible to HIV), then the hamsters would be considered transgenic.

Multiple choice / matching:

29. Consult the image at right. Which of the following statements about the chromosome is/are true?
   a. The two chromatids formed when a single DNA molecule replicated.
   b. The two chromatids formed shortly after fertilization, when maternal and paternal chromatids came together.
   c. The two chromatids will separate during metaphase I of meiosis.
   d. When the chromosome is folded like this, the genes are available to be transcribed.
   e. All of the above statements are true.

30. A virus releases its DNA into a host cell. Hours later, the cell dies as it releases hundreds of new viruses. Where did the nucleic acids and proteins that make up the new viruses come from?
   a. The virus absorbs them from the environment as it divides, just before entering the host cell.
   b. The host cell makes them, under the direction of the viral DNA.
   c. The virus uses its stored ATP to make them shortly after entering the host cell.
   d. All of the above are possible; it just depends on the type of virus.

31. A gene is to a chromosome as ___ is/are to ____.
   a. instructions for knitting a sweater … the sweater
   b. two balls of yarn … one ball of yarn
   c. a brick … a wall
   d. a cell … a cell’s nucleus
   e. an atom … an electron

32. HOW MANY of the following statements apply to both transcription and DNA replication?

   Occurs in the nucleus of a eukaryotic cell
   Copies an entire chromosome
   Requires enzymes
   Occurs during interphase of the cell cycle
   Produces RNA

   a. one    b. two    c. three    d. four    e. five

33. A jellyfish has muscle cells and nerve cells. Why can the same organism produce two (or more) types of specialized cells?
   a. The organism inherits its muscle cells from one parent and its nerve cells from the other parent.
   b. Muscle cells and nerve cells contain different genes, so they make different proteins.
   c. Muscle cells and nerve cells contain all of the same genes, but different combinations of the genes are turned “on.”
   d. Every gamete consists of both muscle and nerve cells, so the organism inherits the specialized cells directly.
34. Suppose the diagram at right shows the chromosomes from a diploid cell of a salamander. Which of the follow genotypes might the normal gametes of this individual have?
   a. $Aa$
   b. $AA$ $aa$ $BB$ $bb$ $CC$ $cc$
   c. $AA$ $BB$ $CC$
   d. $A$ $B$ $C$

35. Refer again to the diploid salamander cell at right. If nondisjunction happened during meiosis, an abnormal gamete might have:
   a. 4 chromosomes instead of 3
   b. 12 chromosomes instead of 6
   c. 7 chromosomes instead of 6
   d. 7 chromosomes instead of 3
   e. 13 chromosomes instead of 12

36. One of the questions in Part 1 of this final was about a drug being tested against prostate cancer. Ideally, what would the best cancer drugs do?
   a. Kill all of the living cells in the body.
   b. Kill all of the nonliving cells in the body.
   c. Kill all of the actively dividing cells in the body, since cancer cells divide out of control.
   d. Kill all of the cells that cannot divide, since cancer cells cannot divide.
   e. Kill only the cells in the cancerous tumor and leave the rest of the body’s cells alone.

37. A feature story in a recent issue of the *Norman Transcript* was about a little girl in McAlester, OK, who has cystic fibrosis. This disease is caused by a recessive allele on chromosome 7. Since she has the disease, she must have inherited the cystic fibrosis allele from:
   a. her father only
   b. her mother only
   c. both of her parents
   d. her sibling

38. Richard Dawkins wrote in *The Selfish Gene*: “…bits of each paternal chromosome physically detach themselves and change places with exactly corresponding bits of maternal chromosome. … The process of swapping bits of chromosome is called **crossing over**. … It means that if you got out your microscope and looked at the chromosomes in one of your own [gametes], it would be a waste of time trying to identify chromosomes that originally came from your father and chromosomes that originally came from your mother. This is in marked contrast to the case of ordinary body cells.” The events described in this passage occur during:
   a. fertilization
   b. mitosis
   c. prophase I of meiosis
   d. somatic cell nuclear transfer
   e. binary fission

39. Which of the following statements about the image at right is/are true?
   a. The image shows a homologous pair of chromosomes.
   b. Sister chromatids have the same alleles.
   c. Each human zygote contains exactly one pair of chromosomes.
   d. Only two of the above are true.
   e. a, b, and c are all true.

40. Suppose that a substitution mutation replaces the first “A” in this mRNA sequence with a “U”:
    A A A G C A G U A C U A
    How many amino acids will be in the polypeptide chain? (Dictionary of genetic code is on page 1 of the exam.)
    a. Zero
    b. One
    c. Two
    d. Three
    e. Four
41. Arrange the following items in order from smallest to largest. Which appears second on your list?
   Reverse transcriptase, HIV, human cell, bacterial cell, amino acid
   a. Reverse transcriptase
d. Bacterial cell
   b. HIV
ej. Amino acid
c. Human cell

42. Which of the following actually occurs in protein synthesis?
   a. tRNA becomes an amino acid
d. Nucleotides become amino acids
   b. DNA becomes mRNA
e. None of these is correct.
c. tRNA becomes mRNA

43. A mutation in DNA could affect:
   a. a gene’s sequence
   b. the sequence of a transcribed mRNA molecule
   c. which amino acid is bound to each tRNA in the cell
   d. which amino acids are in a protein translated from the corresponding mRNA
   e. All of the above except c

44. Probability that a couple with genotypes X^hY and X^hX^h has a child with genotype X^hY … probability that a couple with genotypes DD and Dd has a child with genotype DD
45. Number of sperm required to make a set of conjoined twins … number of sperm required to make a set of identical twins
46. Number of chromosomes in a gamete … number of chromosomes in a zygote of the same species

47. Consult the image at right. Working from the top of the mRNA, what will be the first amino acid to appear in the protein chain?
   a. Isoleucine (Ile)
d. Asparagine (Asn)
b. There won’t be one (it’s a stop codon)
e. Proline (Pro)
c. Leucine (Leu)

48. The anticodon binds by complementary base-pairing to:
   a. an amino acid
d. RNA polymerase
e. proteins
   b. mRNA
c. DNA

49. Suppose that two squirrels are heterozygous for the gene encoding fur color, and they both have gray fur. They have a bunch of offspring. About 25% of the babies have black fur, about 25% have white fur, and the rest have gray fur. Fur color in these squirrels therefore illustrates:
   a. one trait being controlled by two genes.
b. incomplete dominance.
c. complete dominance.
d. codominance.

50. Ultimately, all types of cancer are associated with mutations in genes encoding proteins that enable a cell to:
   a. produce ATP.
d. control mitosis.
b. copy its DNA.
e. do all of the essential activities listed above.
c. transcribe its DNA.
Part III: Questions from the third part of the course

True-false (mark A for true, B for false):

51. Evolution acts to promote the survival of a species; for example, if a prey species evolves camouflage, then natural selection will give predators better eyesight.

52. The evolutionary tree at right shows that a human is more closely related to a sea lily than it is to a sea urchin.

Multiple choice / matching:

53. The evolutionary tree at right shows humans plus five main groups of echinoderms. Why is the human grouped with a bunch of echinoderms?
   a. All evolutionary trees include humans to make the diagram more relatable to our own species.
   b. Humans are chordates; both chordates and echinoderms belong to the deuterostome clade.
   c. Human embryos are invertebrates, as are echinoderms; the tree summarizes the main types of invertebrates.
   d. Like humans, echinoderms are chordates; the tree summarizes the main groups of chordates.
   e. The tree summarizes all of the main clades of aquatic animals; humans represent animals that live on land.

54. In the evolutionary tree above, which group of organisms forms a clade?
   a. sea urchins, sea cucumbers, and sea stars
   b. sea lilies and humans
   c. sea lilies, brittle stars, and sea stars
   d. brittle stars, sea stars, sea cucumbers, and sea urchins
   e. sea stars and sea cucumbers

55. You are making microscope slides in lab. You have a sample of your own cheek cells, some Elodea plant cells, and some fungal hyphae. Unfortunately, you forgot to label your slides. What microscopic features would be helpful as you try to tell the cells apart?
   a. Each cheek cell has a nucleus, but the other cells don’t.
   b. Plant cells and fungal cells have cell walls, but your cheek cells don’t.
   c. Plant cells and fungal cells have chloroplasts, but your cheek cells don’t.
   d. All of the above would be helpful ways to tell the cells apart.

For the next two questions, mark your scantron as follows (answers may be used more than once or not at all):

Mark “a” if the first item is larger than the second
Mark “b” if the first item is smaller than the second
Mark “c” if the two items are the same size

56. Number of segments in a typical mollusk’s body … number of segments in a typical annelid’s body
57. Number of sponge species that produce a gastrula … number of flatworm species that produce a gastrula
58. Number of years since the evolution of the amnion … number of years since the evolution of the placenta
59. Which of the following statements about fungi is true?
   a. The function of a mushroom is to absorb nutrients from the atmosphere.
   b. The simplest fungi are heterotrophs, but the more complex species are autotrophs.
   c. Mycorrhizae are parasites that harm plants.
   d. Although fungi can decompose leaves and other plant-based materials, they cannot colonize animals.
   e. Lichens can colonize bare rock, starting the process of soil-building in a new habitat.

60. In most vertebrates, the female invests more energy in producing and rearing each offspring than does the male. But sometimes the roles are reversed. In pipefish, for example, the male cares for the fertilized eggs in a special pouch on his body, and females compete for access to males. In this species, one of the sexes is larger and more brightly colored than the other. Given this information about pipefish life history, which sex probably has the larger size and brighter colors?
   a. The males
   b. The females

61. House sparrows mate for life; they reproduce sexually. A typical clutch has 4-5 eggs, and the pair may lay two clutches per year. Only about 20–25% of birds that hatch survive to their first breeding season. Does the house sparrow population meet the conditions required for natural selection to occur from generation to generation?
   a. Yes
   b. No

62. Neanderthals died out in Europe between 41,000 and 39,000 years ago, a few thousand years after modern humans reached the continent. This estimate was based on radiometric dating of materials from Western Europe. If the researchers used an isotope with a half-life of 10,000 years to arrive at their estimate, about what percent of isotope X remains in the last Neanderthal fossils?
   a. 50%
   b. 25%
   c. 12.5%
   d. 6%
   e. 3%

63. How many of the following combinations actually exist?
   - A bacterium with a nucleus
   - Algae with chloroplasts
   - A heterotrophic fungus
   - A pine tree with fruits
   - A reptile that lays eggs
   - A protist with a nucleus
   a. two
   b. three
   c. four
   d. five
   e. six

64. The feathery shipworm is a mollusk. The name “shipworm” comes from the fact that they burrow into the wood that makes up boats or docks. Their bodies have specialized bacteria that produce the enzymes that enable the mollusks to survive by eating wood. Counting the shipworms, the bacteria, and the trees that produced the wood, how many different domains are included in this scenario?
   a. zero
   b. one
   c. two
   d. three
   e. four

65. A new study indicates that modern humans and Neanderthals interbred (and presumably produced fertile offspring). What does this result specifically say about modern humans and Neanderthals?
   a. Their DNA must be identical.
   b. They belonged to the same species.
   c. They were primates.
   d. They occupied different habitats.
   e. Human evolution ceased once they interbred.

66. Which of the following is NOT among the main groups of protists?
   a. Yeasts
   b. Protozoa
   c. Algae
   d. Slime molds

67. Which of the following events occurred before all of the others?
   a. Placental mammals outcompeted marsupials on most continents.
   b. Fish with fleshy fins and simple lungs began to emerge from the water.
   c. Algae with the ability to survive in air began to colonize the muddy edges of ponds.
   d. Cells engulfed cyanobacteria during an endosymbiosis event.
   e. Dinosaurs looked into the sky and saw a deadly meteor heading their way.
68. Which of these is NOT among the reasons that bacteria are important to humans?
   a. Bacteria live inside each of our cells, contributing important metabolic products that we need to survive.
   b. Bacteria make foods, such as yogurt and pickles, that we find delicious and nutritious.
   c. Bacteria in sewage treatment facilities decay the organic matter in sewage, so we don’t foul our rivers with human wastes.
   d. “Good” bacteria help prevent “bad” (disease-causing) bacteria from infecting our bodies.
   e. Photosynthesis by some types of bacteria contributes oxygen to the atmosphere.

69. What is the modern evolutionary synthesis?
   a. The idea that all life shares a common ancestor.
   b. The idea that natural selection is the most important mechanism of evolution in most populations.
   c. The idea that ecological interactions are the selective forces that drive the evolution of each species.
   d. The idea that changes in genes produce the variation that natural selection acts on.
   e. The idea that prokaryotes were originally two domains that recently united to form one domain.

70. The photo at right shows an unusual, lantern-shaped fruit called a physalis. You may have never heard of this plant, but since it produces fruits, you know that it must also have:
   a. vascular tissue
d. cuticle
   b. pollen
e. All of these adaptations
   c. seeds

71. What do we know with the most certainty about the origin of life on Earth?
   a. It occurred at least 3 billion years ago.
   b. Life on Earth was “seeded” from outer space.
   c. Cells must have evolved before organic molecules were present.
   d. Oxygen must have been present in the atmosphere before life started.
   e. Eukaryotic cells came first, then prokaryotic cells evolved from them.

72. Which of the following is incorrectly paired with a description or example?
   a. artificial selection – mechanism of evolution that is similar to natural selection, except that a human decides specifically which individuals get to mate
   b. genetic drift – mechanism of evolution that changes allele frequencies in a population at random, not because of unequal reproductive success
   c. mutation – mechanism of evolution that adds new alleles to a population
   d. homologous structure – feature that looks similar in unrelated organisms, like the green color of frogs and the green color of leaves
   e. biogeography – line of evidence for evolution that relies on the location of past or present species on Earth

73. *Daphnia* are small aquatic crustaceans that use their eyes to see predators and to find mates. However, the animals that eat *Daphnia* can see big-eyed *Daphnia* better than those with small eyes. Over many *Daphnia* generations, what should happen to Daphnia eyes?
   a. They will get larger and larger.
   b. They will get smaller and smaller until they disappear.
   c. They will stabilize at some intermediate size, reflecting a balance between Daphnia vision and predator vision.

74. *Daphnia* is a crustacean (a type of arthropod), so it has:
   a. radial symmetry
d. phloem
   b. an incomplete digestive tract
e. an exoskeleton made of chitin
   c. a notochord
75. Each of the following pairs of organisms has a similar name. Which of pairs contains organisms that are the most *distantly* related? [Hint: Figure out what kingdom each organism is in.]
   a. A “club moss” (a type of seedless vascular plant) … a true moss
   b. The “slug” of a slime mold … a true slug (a type of mollusk)
   c. A false morel (a type of fungus) … a true morel (another type of fungus)
   d. A crabapple tree … a true apple tree
   e. A lion fish … a lion

**Part IV: Questions from the fourth part of the course**

**True-false (mark A for true, B for false):**

76. Assuming that the “10% rule” is correct, in the food chain at right, only about 0.1 kg of swordfish could be supported on 1,000,000 kg of producers (picophytoplankton).

77. The shape of the exponential growth curve reflects ever-increasing competition for food.

78. Burning fossil fuels definitely releases CO₂, but no one knows whether CO₂ actually traps heat in the atmosphere.

**Multiple choice / matching:**

79. Billy showed a video of succession from bare lava to a mature forest. Besides the amount of plant biomass, the most striking change was that ____.
   a. the atmosphere’s CO₂ concentration went down so much
   b. a thick soil layer formed where there was previously only bare rock
   c. the food web became less complex
   d. the amount of plastic that had accumulated in the ecosystem
   e. global warming had altered the communities in so many ways

80. A carbon atom in your body could have previously been in the atmosphere, a plant, or another human.

81. Retired professor Vic Hutchison feeds pecans to squirrels.

82. Fire sweeps through Oklahoma’s Tallgrass Prairie Preserve.

83. In the food web shown at right, the snake is a:
   a. primary consumer
   b. secondary consumer
   c. tertiary consumer
   d. a, b, and c are all correct
   e. only b and c are correct

84. Consider just the food chain of green plants → rabbit → fox. If the concentration of mercury in the grass is 1 g/kg, what is the approximate concentration of mercury in the fox? Assume that 90% of the energy at a trophic level is lost as heat and that no mercury is excreted or breaks down through the food web.
   a. 0.01 g/kg
   b. 0.1 g/kg
   c. 1 g/kg
   d. 10 g/kg
   e. 100 g/kg
The next three questions relate to the following scenario:

Humpback whales are returning to New York Bay. According to an article I just read, “Whale spotters have recorded twice as many whales this summer [100 whales] as last summer [43 whales], and almost 20 times as many as in 2011 [5 whales]. Researchers say that a cleaner bay and a growing population of fish for whales to feed on are responsible for the trend.” The article goes on to say that “the water is the cleanest it has been in over a decade.” It also says that humpback whales eat menhaden, a “tiny silver fish” that “was deemed overfished … in 2012, [so] “the allowed Atlantic catch [by fishermen] was drastically cut back. Since then, 300 million more of these fish are inhabiting the Atlantic Coast.”

85. Suppose that humpback whales have a death rate of 20 per year and a birth rate of 30 per year. Assuming 50 whales migrate into the New York Bay population and five migrate out of the population, approximately how many individuals will there be next year? Note that 100 whales were in the population this year.
   a. 205  b. 170  c. 155  d. 110  e. 100

86. The humpback whale scenario implies that ____ is a major obstacle to whale survival.
   a. water pollution  d. global climate change
   b. invasive fish species  e. habitat loss
   c. invasive phytoplankton species

87. What would happen if the whale population got too large for New York Bay?
   a. They would evolve lower food requirements so the offspring could all survive.
   b. The menhaden would evolve faster reproduction, to provide a larger carrying capacity.
   c. More autotrophs would enter the bay, increasing the food source to rescue the entire food web.
   d. Competition for space and food would increase, so some whales might migrate to other habitats.
   e. The whales would evolve into two species, then one would drive the other one extinct.

88. A CAFO (concentrated animal feeding operation) is an “artificial” ecosystem because it lacks:
   a. autotrophs
   b. consumers
   c. sufficient decomposers
   d. a, b, and c
   e. a and c only

89. The diagram at right shows age structure diagrams for two countries. Which country’s population will grow the fastest in the coming decades?
   a. Country A
   b. Country B
   c. Each “slice” of the diagram includes such a small fraction of the population that the age structure won’t allow us to predict future growth.

90. The most important factors that determine the types of plants in each terrestrial biome include all of the following EXCEPT:
   a. O₂ concentration  b. temperature  c. rainfall  d. fire

91. In an interaction such as predation or herbivory:
   a. energy is transferred from one trophic level to another, but atoms are not.
   b. each of the participants loses energy to the surroundings in the form of heat.
   c. carbon, nitrogen, and phosphorus atoms are lost from the ecosystem and must be replenished from the outside.
   d. both participants increase their reproductive success as a result of the interaction.
   e. All of the above are correct.
92. A fish called the Topeka Shiner used to occupy rivers all over Kansas, but thanks to dams, the fish now occurs only in the Flint Hills region of Kansas. For species that live in rivers, dams are a form of:
   a. water pollution
d. parasitism
   b. eutrophication
e. exponential tradeoff
   c. habitat destruction

93. The graph at right shows how:
a. an abiotic force affects a community
b. an abiotic force affects a community
c. an abiotic force affects a population
d. an biotic force affects a population

94. How many of these biomes are correctly paired with their description?
   - Chaparral – shrubby plants adapted to fire and hot, dry summers
   - Desert – plants adapted to extreme drought
   - Ocean floor – no light, constant temperature, salt water
   - Savanna – dense stands of fire-adapted evergreen trees
   - Temperate deciduous forest – trees that lose their leaves each winter
   - Tundra – Arctic biome with extreme cold, permafrost, and many migratory animals
   a. two b. three c. four d. five e. six

95. Bison once inhabited the entire Great Plains, which is part of the ___ biome.
   a. savanna b. tropical grassland c. temperate grassland d. taiga e. tundra

96. Wikipedia’s article on bison shows the data at right. These data are consistent with _____ population growth.
   a. exponential b. logistic c. Neither a nor b

97. Bison mate in the autumn, then the female is pregnant for 285 days. A single calf is born and nurses for about 18 months; males leave the mother’s herd at about 3 years of age. These data are consistent with a ___ life history.
   a. opportunistic b. equilibrial c. Neither a nor b

98. The bison herd at the Tallgrass Prairie Preserve is vaccinated against various harmful, infectious diseases caused by bacteria. Those disease-causing organisms are an example of a potential ___.
   a. instance of an equilibrial species infecting an opportunistic species
b. mutualistic symbiotic relationship
c. abiotic limit on population growth
d. density-dependent limit on population growth
e. density-independent limit on population growth

99. When Billy talked about eutrophication, he showed a photo from a 1974 experiment comparing two halves of a lake. One half was pea-green, and the other was clear blue. The difference between the two halves occurred because the researcher added ____ to one side but not the other.
   a. CO₂ b. phosphorus c. organic carbon d. water e. O₂

100. What color is your test form?
   a. Green b. Yellow
If you want to check your answers against the key immediately after the exam, mark them on this test form (as well as on the scantron).

😊 😊 Congratulations on surviving non-majors biology!! Enjoy your well-deserved break. 😊😊

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<th>After you check the key, do these calculations to figure your final exam score:</th>
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<tr>
<td>Total correct (part 1):</td>
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<td>Points (# correct x 2):</td>
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<td>Total final exam score = sum of the points on all four parts:</td>
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<th>If you want to figure out your improvement points, do this:</th>
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<td>(B) Actual score on exam 1:</td>
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<td>Improvement = (A) – (B):</td>
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