A group of physiologists is interested in determining if artificial sweetener XX is safe. Based on all available information, they hypothesize that sweetener XX has no effect on health at a low concentration but causes bladder cancer at high concentrations. They design the following experiment.

Group 1: no sweetener XX in food
Group 2: 5% sweetener XX in food
Group 3: 10% sweetener XX in food
Group 4: 15% sweetener XX in food

10 genetically identical rats were randomly chosen for each group. All environmental conditions, such as availability of water, cage conditions, temperature, etc. were the same for all groups. After 4 months, the animals were sacrificed and the bladders were removed and examined for the presence of cancer.

1. The independent/experimental variable in this experiment is
   a) the number of groups.
   b) the amount of sweetener in the food.
   c) the number of mice per group.
   d) the presence of bladder cancer.

2. The dependent/measured variable in this experiment is
   a) the number of groups.
   b) the amount of sweetener in the food.
   c) the number of mice per group.
   d) the presence of bladder cancer.

3. The experiment above is an example of
   a) an observational experiment.
   b) a correlation experiment.
   c) a controlled experiment.
   d) an uncontrolled experiment.

4. Which one of the following statements about heat exchange between a homeotherm and its environment is false?
   a) Heat energy always moves down its concentration gradient from warmer to cooler objects.
   b) The temperature gradient between the outer surface of the homeotherm and the environment can be changed by the organism (for example, vasoconstriction or by moving).
   c) The core body temperature of the homeotherm stays within a narrow range, regardless of external temperature extremes.
   d) Radiation serves as a means of heat gain but not of heat loss.
   e) The rate of heat loss is related to the homeotherm’s surface-to-volume ratio.

5. You would correctly predict that animals have and/or use counter-current heat exchangers when the difference between their internal temperature and their environmental temperature is
   a) large.
   b) small.
   c) zero.
   d) none of the above because it depends on wind conditions.
   e) none of the above because they use them at all times.
6. Food spoils when microorganisms (mold and bacteria) come in contact with it, and use it for food themselves. Why does refrigeration prolong the shelf life of food, compared to food kept at room temperature in a cupboard/closet?
   a) Mold cannot live in the refrigerator.
   b) Darkness in the refrigerator slows the spoilage process.
   c) Cool temperatures slow down reactions involving enzymes in microorganisms, thus slowing the spoilage process.
   d) Cool temperatures speed up reactions involving enzymes in microorganisms, thus slowing the spoilage process.

7. Image that you want to study the effects of a pesticide on reproduction in an endangered bird species that is at risk for extinction. You have several years of data on reproduction in this species, along with pesticide concentrations, at a large number of locations. Which of the following studies or analyses would be appropriate given that you fear it may be highly toxic to the few remaining members of the species?
   a) a controlled experiment in which some birds are exposed to the pesticide and others are not
   b) a study in which you examine the correlation between reproduction and amount of pesticide present
   c) a repeated measures experiment in which bird reproduction is measured before and after exposure of individual birds to the pesticide
   d) a vasoconstriction study
   e) a graph of the thermal neutral zone for this species

8. Increasing the length of the nephron loops in the kidney of an organism would result in
   a) less concentrated urine.
   b) more concentrated urine.
   c) longer bile ducts.
   d) shorter bile ducts.
   e) improved thermoregulation.

9. Suppose you are at a party and observe a lively conversation in which five individuals all attest to personal experiences that seem to defy probability, such as picking up the telephone to call a friend only to find that they had just called and are already on the line. They all agree that this represents a psychic phenomenon. As someone with some level of scientific training, you should conclude that their interpretation __________.
   a) must be false BECAUSE you don't believe that psychic phenomena exist.
   b) must be true BECAUSE five people all agreed on it.
   c) is not justified BECAUSE there is no control or objective standard to judge by.
   d) must be false BECAUSE it is impossible that those events could have occurred by chance.
   e) must be true BECAUSE there is no other possible explanation.

10. An environmental scientist determines that the amount of algae (microscopic plants) in a lake, based on once-a-year (in summer) sampling for 10 years, increased 500% over that period. It is well known that, in general, certain types of water pollution (nutrients like nitrogen and phosphorus) can increase the amount of algae in lakes. Knowing nothing else, how should she interpret this information?
    a) The increase in algae MAY OR MAY NOT be caused by increased pollution.
    b) The increase in algae CANNOT be caused by increased pollution, because the evidence is too weak.
    c) The data are adequate to represent (sample) the lake throughout each year.
    d) The increase in algae is CERTAINLY caused by increased pollution.
    e) More than one of the above (a-d) are correct.
During a recent driving trip across the southwestern United States, Dr. Brainwave observed several new things. Creosotebush was common and appeared to be spaced evenly over the desert surface. In areas receiving more annual rainfall, creosotebush populations appeared more dense (more plants/acre) and closer together, than in areas receiving less annual rainfall. He is already confident in his knowledge that rainfall varies from place to place, and that plants need water. Dr. Brainwave, being the disciplined scientist he is, returned home with ideas for some experiments to help him understand the distribution of creosotebush.

11. Which one or more of the following is/are the most obvious hypothesis(es) about creosotebush distribution for Dr. Brainwave to test, given this new set of observations?
   a) creosotebush needs water
   b) rainfall varies from site to site in the desert
   c) creosotebush density (number of plants/acre) increases with increasing annual rainfall
   d) distance between creosotebushes increases with increasing rainfall
   e) all of the above

12. Dr. Brainwave cannot figure out a way to conduct a completely controlled experiment to test his hypothesis, so he plans a correlation experiment using data to be gathered from existing creosotebush communities. Which of the following variables should Dr. Brainwave measure at each of his 25 experimental sites?
   a) annual rainfall
   b) daily temperature
   c) number of living creosotebushes /acre
   d) number of dead creosotebushes /acre
   e) (a) and (c)

13. Once an explanation is considered a theory
   a) it is never challenged.
   b) it cannot be changed.
   c) it cannot be disproved.
   d) it is considered proven.
   e) None of the above.

A scientist is interested in testing the effect of succinate as a dietary supplement. He hypothesizes that because succinate is used in energy releasing pathways, people adding it to their food will feel more energetic and be more active. He recruits 200 people, assigns them to one of 2 groups, explains his hypothesis to them and tells them to which group they belong. He supplies one group with powdered succinate and asks both groups to record how they feel each morning.

14. You are asked to critique the study above. With which one or more of the following would you correctly agree?
   a) The group receiving succinate is the control group.
   b) The experimenter should have given both groups equal amounts of succinate.
   c) The experimenter should have given neither group succinate.
   d) The results will be biased in favor of succinate because the subjects know about their treatments.
   e) (a) and (c)

15. You are driving across the Sonoran Desert - in Arizona - by yourself in your newly-acquired previously-owned truck. It is mid-July and not a cloud in the sky – air temperature is well above 110°F. Your truck overheats and stops. You are 15 miles from town and there is not a car in sight. You start walking toward town to get help. Which one of the following is most likely to occur?
   a) Your body temperature is likely to approach the upper critical point, you experience vasoconstriction and your metabolic rate decreases.
b) Your body temperature is likely to approach the lower critical point, you experience vasoconstriction and your metabolic rate increases.

c) Your body temperature is likely to approach the upper critical point, you experience vasodilation and your metabolic rate increases.

d) Your body temperature is likely to approach the lower critical point, you experience vasodilation and your metabolic rate decreases.

e) Your body temperature is likely to approach the upper critical point, you experience vasodilation and your metabolic rate decreases.

16. You survived your desert ordeal and are now in the mountains in Colorado - driving the same truck. Your truck suddenly lurches to a stop and slides off the road into a deep snow drift. You are miles from the nearest town. It is snowing so hard you cannot get out and walk so you decide to wait for help in your vehicle. Besides making a mental note to purchase a new vehicle and put together an emergency survival kit - which one of the following is likely to occur?

a) Your body temperature is likely to approach the upper critical point, you experience vasoconstriction and your metabolic rate decreases.

b) Your body temperature is likely to approach the lower critical point, you experience vasoconstriction and your metabolic rate increases.

c) Your body temperature is likely to approach the upper critical point, you experience vasodilation and your metabolic rate increases.

d) Your body temperature is likely to approach the lower critical point, you experience vasodilation and your metabolic rate decreases.

e) Your body temperature is likely to approach the upper critical point, you experience vasodilation and your metabolic rate decreases.

17. Which one of the following statements concerning natural selection is false?

a) The offspring of individuals that are better adapted to the environment will make up a larger proportion of the next generation.

b) Natural selection directs the course of evolution by the accumulation and maintenance of traits that adapt a population to its environment.

c) Natural selection changes the genetic composition of an individual in a favorable direction for a particular environment.

d) Natural selection depends upon the existence of genetic variability in a population, which in turn arises through mutations.

18. Knowing that traits are inherited - individuals in a population who possess the _____ will most likely make up more of the reproductive base for the next generation.

a) least variation in traits

b) greatest variation in traits

c) largest distribution around the world

d) traits most suited for the present environment

19. Tropical rain forests are warm and wet year-round, and have a dense tree canopy such that little light penetrates to the forest floor. It is estimated that many thousands of species of plants and animals (especially herbivorous insects) occupy small areas of rain forests. Based on this information, predict which one or more of the following characteristics should be favored by natural selection.

a) Rain forest mammals should have exceptionally thick fur.

b) Leaves of plants on the forest floor should have a low ratio of surface area to volume.

c) Rain forest animals in general should produce a concentrated (low volume) urine.

d) Rain forest plants should tend to contain poisonous chemicals.

e) All of the above (a-d) should be favored by natural selection.

20. A U.S. Customs agent intercepts an undocumented, illegal shipment of exotic animals from a wide variety of ecosystems around the world. Among them is a small mammal (a homeotherm) that is unknown to science. A zoologist is enlisted to locate the origin of the mammal, and she will use its characteristics to narrow the search. Its
skinny body is only about 6 inches (15 centimeters) long, but it has a hairless tail about twice that long, and relatively little white hair on the rest of its body. It also has large ears in relation to its body, and sharp claws that resemble those of animals that burrow into the ground. Which one or more of the following statements is logically consistent with this information?

a) Its high surface area-to-volume ratio and hairless body suggests it is from a warm biome such as a desert.
b) Its low surface area-to-volume ratio suggests it is from a cold biome such as a tundra.
c) Its burrowing claws suggest it is from a tundra.
d) Its white hair and hairless tail suggest it is from a tundra.
e) (b) and (d) are both consistent with information

21. Certain places on Earth become desert biomes BECAUSE _______________.
   a) those locations are closer to the sun than other biomes.
   b) plants such as cacti grow there.
   c) most desert animals require little water.
   d) the soil in those locations has a high surface area-to-volume ratio.
   e) None of the above (a-d) explain why certain places become deserts.

22. A poikilothermic animal ______________.
   a) has a constant metabolic rate regardless of its body temperature.
   b) has no way to change its body temperature.
   c) has a metabolic rate that is a function of its body temperature.
   d) is always colder than the surrounding air.
   e) is always warmer than the surrounding air.

23. One of the BIOL 1114 labs had more lab groups than mice, so a resourceful TA handed one of the groups a banana out of her lunch and said "Here, use this." The students thought the TA must be out of her mind, but did not want to offend her and jeopardize their grades, so proceeded to run the mouse experiment with a banana. Their data showed increasing CO\textsubscript{2} concentration over time inside the jar containing the banana. The lab group at the next table doubted the results and also ran the experiment, with the same outcome. Next they tested an empty jar and detected no CO\textsubscript{2}. The most logical explanation for this is:
   a) Bananas use sugar to fuel their cells and give off CO\textsubscript{2}, just as do mice.
   b) There was a cricket hiding in the jar.
   c) CO\textsubscript{2} concentration increases inside any closed jar.
   d) The computer failed.
   e) The sensor failed.

24. The next part of their mouse experiment required cooling the banana and measuring CO\textsubscript{2} concentration in the jar for five minutes. Given what you know about enzyme function and respiration rate with decreasing temperatures, you would correctly predict the following:
   a) Cold bananas will give off just as much CO\textsubscript{2} as warm bananas.
   b) Cold bananas will give off less CO\textsubscript{2} than warm bananas.
   c) Bananas will not give off CO\textsubscript{2} in either case.
   d) Cold bananas will give off more CO\textsubscript{2} than warm bananas.

25. In the desert, creosotebushes compete for resources with other plants. You would hypothesize that the limiting factor (required item in shortest supply) for which they are all competing is
   a) salt.
   b) CO\textsubscript{2}.
   c) water.
   d) sunlight.
   e) O\textsubscript{2}.
26. Even in the peak growing season one still finds bare ground (i.e. no other plants) around creosotebushes. Your best hypothesis concerning the mechanism by which creosotebushes compete is that they
   a) deprive the other plants of CO₂.
   b) deplete the O₂ in the soil.
   c) use secondary metabolites that serve as toxins to the other plants.
   d) dispense excess H₂O into the air.
   e) decoy all the available pollinators to them.

27. An arctic fox has a lower critical temperature of -40°C (environmental). A naked mole rat has a lower critical environmental temperature of 32°C (environmental). At 10°C, you would predict which one or more of the following
   a) the arctic fox is shivering and the naked mole rat sweating.
   b) both animals are shivering.
   c) the arctic fox has raised its metabolic rate but the naked mole rat has not.
   d) the arctic fox is comfortable and the naked mole rat is shivering.
   e) both (a) and (c).

28. Which one or more of the following graphs correctly display the data (given below) from a study of the relationship between age and reaction time.

<table>
<thead>
<tr>
<th>Age (yr)</th>
<th>Time until response (milliseconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>75</td>
</tr>
<tr>
<td>22</td>
<td>2</td>
</tr>
<tr>
<td>65</td>
<td>108</td>
</tr>
<tr>
<td>44</td>
<td>18</td>
</tr>
<tr>
<td>51</td>
<td>35</td>
</tr>
</tbody>
</table>

a) b) c) d)
29. You observed the cardboard organism *Quattro variegatus* in lab. Before performing an experiment to test the hypothesis that larger *Quattro variegatus* are captured more often than smaller ones because they are more easily seen, which one or more of the following should a good scientist consider?
   a) The sex of the larger *Q. variegatus*.
   b) The bias of the researchers collecting the samples.
   c) The relative surface area of the different sizes of the *Q. variegatus* in the sample population.
   d) (a) and (b).
   e) (b) and (c).

30. Which of the following has the greatest surface-to-volume ratio?

   a) American Bison
   b) Badger
   c) Chipmunk
   d) Pronghorn
   e) Polar Bear