

Clemson University Biology Merit Exam
12 April 2002

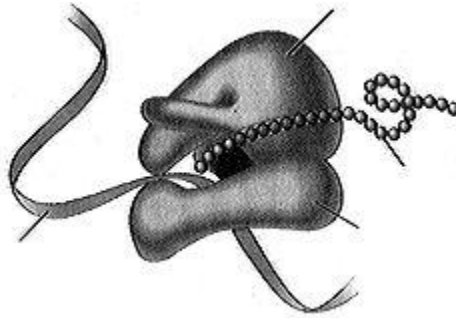
The theme of this exam is that annoying and sometimes dangerous vine, poison ivy:



1. Poison ivy belongs to the Kingdom
 - a) Plantae.
 - b) Angiospermae.
 - c) Eucarya.
 - d) Chlorophyta.
2. The Latin name of poison ivy is *Toxicodendron radicans*. These two names, respectively, are the
 - a) species and genus.
 - b) genus and specific epithet.
 - c) genus and species.
 - d) species and race.
3. The custom of naming species with two names as shown above was originated by
 - a) Francis Bacon.
 - b) Chares Darwin.
 - c) Carolus Linnaeus.
 - d) Louis Pasteur.
4. Poison ivy belongs to the sumac family, the Anacardiaceae, which has about 600 species. Poison ivy in the US has seven varieties; two are *Toxicodendron radicans radicans* (plant 1) and *Toxicodendron radicans verrucosum* (plant 2). The sumac family also contains poison sumac (*Toxicodendron vernix*, plant 3) and a Florida plant called poison-wood (*Metopium toxiferum*, plant 4). Of these four plants, you would expect the fewest DNA similarities between plants
 - a) 1 and 2.
 - b) 2 and 3.
 - c) 3 and 4.
 - d) 1 and 3.
5. A book on poisonous plants lists 68 unrelated families in which poisonous plants are found. However, most of the plants in these 68 families are not poisonous. This seems to be evidence that being poisonous
 - a) evolved independently in many different plant lineages.
 - b) gives a plant species a decisive selective advantage.
 - c) arose before most current plant families evolved.
 - d) is not controlled by the genetics of a plant.
6. Poison ivy cells would have ..., but human cells would not.
 - a) an endoplasmic reticulum
 - b) a cell wall
 - c) mitochondria
 - d) a membrane-bound nucleus.

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7. The picture below shows an important poison ivy cellular process--making The organelle shown in the picture is a



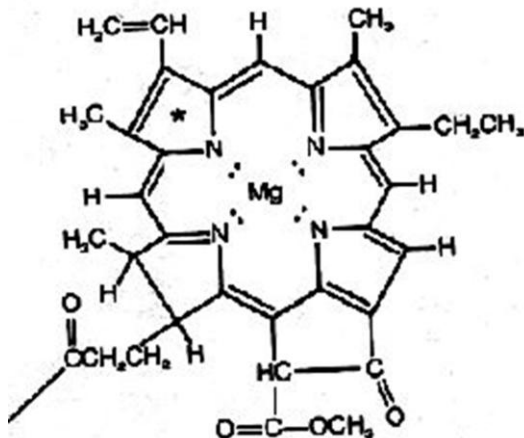
- a) proteins ... ribosome. b) enzymes ... Golgi apparatus.
 c) starch ... centriole. d) ATP ... mitochondrion.

8. In the picture above, the "beaded" molecule that is emerging from the organelle is ... and the long, ribbon-like molecule is

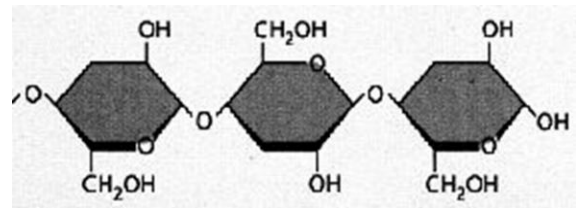
- a) a protein ... DNA. b) cytochrome ... starch.
 c) a polypeptide ... mRNA. d) a carbohydrate ... amylase.

9. Poison ivy contains large amounts of both of the molecules 1 and 2 below. The first molecule has a long hydrocarbon tail attached at its bottom left, and the second one is part of a very long series of units like the three shown.

Molecule 1



Molecule 2



These two molecules are ... and ..., respectively.

- a) ATP and starch. b) DNA and RNA.
 c) glucose and fructose. d) chlorophyll and cellulose.

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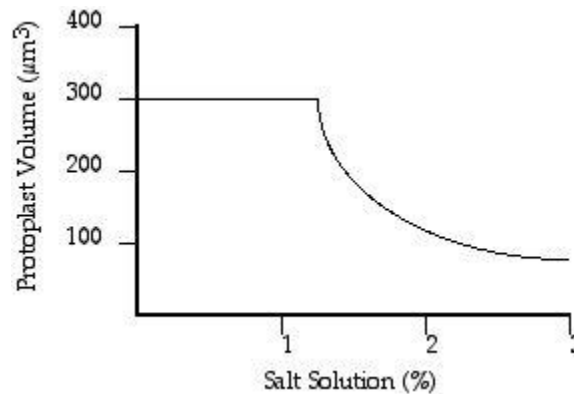
10. We would expect to find most of the first molecule above in a poison ivy cell's ..., and the second molecule would be found in its

- a) nucleus ... ribosomes.
- b) mitochondria ... food vacuoles.
- c) chloroplasts ... cell walls.
- d) nucleus ... lysosomes.

11. The "protoplast" of a plant cell includes the cell membrane and everything inside it. Human red blood cells are isotonic to a 0.85% NaCl solution. A botanist places some poison ivy tissue (with intact cell walls) in this solution, and the cell protoplasts inside the cell walls neither swell nor shrink. From these data alone, she can conclude that poison ivy cells are ... to human red blood cells.

- a) isotonic
- b) either isotonic or hypertonic
- c) either isotonic or hypotonic
- d) either hypotonic or hypertonic

12. The botanist collects further data on the equilibrium volume of the poison ivy cells in several different solutions:



With these new data, we can conclude that poison ivy cells are ... to human red blood cells.

- a) hypertonic
- b) isotonic
- c) hypotonic
- d) None of these. The new data do not show a pattern consistent with osmosis.

13. Like most plants, poison ivy produces its own complex organic molecules by photosynthesis. This means that it is a(n)

- a) autotroph.
- b) heterotroph.
- c) mixotroph.
- d) homotroph.

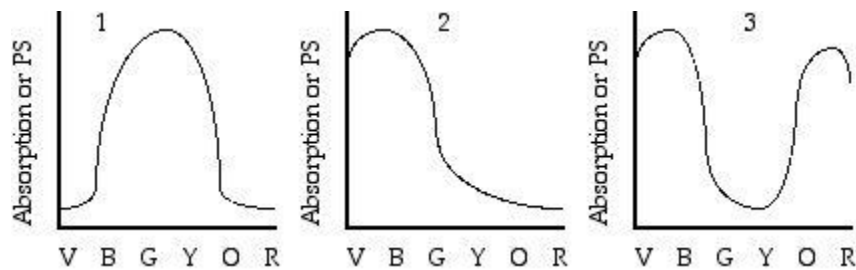
14. Photosynthesis is an ... reaction, meaning that the products contain ... bond energy than the reactants did.

- a) exergonic ... more
- b) exergonic ... less
- c) endergonic ... more
- d) endergonic ... less

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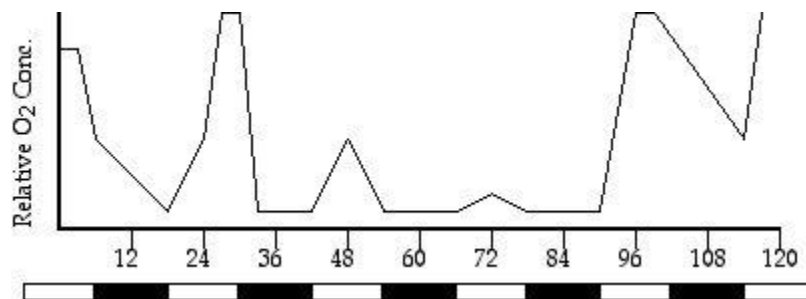
15. The graphs below show three curve shapes that depict either how absorption of light or photosynthesis might vary with light color in a green poison ivy leaf. "VBGYOR" gives the colors of light as violet, blue, green, yellow, orange and red.



The absorption of light by a poison ivy leaf varies with light color as in curve ... above; the photosynthesis of the leaf varies with light color as in curve

- a) 1 ... 2. b) 1 ... 3. c) 3 ... 1. d) 3 ... 3.

16. The botanist who did the osmotic experiment on the poison ivy cells then performs a photosynthetic experiment. She puts a poison ivy plant in a sealed container for five days in its natural location on the edge of a forest. The record of O_2 concentration in the container is as follows:



Here, the numbers on the x axis are hours since the start of the experiment, and the light and dark bars underneath represent periods of daylight and darkness, respectively. Oxygen rises in the container in periods when ...; it falls in periods when

- a) respiration exceeds photosynthesis ... photosynthesis exceeds respiration.
 b) photosynthesis exceeds respiration ... respiration exceeds photosynthesis.
 c) respiration is occurring ... photosynthesis is occurring.
 d) photosynthesis (but not respiration) is occurring ... respiration (but not photosynthesis) is occurring.

17. The strange results around 72 hours could be explained by a

- a) very cloudy day.
 b) cool day when respiration was low but photosynthesis was high.
 c) sunny day when the plant's stomata were wide open.
 d) a hot, sunny day when respiration and photosynthesis both went up by the same amount.

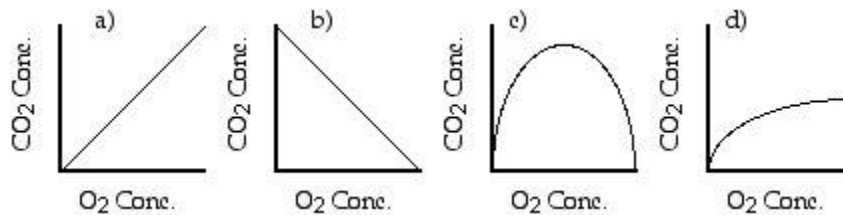
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18. Notice that the oxygen plateaus on some days (that is, it never gets higher than a certain concentration). This could be caused by the fact that

- a) CO₂ in the chamber is all taken up before the day is over.
- b) a high oxygen concentration stimulates plant respiration.
- c) plants that have high sugar concentrations respire more.
- d) All of these could limit oxygen increase per day.

19. If we were to graph many observations of the concentration of O₂ in the chamber against simultaneous observations of the concentration of CO₂ in the chamber over the five days above, we would see a pattern like



20. Photosynthesis generates oxygen mostly directly because

- a) CO₂ is reduced by the light-independent reactions.
- b) ribulose biphosphate has five carbons but glucose has six.
- c) the light-dependent reactions split water.
- d) oxygen is the final electron acceptor in photosynthesis.

21. Poison ivy often climbs up tree trunks. When a plant stem grows up, this is called ... geotropism and is caused mainly by different amounts of ... on the top and bottom of the stem.

- a) positive ... gibberellins
- b) negative ... auxins
- c) positive ... cytokinins
- d) negative ... oligosaccharins

22. A poison ivy vine can get as thick as a person's wrist. If such a thick, woody vine were cut, the bulk of the vine cross-section would consist of On the other hand, if a thin, growing tip of a poison ivy vine were cut, most of the cross-section there would consist of

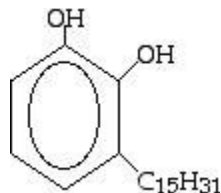
- a) secondary xylem ... parenchyma.
- b) parenchyma ... primary phloem.
- c) parenchyma ... sclerenchyma.
- d) ovary wall ... endosperm.

23. In trying to decide whether poison ivy is a monocot or a dicot, it is relevant to consider the fact(s) that poison ivy has

- a) net-veined leaves.
- b) secondary growth.
- c) a corolla with 5 petals.
- d) All of these.

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24. Poison ivy is poisonous because of a heavy, yellow oil called urushiol. This oil is a mixture of catechol molecules with slightly different side chains; an example is



The side chain is a long hydrocarbon chain. Urushiol is probably water-... because it

- a) soluble ... has a hydrogen:carbon ratio greater than 2:1.
- b) soluble ... has a benzene ring.
- c) insoluble ... mostly consists of a highly nonpolar hydrocarbon chain.
- d) insoluble ... is such a large molecule.

25. Some people are so sensitive to urushiol that their skin will erupt in blisters if they are exposed to as little as 2 micrograms. This is about 1/30 of the weight of a single grain of table salt. If urushiol has a density of 1 g/mL, like water, then 1 mL of urushiol contains ... effective doses of 2 micrograms each.

- a) 5 million
- b) 500,000
- c) 500
- d) 0.5

26. Contrary to popular belief, the urushiol does not appear on the surface of undamaged leaves. It is carried in resin canals near the phloem of the leaf, stem, and fruit, and only would be on the leaf surface if the leaf is injured somehow. The normal function of phloem in a plant is to

- a) transport organic material.
- b) synthesize poisonous oils.
- c) absorb water from the soil.
- d) make gametes.

27. When urushiol gets on human skin, it penetrates the top layer of skin cells and binds to cells deep in the epidermis within about 30 minutes. After this, the urushiol is almost impossible to wash off. Urushiol itself is harmless, but now the trouble begins as a cell-mediated immune response is mounted against all cells that have urushiol on their membranes. This causes tissue destruction and blistering. This cell-mediated response will consist mostly of

- a) abundant production of antibodies by plasma cells.
- b) lysing of affected cells with perforins from cytotoxic T-cells.
- c) a release of histamine from B-cells.
- d) enormous production of immunoglobulins by erythrocytes.

28. Of course, the poison ivy symptom that most people notice is itching. The reason for the itching is not understood, but it must somehow involve stimulation of sensory neurons in the skin. The inflammation ... the permeability of sensory neuron membranes to ... and causes the initiation of an action potential.

- a) increases ... potassium
- b) decreases ... sodium
- c) decreases ... potassium
- d) increases ... sodium

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29. When the person scratches the itchy area, a sequence of events leads to muscle contraction. Consider this list of events:

1. Calcium ions spill from sarcoplasmic reticulum.
2. Troponin moves aside to reveal actin active sites.
3. Myosin attaches to actin.
4. ATP is split and ADP and inorganic phosphate are released.
5. Myosin heads bend.

The correct order of these events is

- a) 1 2 3 4 5 b) 3 1 2 5 4 c) 3 1 5 2 4 d) 1 3 2 5 4

30. The body attempts to limit the damage of poison ivy by secreting anti-inflammatory hormones called corticosteroids. These also suppress the immune response that causes the rash. These hormones come from the ... gland.

- a) pituitary b) adrenal c) thyroid d) pineal

31. Ironically, we don't know why poison ivy produces urushiol. It is not to protect the plant, because many kinds of mammals and birds eat poison ivy berries without ill effect. If a raccoon eats a poison ivy berry, and assuming that raccoon digestion is similar to human digestion, protein in the berry will be attacked by enzymes for the first time in the raccoon's

- a) mouth. b) stomach. c) small intestine. d) large intestine.

32. The raccoon needs to eat protein because protein supplies it with

- a) vitamins. b) carbohydrates. c) amino acids. d) purines.

33. Some people seem to be immune to poison ivy. Which of the following is the most convincing explanation of immunity? "Resistant people don't have

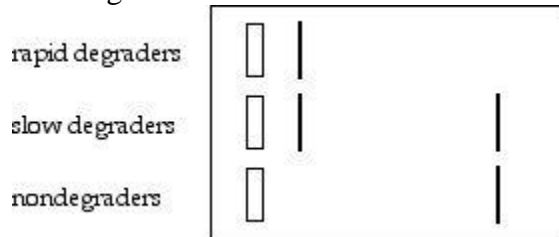
- a) cytotoxic T cells that secrete perforin."
- b) a sufficiently high albumin concentration in the blood."
- c) helper T cells that recognize urushiol."
- d) erythrocytes that secrete immunoglobulins."

34. Assume that resistance to poison ivy is controlled at one X-linked locus, and the resistance allele is completely dominant. If a resistant man marries a heterozygous resistant woman,

- a) all their offspring will be resistant.
- b) all their sons will be resistant, but all their daughters will be sensitive.
- c) half their sons and all their daughters will be resistant, but half their sons will be sensitive.
- d) all their daughters will be resistant, and all their sons will be sensitive.

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35. Another way of being resistant to poison ivy is to be able to break down the urushiol before the immune system recognizes it. Say that urushiol is broken down by an enzyme controlled at a single, autosomal locus. Furthermore, there are three phenotypic classes in the general population: rapid degraders (who show few poison ivy symptoms), slow degraders (who show intermediate symptoms), and nondegraders (who show full symptoms). If we perform electrophoresis on the enzyme in each of these phenotypic classes, we see the following:



The empty rectangles represent the loading wells. These data are consistent with the idea(s) that

- a) both nondegraders and rapid degraders have the same enzyme but different genotypes.
- b) each enzyme contains four subunits, and its effectiveness depends on the number of efficient subunits that it has.
- c) the enzyme locus can hold four possible alleles, and each allele produces an enzyme with a different effectiveness.
- d) slow degraders are heterozygotes that make both an effective and an ineffective enzyme.

36. The gene for one form of this enzyme begins with the sequence ACTTAG. This segment of DNA codes for ... amino acids and would be transcribed into the RNA sequence

- a) 2 ... UGAAUC
- b) 3 ... ACUUAG
- c) 3 ... UGAAUC
- d) 2 ... GATTCA

37. Some people can get poison ivy in their respiratory tracts from inhaling smoke that contains urushiol on tiny particles of soot. This is a serious problem for firefighters who control forest fires. If a smoke particle is being inhaled and it has just passed the larynx, it will next encounter the

- a) trachea.
- b) pharynx.
- c) alveoli.
- d) sinus cavities.

38. If the poison ivy rash is scratched excessively, it can lead to bacterial infection. Bacteria are ... cells, which means that they don't have

- a) prokaryotic ... DNA.
- b) eukaryotic ... ribosomes.
- c) prokaryotic ... nuclei.
- d) intronic ... messenger RNA.

39. If a doctor wants to identify the bacteria that have infected a wound, he might determine whether the bacteria are Gram-positive or Gram-negative. This is decided by determining whether or not the bacteria

- a) have flagella.
- b) are colored by a certain dye.
- c) are resistant to a certain antibiotic.
- d) can form spores.

40. Poison ivy functions in an ecosystem as one of the

- a) primary producers.
- b) primary consumers.
- c) secondary consumers.
- d) decomposers.