Clemson University Biology Merit Exam
8 April 2005

Please choose the **best** answer for each of the following questions. Questions marked with an "*" are worth 4 points each; questions marked with a "#" are worth 2 points each; the unmarked questions are worth 1 point each.

CAUTION: Incomplete erasures and smudges can be read as marks. To avoid having a choice read incorrectly, make your marks lightly at first. After you have made all your changes, blacken in your marks just before you turn in your answer sheet.

The theme of this exam is roses, perhaps the most beautiful and symbolic of flowers.

1. Roses belong to the Kingdom
   a) Plantae. b) Chlorphyta. c) Anthozoa. d) Fungi.

2. Rose cells have
   a) cellulose cell walls. b) membrane-bound nuclei in their cells.
   c) chloroplasts. d) <u>All</u> of these.

3. Humans and roses <u>both</u> have
   a) cellulose cell walls. b) membrane-bound nuclei in their cells.
   c) chloroplasts. d) <u>All</u> of these.

4. Some common wild rose species are *Rosa rugosa, Rosa multiflora,* and *Rosa glauca*. Therefore, *Rosa* is the
   a) genus b) species. c) class. d) variety.

5. Roses belong to the family Rosaceae. They also belong to the subfamily Rosoideae, which includes strawberries. Apples are in the Rosaceae, but in the subfamily Pomoideae. The <u>least</u> related pair is

a) *Rosa rugosa* and *Rosa multiflora.*
b) strawberries and *Rosa multiflora.*
c) strawberries and *Rosa rugosa.*
d) apples and *Rosa glauca*.

6. Most garden roses have from 25-45 petals, but wild roses, from which they were derived, usually have 5 petals (see pictures below). Roses also have woody stems. Finally, the veins in rose leaves branch off a central vein. This means that roses are
a) monocots.
b) dicots.

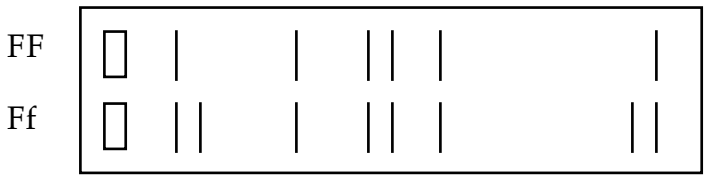

Left: Variety 'Anna Pavlova,' a product of the rose breeder's art. Right, *Rosa canina*, a wild rose of Europe, and one of the first roses to be cultivated there.

7. The names "monocot" and "dicot" refer to whether the plant in question has one or two of a certain plant part
a) on its leaves.
b) in its flower.
c) in its seeds.
d) on its roots.

8. Most roses that we grow in our gardens are not species found in the wild, but hybrids developed by breeders. For example, tea roses are hybrids of *R. chinensis* and *R. gigantea* that have especially fragrant blooms, more fragrant than the blooms of either of the parent species. Assume that fragrance is partly controlled at the F locus. *R. chinensis* uniformly has the genotype FF, and *R. gigantea* has the genotype ff. A cross between these two species will produce offspring that all
a) have the same F phenotype.
b) have the same F genotype.
c) are heterozygous at the F locus.
d) <u>All</u> of these.

* 9. Recall that tea roses are more fragrant than *R. chinensis* (FF) or *R. gigantea* (ff). Fragrance at the F locus cannot be governed by ... dominance because all the *R. chinensis* x *R. gigantea* offspring have
a) complete ... a broad range of phenotypes.
b) incomplete ... the same phenotype.
c) complete ... a different phenotype from both parents.
d) incomplete ... the same phenotype as one parent.

* 10. The DNA of an FF rose is treated with a restriction enzyme and electrophoresed. Then the DNA of a heterozygous plant is treated with the same enzyme. The results are shown below. Assume that only DNA that is part of the F and f genes is shown.



Our conclusions from this are that the F allele contains ... restriction sites for the enzyme and the f allele contains ... sites.

a) 6 ... 8 b) 5 ... 1 c) 6 ... 2 d) 3 ... 4

* 11. The results above seem to indicate that

a) the F allele is larger than the f allele.
b) the F allele is smaller than the f allele.
c) the F and f alleles are about the same size.

* 12. Assume that fragrance is controlled at three loci, and that tea roses are heterozygous at all three loci. A "rosarian" (rose enthusiast) crosses his two most fragrant tea roses together. The offspring of this cross will ... because

a) all be more fragrant than the original two tea roses ... dominant and recessive alleles will magnify each other's effects.
b) not be fragrant at all ... dominant and recessive alleles will cancel each other.
c) have a range of fragrance ... only some of the offspring will be heterozygous at all three loci, like the parent tea roses.
d) have a range of fragrance ... half the offspring will have the same genotype as *R. chinensis*, and half will have the same genotype as *R. gigantea.*

13. Say that tea roses have such strong fragrance because they have a certain enzyme. If this enzyme is like most enzymes, it is composed of ... linked by ... bonds.

a) amino acids ... peptide b) fatty acids and glycerols ... ester
c) monosaccharides ... glycosidic d) nucleotides ... phosphodiester

\# 14. All the bonds mentioned in answers a-d of the previous question have in common the fact(s) that they

a) are based on double carbon-carbon bonds.
b) are formed by dehydration synthesis.
c) are the result of acid-base reactions.
d) <u>All</u> of these.

15. Part of the fragrance enzyme above is coded by a section of DNA that reads TGTGCCGTG. The DNA complementary to this strand will read

a) AGAGCCGAG. b) GTGCCGTGT.
c) ACACGGCAC. d) GAGCCGAGT.

16. The DNA section above gets involved in protein synthesis. Consider the following steps.

1. RNA polymerase moves along DNA.
2. The small and large ribosomeal subunits come together.
3. DNA unwinds.
4. The first codon-anticodon base pairing takes place.
5. The first peptide bond is formed.
6. tRNA picks up the first amino acid.

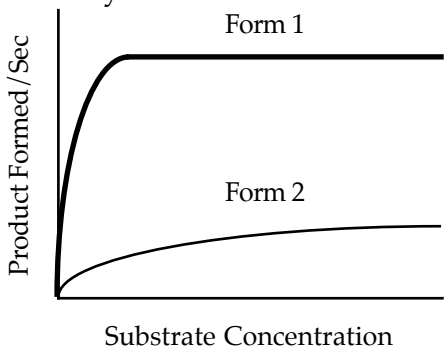
In what order would these steps occur?

a) 3 1 2 4 5 6
b) 2 1 3 6 5 4
c) 4 3 1 2 5 6
d) 3 1 2 6 4 5

* 17. Given that this gene does produce an enzyme, does the gene contain exons? Does it contain introns?

a) Yes, and certainly no.
b) Yes, and probably yes.
c) No, and certainly yes.
d) No, and probably no.

* 18. The enzyme that produces the fragrant compound exists in two forms. A biochemist compiles the following data on the reaction rate of the two forms. The graphs show the amount of product produced per unit time as a function of the initial concentration of the enzyme's substrate:



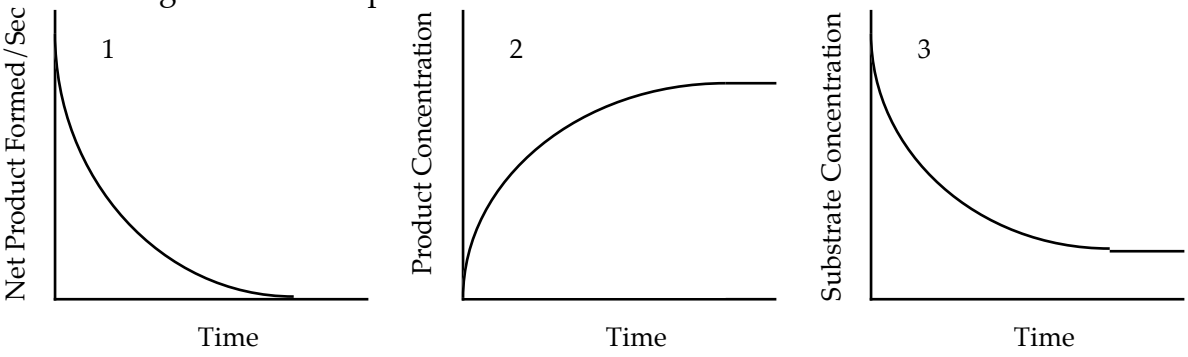
The enzyme form that has the higher maximum reaction rate is ...; the form that has the higher affinity for the substrate molecule is

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

19. The reason that both curves level off as they go to the right is that at high substrate concentrations,

a) the backward reaction becomes more important than the forward reaction.
b) the substrate is acting as an inhibitor.
c) all the enzyme active sites are occupied by substrate.
d) the enzyme becomes denatured.

* 20. Suppose we incubate a moderate quantity of substrate with Form 1 of the enzyme. The reaction has everything it needs to form product. Which of the following would we expect in the next few minutes?

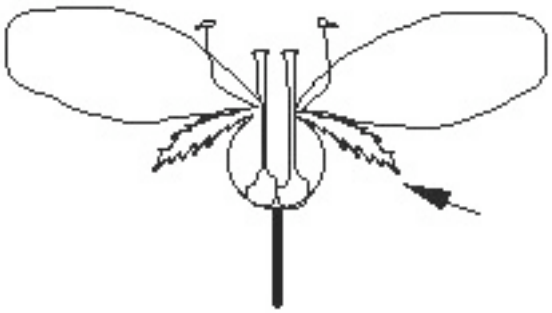


a) 1 would happen, but not 2 and 3.
b) 2 would happen, but not 1 or 3.
c) 2 and 3 would happen, but not 1.
d) <u>All</u> of these curves are expected.

\# 21. In the wild, roses with fragrance have an advantage mainly because they can
a) repel herbivores.
b) attract pollinators.
c) get rid of toxic compounds.
d) photosynthesize more efficiently.

22. Roses would just be another plant if it weren't for their beautiful flowers. Flowers allow the rose plant to
a) engage in sexual reproduction.
b) warn herbivores that its leaves are toxic.
c) store soil nutrients.
d) take up water even when the soil is dry.

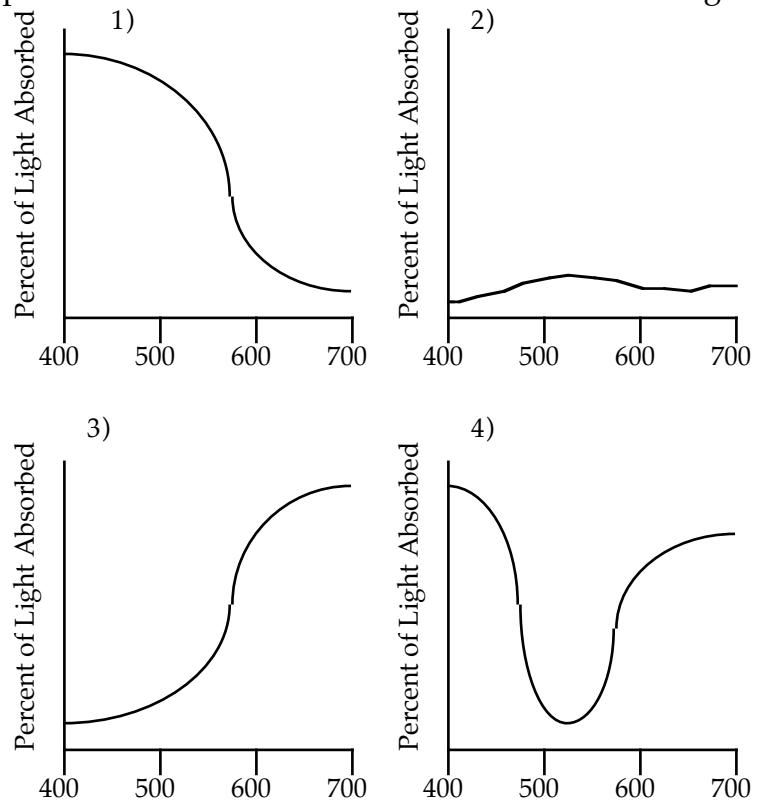
\# 23. The following very simple diagram of a rose flower is on the American Rose Society Web site.



The structure indicated by the arrow is a
a) petal.
b) stigma.
c) style.
d) sepal.

The next question deals with rose color. Dr. Kosinski's wife (who is a florist) tells him that red roses are said to symbolize love, white roses signify innocence or a secret that needs to be kept, yellow roses indicate friendship, and coral roses indicate desire. Finally, Clemson fans will want to know that orange roses symbolize *fascination*.

* 24. Say a rose plant has glossy, green leaves, some flowers that are almost white, and other flowers that range from light pink to red. The absorption spectra for a leaf, a white flower, and a red flower are shown below. Another (irrelevant) absorption spectrum is also shown. The x axis shows wavelength in nm.



The absorption spectra for the leaf, the white flower, and the red flower, respectively, are shown in graphs

a) 1, 3, and 2. b) 4, 2, and 1. c) 4, 2, and 3. d) 3, 4, and 1.

* 25. The leaves are absorbing light. Most of the energy of this light is ..., but at least some of the light energy is

a) re-radiated as heat ... captured in bond energy in NADPH.
b) used to split chlorophyll ... used to synthesize water from hydrogen and oxgyen.
c) captured in bond energy in NADH and $FADH_2$ ... used to oxidize CO_2.
d) united with oxygen to form water ... used to liberate CO_2.

\# 26. Rose leaves absorb more than energy. If they are to use the light energy productively, they must also take up ... from the <u>air</u>. They will use this material

a) CH_4 ... as an energy source to power photosynthesis.
b) NH_3 ... to make amino acids from fatty acids.
c) H_2O ... to replace water given off in respiration.
d) CO_2 ... to synthesize sugar in the Calvin-Benson Cycle.

* 27. It is a warm, sunny day with a moderate breeze in the rose garden. Then the sun sets. You would expect that the absorption of the substance in question 26 would ... as darkness falls because
a) decrease ... NADPH gets so high at night that it poisons the Hill Reaction.
b) increase ... when a plant is not photosynthesizing, it is making proteins.
c) decrease ... the guard cells lose potassium and water as darkness falls.
d) increase ... if photosynthesis is not going on, the plant needs an alternate energy source.

* 28. If the soil begins to dry out and the rose plant becomes stressed by lack of water, the hormone ... will probably be released and will also influence the ability of the plant to absorb the substance in question 26.
a) auxin b) abscisic acid c) cytokinin d) florigen

29. Roses prefer soil with a pH of about 6.0. This soil would be considered
a) acidic. b) basic. c) exactly neutral.

* 30. The concentration of hydrogen ions in a solution with pH 6.0 would be about ... times their concentration in a solution with pH 6.5.
a) 100 b) 3 c) 0.3 d) 0.01

\# 31. A certain rose food is a blue powder that is dissolved in water. The roses are then watered with the solution. Suppose a gardener reasons that if a little is good, a lot more will be better, and he makes a solution that is 10 times as concentrated as the recommended one. He has created a fertilizer solution that will be ... to the rose root cells, and the cells immersed in this solution will probably ... water.
a) hypotonic ... take on b) hypotonic ... lose
c) hypertonic ... take on d) hypertonic ... lose

\# 32. Because most garden roses have been produced by breeders who care mostly about big, showy blooms, these roses have fewer defenses against herbivores than the less spectacular wild roses. One of the worst rose enemies is the Japanesee beetle. The beetle adults eat the flowers. As a beetle's mandibles crush and pierce a rose cell, they will first contact the cell wall, consisting mostly of ..., then the cell membrane, mostly ..., and then finally the chromatin, mostly made up of
a) cellulose ... phospholipid ... DNA and protein.
b) triglycerides ... glycogen ... amino acids and fatty acids.
c) fructose ... proteoglycans ... chitin and lipoprotins.
d) steroids ... amylose ... nucleic acids.

\# 33. The gardener arrives and sees the beetles on the roses. He recognizes them instantly because of their green and copper color. The gardner is able to perceive color on the beetles because
a) the iris refracts each color of light slightly differently.
b) the retina contains three different types of cones, each with a different visual pigement.
c) blues and greens fall on the sclera, but "warmer" colors fall on the choroid.
d) the lens bends light so each color falls on a different section of the conjunctiva.

The Japanese beetle, *Popillia japonica.*

3 * 4. The gardener is dismayed at the damge the beetles have already done. After a season of work, he could lose his roses in one day! The emotional stress causes his heart to beat faster because

a) luteinizing hormone is being released and is saturating receptors in the cardiac center of the medulla.
b) corticotropin is stimulating his vagus nerve.
c) thyroxine is making the AV node less of a barrier to transmission of impulses.
d) epinephrine is causing his SA node to be more leaky to calcium ions.

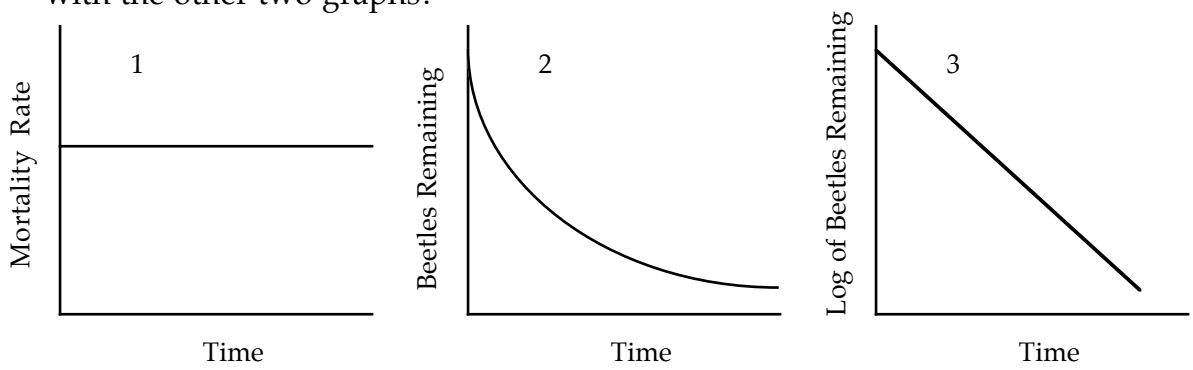
35. The gardener wastes no time. He turns to hurry to his garage. His muscles are contracting because action potentials in his motor nerves are directly causing

a) actin in his muscles to polymerize into a spiral.
b) hydrolysis of the peptide bond between myosin and actin.
c) calcium ions to spill from his sarcoplasmic reticulum.
d) troponin and tropomyosin to become temporarily insoluble.

36. The garage is some distance away and up a hill. As the gardener exercises, some physiological variables are going to increase, and some are going to decrease. Two that will increase might be ...; two that will decrease might be

a) venous CO_2 and cardiac output ... arterial blood pH and venous oxygen.
b) blood pressure and oxygen saturation of venous hemoglobin ... breathing rate and arterial vasoconstriction.
c) venous blood pH and velocity of blood flow in the aorta ... blood pressure in the capillaries and body temperature.
d) velocity of blood flow in the aorta and arterial blood pH ... oxygen concentration in the alveoli and blood pressure.

* 37. The gardener gets a can of insecticide and returns to the garden. When this insecticide was being tested by the manufacturer, a group of Japanese beetles were subjected to a low concentration, and the number of living beetles over time was recorded. Which graph below (if any) shows a pattern of results that is inconsistent with the other two graphs?



a) 1 does. b) 2 does. c) 3 does.
d) <u>All</u> three graphs tell a consistent story.

\# 38. This particular insecticide blocks neurotransmitter receptors in synapses. The main and most direct result of this will be that the Japanese beetles will be unable to
a) stop neurons from firing action potentials after a stimulus has passed.
b) transmit an action potential from one neuron to another.
c) carry out saltatory conduction.
d) repolarize their axon membranes after an action potential has passed.

39. By the dozen, the Japanese beetles drop off the roses and fall onto the ground. They lie on their backs, spasmodically waving their legs in the air. To be sure they're dead, the gardener steps on them as they fall. They crunch underfoot because he is crushing their hard ... exoskeletons.
a) purine b) cellulose c) peptidoglycan d) chitin

40. The gardener has won this round, but a few beetles are still hidden on the roses. They happened to be resistant to the insecticide. They will lay their eggs in his lawn, the grubs will feed on the roots of his grass, and next year the Japanese beetle adults on his roses will be mostly resistant to this insecticide. This story is most clearly an example of
a) mutation. b) genetic drift. c) natural selection. d) linkage.