

**University of Toronto
Ontario Biology Competition**

1997 Examination

Time: 90 minutes

Number of questions: 60

General Instructions

- Do not open this booklet until you are instructed to do so.
- Print your name at the top of this booklet.
- Indicate all of your answers to the questions on the separate Response Form. No credit will be given for anything written in this booklet, but you may use the booklet for notes or rough work. No additional time will be given after the exam to transfer your answers to the Response Form.
- After you have decided which of the suggested answers is best, COMPLETELY fill in the corresponding bubble on the Response Form. Give only one answer to each question. If you change an answer, be sure that the previous mark is erased completely.
- Use your time effectively. Do not spend too much time on questions that are too difficult. Go on to other questions and come back to the difficult ones later if you have time. It is not expected that everyone will be able to answer all questions.
- Good luck and have fun!

Should you guess the answers to questions about which you are not certain?

Since your score on the exam is based on the number of questions you answered correctly minus one-third of the number you answered incorrectly, it is improbable that guessing will improve your score (it is more likely to lower your score). (No points are deducted or awarded for unanswered questions.) However, if you are not sure of the correct answer but have some knowledge of the question and are able to eliminate one or more of the answer choices, then your chance of getting the right answer is improved, and it may be advantageous to answer such a question.

1. Which statement is **FALSE**?
 - a. A ribosome is smaller than a centriole.
 - b. The nucleus has one membrane surrounding it.
 - c. Plant cells contain mitochondria.
 - d. A centriole contains microtubules.
 - e. The largest organelle in a typical plant cell is the vacuole.

2. A scientist put some plant cells in a solution of glucose and, after 30 minutes, measured the concentration of glucose inside the cells. When she repeated the experiment using double the concentration of glucose in the solution, the concentration of glucose inside the cells also doubled. Which of the following principles does this experiment demonstrate?
 - a. Glucose enters plant cells by active transport.
 - b. Glucose enters plant cells by endocytosis.
 - c. Glucose enters plant cells by some type of diffusion.
 - d. Plant cells cannot synthesize glucose.
 - e. Glucose moves into plant cells by osmosis.

3. Which statement best explains why protozoans that live in pond water must use exocytosis to get rid of excess water in their cytoplasm?
 - a. The pond water is hypotonic to the protozoan cytoplasm.
 - b. The pond water is hypertonic to the protozoan cytoplasm.
 - c. The pond water is isotonic to the protozoan cytoplasm.
 - d. Water cannot diffuse across the protozoan plasma membrane.
 - e. Protozoans take up water by endocytosis; therefore, they must expel it by exocytosis.

4. Plant cells can often grow larger than animal cells because:
 - a. photosynthesis produces more energy than does respiration.
 - b. plant cells need less food than animal cells.
 - c. plants use their energy for growth while animals spend much of their energy on movement.
 - d. plant cells have a cell wall which makes their surface to volume ratio very large.
 - e. the large central vacuole of plant cells reduces the depth of the cytoplasm and allows entering molecules to rapidly diffuse from the plasma membrane to all parts of the cytoplasm.

5. Which of the following cell types provide mechanical support for plants?
 - a. Tracheids, sclerenchyma fibres, collenchyma
 - b. Sclerenchyma fibres, cork, cortex
 - c. Sieve tubes, vessel elements, epidermis
 - d. Sclerenchyma fibres, pith cells, epithelial cells
 - e. Pith, cortex, xylem

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6. Water can move from the soil and up through the world's tallest living tree (which is 110 metres high) by which of the following process(es)?
- Osmosis
 - Root pressure
 - Pressure flow
 - Adhesion and cohesion of water molecules
 - All of the above
7. Which statement about the function of the Casparian strip is **CORRECT**?
- It prevents excess transpiration from leaves.
 - It regulates ion movement into the root vascular cylinder.
 - It prevents disease organisms from invading the plant.
 - It prevents ions from leaking out of the xylem into leaves.
 - It is the pathway for nutrient transfer from xylem to phloem.
8. What path does a carbon atom take in going from the atmosphere into the cell wall of a root cap cell?
- Stoma---proplastid---chloroplast---vessel element---procambium---apical meristem---root cap
 - Stoma---chloroplast---phloem---apical meristem---procambium---root cap
 - Stoma---chloroplast---vessel element---procambium---apical meristem---root cap
 - Stoma---chloroplast---sieve tube---procambium---apical meristem---root cap
 - All of these paths are possible.
9. The plant growth regulator involved in aging and ripening of fruit is:
- cytokinin.
 - auxin.
 - gibberellin.
 - abscisic acid.
 - ethylene.
10. Which of the following provides the best evidence that all known forms of life descended from a common ancestor?
- DNA
 - Chloroplasts
 - The genetic code
 - The homeobox sequence
 - Mitochondria

11. Two cells which are exactly like the original cell result from:
- gamete formation.
 - meiosis.
 - mitosis.
 - sexual reproduction.
 - syngamy.
12. Imagine that in a plant, hairy leaves are dominant to smooth leaves, and blue flowers are dominant to white. You cross a pure breeding hairy-leaved, blue-flowered strain with a pure breeding smooth-leaved, white-flowered strain. You allow the offspring to self-fertilize, and observe that the F₂ offspring are 69% hairy-leaved and blue-flowered, 19% smooth-leaved and white-flowered, 6% hairy-leaved and white-flowered, and 6% smooth-leaved and blue-flowered. Based on these observations you can conclude that the two genes:
- are in the same biochemical pathway.
 - segregate independently.
 - exhibit typical Mendelian ratios.
 - are on the same chromosome.
 - show epistatic interactions.
13. Recently, scientists induced a single diploid cell from an adult sheep (the "mother") to grow into a lamb, named Dolly. How closely are Dolly and her "mother" related?
- They are completely unrelated.
 - They are about as related as a brother and a sister would be.
 - They are about as related as fraternal twins.
 - They are about as related as identical twins.
 - They are completely identical genetically.
14. You are moving to Africa and you have heard that the Green Fever virus disease is common there. Before you leave, you visit your doctor for advice. Which of the following is your doctor most likely to recommend? You should:
- take a large supply of antibiotics with you.
 - wash your food in an antiseptic before you eat it.
 - get vaccinated against the disease.
 - not worry as viruses only cause diseases in plants.
 - get regular blood tests which will use the light microscope to look for virus particles.

15. A hospital technician, while doing some routine culturing of micro-organisms in a lab, noticed a bacterial colony growing on a culture medium containing three different antibiotics. He identified the bacterium as one that did not cause a human disease, but he still reported his observation to the hospital administration. Which statement is **CORRECT**? He was worried because:
- he had no way of killing this bacterium now that it was resistant to antibiotics.
 - resistance to antibiotics could be transferred to disease-causing bacteria by transduction or conjugation.
 - the bacterium might feed on the antibiotics and therefore be able to grow in people taking these antibiotics.
 - there should be no bacteria inside a hospital.
 - if people accidentally ingested the bacteria with their food, they would become resistant to the antibiotic.
16. Which statement is **FALSE**?
- Viruses primarily contain nucleic acids and protein.
 - All viruses are parasites.
 - Bacteria are usually less than 2 micrometres in diameter.
 - Autotrophic bacteria can use carbon dioxide as their sole source of carbon.
 - Bacteria can only fix nitrogen when they are inside the root nodules of leguminous plants, such as peas and beans.
17. Which statement is **FALSE**?
- Pepsin is an enzyme that acts on peptide chains to digest proteins.
 - The enzyme enterokinase produces the protein-digesting enzyme trypsin from trypsinogen.
 - The bile helps digestion by breaking fat into tiny droplets.
 - The pancreas produces more than 20 different digestive enzymes.
 - Salivary amylase starts the process of protein digestion in the mouth.
18. Which of the following best represents the path taken by an amino acid molecule after it is ingested?
- mouth---salivary glands---oesophagus---small intestine---pancreas
 - mouth---oesophagus---stomach---duodenum---liver
 - mouth---duodenum---stomach---small intestine---colon
 - mouth---oesophagus---pancreas---jejunum---stomach
 - mouth---jejunum---liver---colon---small intestine
19. Which of the following statements about the gills of fish is **FALSE**?
- The flow of water over the gill is in the same direction as the flow of blood in the filament.
 - Oxygen gas dissolved in the water diffuses into blood vessels of the gill.
 - Blood flows into and out of each filament of the gill in separate vessels.
 - Decreasing the rate of movement of water over the gills would decrease oxygen uptake.
 - Most fish actively force water over their gills by movement of the operculum.

20. In a mammalian lung the rate at which oxygen could be obtained from the air would increase if:
- tidal volume decreased.
 - the cells lining the alveoli and capillaries were thinner.
 - blood haemoglobin content were lower.
 - you ascended to a higher altitude.
 - the alveoli were larger.
21. Which statement is **FALSE**?
- Capillaries in muscle are usually empty of blood.
 - The mammalian heart will continue to beat when its nerve supply is cut.
 - In vertebrates, veins can be distinguished from arteries because veins carry deoxygenated blood.
 - Water and small molecules can easily pass through the walls of most capillaries.
 - Circulation of blood in the coronary arteries is greatest during diastole, when the heart is filling.
22. If a molecule of carbon dioxide released into the blood in the foot of a human foetus is exhaled through the mouth of the mother, it will **NOT** travel through the:
- right atrium of the foetus.
 - right atrium of the mother.
 - left ventricle of the foetus.
 - left ventricle of the mother.
 - placenta.
23. Which statement is **FALSE**?
- Cell division to form a blastocyst begins after the fertilized egg is implanted in the endometrium of the uterus.
 - The placenta contains cells derived both from the embryo and the mother.
 - Follicle stimulating hormone (FSH) stimulates the production of sperm in the male testes.
 - Human males can continue to produce sperm throughout life, whereas females stop producing eggs during menopause.
 - Some female mammals only release eggs from their ovaries when copulation occurs.
24. Trace a sperm cell from the structure where it is produced to fertilization of the egg:
- seminiferous tubules (1); vas deferens (2); uterus (3);
fallopian tube (4); vagina (5); epididymis (6); and urethra (7).
- 6, 1, 2, 7, 5, 3, 4
 - 1, 6, 2, 7, 5, 3, 4
 - 1, 6, 2, 7, 5, 4, 3
 - 1, 2, 6, 7, 5, 3, 4
 - 1, 2, 6, 7, 5, 4, 3

25. The atomic number of an element is the same as the number of:
- neutrons in each atom.
 - neutrons + protons in each atom.
 - protons + electrons in each atom.
 - protons in each atom.
 - electrons in an ion.
26. All of the following molecules are carbohydrates **EXCEPT**:
- lactose.
 - haemoglobin.
 - cellulose.
 - glycogen.
 - starch.
27. What is the difference between covalent and ionic bonds?
- Covalent bonds are the sharing of neutrons; ionic bonds are the sharing of electrons.
 - Covalent bonds are the electric attraction between two atoms; ionic bonds are the sharing of electrons between atoms.
 - Covalent bonds are the sharing of protons between atoms; ionic bonds are the electric attraction between two atoms.
 - Covalent bonds are the sharing of protons between atoms; ionic bonds are the sharing of electrons between two atoms.
 - Covalent bonds are the sharing of electrons between atoms; ionic bonds are the electric attraction between two atoms.
28. What would be an expected consequence of changing one amino acid in a particular protein?
- The primary structure would be changed.
 - The tertiary structure would be changed.
 - The biological activity of this protein might be altered.
 - The number of amino acids present would stay the same.
 - All of the above are expected.
29. The essential characteristic of a polar molecule is that it:
- contains oxygen.
 - contains ions as part of the structure.
 - has an asymmetrical distribution of electrical charge.
 - is formed at extremely low temperatures.
 - contains double or triple bonds.

30. A scientist produced some mutant fungal cells that, under normal growth conditions, were much smaller, and which grew much more slowly, than normal cells. When the mutant and normal cells were each grown in a glucose solution in a tightly sealed container and examined after 1 week, the two types of cells looked identical and had grown to the same extent. Which statement best explains these results?
- Each mutant fungal cell was lacking a Golgi apparatus.
 - Glucose is poisonous to fungal cells.
 - Glucose could not be used as an energy source by mutant fungal cells.
 - The mutant fungal cells had abnormal mitochondria.
 - The mutant fungal cells had abnormal lysosomes.
31. Animal cells were placed in a water solution containing sodium and potassium ions. After 10 minutes, the concentration of sodium had increased in the solution, but the concentration of potassium had decreased. When the experiment was repeated with glucose added to the solution, the concentration of sodium in the solution increased faster, but the decrease in potassium was the same as in the first experiment. Which statement best explains these results?
- Sodium leaves the cells, and potassium enters the cells, by passive transport.
 - Sodium is excreted from the cells by active transport and potassium enters the cells by passive transport.
 - Glucose enters the cells by passive transport.
 - Sodium leaves the cells by passive transport and potassium enters the cells by active transport.
 - The plasma membrane is more permeable to sodium ions than potassium ions.
32. Which statement is **FALSE**?
- Glucose-6-phosphate is an intermediate in glycolysis.
 - Pyruvate from glycolysis enters the mitochondrion and is converted to acetyl coenzyme A.
 - Some energy from ATP is required for glucose to enter the glycolysis process.
 - For each glucose molecule broken down during aerobic respiration, the citric acid cycle produces more ATP molecules than does the electron transport chain.
 - The energy to make ATP comes from a proton gradient across the inner mitochondrial membrane, which is made by passing electrons through the electron transport chain.
33. Fats are a better source of energy than carbohydrates because:
- fats are digested better than carbohydrates.
 - the oxidation of fats produces larger quantities of ATP.
 - fats are converted to fatty acids that directly enter the citric acid cycle.
 - fats enter cells faster than carbohydrates.
 - fats can be broken down by glycolysis without entering the mitochondrion.

34. Hibernating animals (that sleep all winter) have tissues containing mitochondria with a membrane protein that accelerates electron transport while blocking the synthesis of ATP. What is the consequence of this?
- Energy is saved because glycolysis and the citric acid cycle shut down.
 - Hibernating animals do not have enough energy to keep warm in cold weather, so they have to sleep through the entire winter.
 - Pyruvate is converted to lactic acid by anaerobic fermentation.
 - Hibernating animals can synthesize fat instead of wasting energy on respiration.
 - The energy of respiration is converted to heat.
35. An investigator wanted to test the mass-flow theory of phloem transport. She knew that a growing melon must receive a large flow of organic material by way of the slender vine. Therefore, she thought if she cut the vine, a good deal of phloem sap should leak out of the stump. But when she tried, only a small droplet of phloem sap emerged from the stump. What is most likely to have happened?
- The mass-flow theory was wrong.
 - The flow stopped because the melon no longer provided the needed pull.
 - The flow stopped because without the melon, phloem transport was no longer needed.
 - The sieve pores probably got plugged with P-protein.
 - The callose system stopped producing ATP needed for transport.
36. Which statement comparing the biochemical processes of photosynthesis and cellular respiration is **FALSE**?
- Both biochemical processes take place in specialized organelles that have complex systems of internal membranes.
 - ATP synthesis in both processes relies on the chemiosmotic mechanism, involving the pumping of protons through a membrane.
 - Both processes involve the passing of electrons from carrier to carrier in a series of oxidation-reduction reactions which liberate energy.
 - The initial source of electrons which pass from carrier to carrier are from high-energy food molecules in both processes.
 - Oxygen is an end-product of photosynthesis and carbon dioxide is an end-product of cellular respiration.
37. Which statement about the Calvin cycle is **FALSE**?
- It is used by C_4 plants to concentrate carbon dioxide.
 - The initial carboxylation reaction is catalysed by the enzyme RUBP carboxylase (Rubisco).
 - The reduction of 3PG to a sugar phosphate requires ATP, $NADPH^+$, and H^+ .
 - It is a process which involves enzymes that are light activated.
 - The Calvin cycle operates in C_3 , C_4 , and Crassulacean Acid Metabolism (CAM) plants.

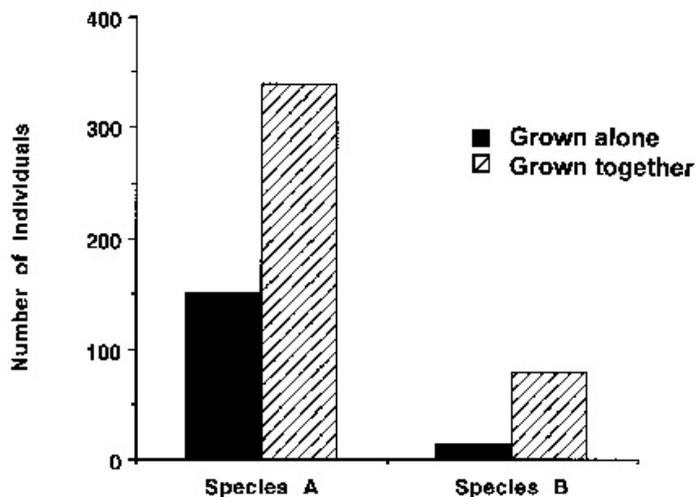
38. Which statement concerning stomatal function is **FALSE**?
- Stomata are open when the turgor pressure of the guard cells decreases.
 - When stomata are about to open, potassium ions are actively transported into the guard cells from the surrounding cells of the epidermis.
 - To close stoma, potassium ions diffuse passively out of the guard cells.
 - Low levels of carbon dioxide stimulate the opening of stomata.
 - High levels of water stress promote stomatal closure.
39. Which statement best explains why C_4 grasses often do better than C_3 grasses in hot, dry environments?
- C_4 grasses open their stomates at night.
 - C_4 grasses have nearly eliminated photorespiration.
 - C_4 grasses generate a positive turgor pressure under high temperatures.
 - The enzymes for photorespiration in C_4 grasses are inactivated at high temperatures.
 - The rate of cellular respiration is higher for a C_3 grass than for a C_4 grass at higher temperatures.
40. In a charged transfer RNA, the nucleotide bound to the amino acid is adenosine (A), and the next two nucleotides are cytosines (C). What can you tell about the DNA codon to which this transfer RNA corresponds?
- The codon is TGG.
 - The codon is ACC.
 - The codon is UGG.
 - The first position is A, but you can't tell about the others from the information given.
 - You can't tell anything about the codon from the information given.
41. Approximately what percentage of the DNA in the human genome is both transcribed and translated?
- 100%
 - 70%
 - 50%
 - 20%
 - 3%
42. Which of the following is true of all cancer cells? The rapid growth and division of cancer cells is caused by:
- bacterial infection.
 - breakdown of normal gene regulation.
 - viruses.
 - changes in the intracellular hormone receptors.
 - toxic chemicals.

43. Which application of genetics has had the greatest impact on the well being of humans to date?
- Plant breeding
 - Animal breeding
 - Genetic engineering
 - In vitro fertilization
 - Genetic counselling
44. If you were on a jury trying to determine whether a man was the father of a child, which kind of evidence should you consider to be most informative?
- Blood type
 - Skin colour
 - DNA fingerprint
 - Enzyme electrophoretic type
 - Fingerprints
45. New strains of bacteria are becoming resistant to antibiotics at a high rate. Which genetic process is now responsible for most of this increase in the proportion of resistant bacteria?
- Transformation
 - Transduction
 - Mutation
 - Insertion
 - Transposition
46. Which statement best defines evolution?
- The close resemblance between parents and their offspring
 - Difference between individuals in survival
 - Individuals in two populations look different
 - Change in the phenotype of an individual through time
 - Change in genetic composition of a population
47. What is the main target of natural selection?
- The population
 - Individual phenotype
 - Individual genotype
 - Individual gene
 - The species

48. Scientists consider the horse and the donkey to be different species, but when individuals of these two species mate they produce a strong offspring called a mule. According to the biological species concept, should scientists reclassify the horse and donkey as belonging to the same species?
- Yes, horses and donkeys must be considered one species if they can mate and produce an offspring.
 - Yes, because horses and donkeys are morphologically similar.
 - No, because the mule cannot breed with either horse or donkey.
 - No, because this cross-mating is rare in nature.
 - No, horses and donkeys are probably different genetically, which is the only factor used in determining species.
49. A biologist sequenced the cytochrome *c* enzyme in a range of animals and compared the amino acid (AA) differences between pairs of species. Which of the following results would be most consistent with modern systematics?
- Chimpanzee/rhesus monkey 23 AA differences; horse/chimpanzee 2 AA differences; chimpanzee/shark 8 AA differences.
 - Chimpanzee/rhesus monkey 23 AA differences; horse/chimpanzee 23 AA differences; chimpanzee/shark 23 AA differences.
 - Chimpanzee/rhesus monkey 12 AA differences; horse/chimpanzee 8 AA differences; chimpanzee/shark 3 AA differences.
 - Chimpanzee/rhesus monkey 2 AA differences; horse/chimpanzee 12 AA differences; chimpanzee/shark 23 AA differences.
 - Chimpanzee/rhesus monkey 2 AA differences; horse/chimpanzee 23 AA differences; chimpanzee/shark 12 AA differences.
50. If one gamete in five carries a recessive allele, what must be the frequency of the homozygous recessive genotype in a population at Hardy-Weinberg equilibrium?
- 4%
 - 16%
 - 20%
 - 60%
 - 80%
51. Which statement is **FALSE**?
- Even if the sodium-potassium pump of a nerve cell brings about ion exchange, the fact that the membrane is naturally more permeable to sodium means that more sodium will leak out than potassium in.
 - The energy for the sodium-potassium pump probably comes from the breakdown of ATP to ADP.
 - Axons usually synapse with the dendrites or the cell body of the next neuron in a sequence.
 - In vertebrates, myelinated nerve fibers generally transmit impulses more rapidly than do unmyelinated fibers of comparable diameter.
 - Neurons do not make direct connections with one another; they are separated by a space known as the synaptic cleft.

52. Which of the following would **NOT** result from the release of adrenalin (epinephrine)?
- Decreased blood flow to skin
 - Increased oxygen consumption
 - Rise in blood pressure
 - Increased conversion of glycogen to glucose
 - Increased blood flow to intestine
53. Suppose you were a neuroscientist and had been given a sample of a new snake venom. You test its effect on action at a synapse, and find that it increases the magnitude of the normal depolarizing excitatory response. The most likely explanation for this is that the venom is:
- blocking release of the neurotransmitter from the vesicles.
 - binding with the neurotransmitter receptors to interfere with neurotransmitter binding.
 - binding with the neurotransmitter receptors to mimic the action of the neurotransmitter.
 - acting to break down the neurotransmitter in the synaptic cleft.
 - preventing the presynaptic action potential from arriving at the synapse.
54. Which statement is **FALSE**?
- Steroid hormones act by passing through the cell membrane and affecting gene transcription.
 - Adrenaline (epinephrine) acts on cell membrane receptors to stimulate production of second messengers.
 - The anterior pituitary releases several hormones which act on other endocrine glands.
 - Insulin is produced in the islets of Langerhans in the spleen, when blood sugar levels fall.
 - The posterior pituitary releases a hormone that regulates kidney activity and blood pressure.
55. Which statement is **FALSE**?
- The kidney produces a concentrated urine by establishing a high concentration of salt and urea surrounding the collecting ducts.
 - The hypothalamus is a region of the hind brain important in regulating cardiovascular function, such as heart rate and blood pressure.
 - In typical reflex arcs, impulses in sensory neurons activate motor neurons via interneurons.
 - A drop in body temperature is countered by measures such as increasing metabolic rate and shutting down circulation in the skin. This is an example of negative feedback.
 - Both the brain and spinal cord are connected to nerves that carry motor and sensory information to and from the viscera.

56. Approximately 1.5 million species have been identified and described by scientists. Which group contains the most species worldwide?
- Bacteria
 - Fungi
 - Vascular plants
 - Insects
 - Mammals
57. Which nutrient is most likely to limit primary production in terrestrial ecosystems in Canada?
- Carbon
 - Sulfur
 - Phosphorus
 - Nitrogen
 - Potassium
58. Two insect species were used in a laboratory experiment. For one treatment, both species were grown by themselves (in separate chambers) on a suitable food source. For the second treatment, the two species were grown together (in the same chamber) on the same type and amount of food as in the first treatment. The figure below shows the results (the number of individuals of each species in the two treatments) at the end of the experiment. Based on these results the two species should be classified as:
- competitors.
 - antagonists.
 - mutualists.
 - predators or pathogens.
 - commensalists.



59. In a hypothetical developing nation, new government policies and international aid have resulted in improved family planning and decreased death rates. As a result, the average number of children per female, the average age of reproduction, and the average life expectancy are now the same as in Canada. If we ignore changes in population size because of immigration and emigration, the population growth rate of the developing nation will now:
- be the same as Canada's.
 - decrease, attaining Canada's growth rate within 10 years.
 - remain higher than Canada's because of climate.
 - remain higher than Canada's because of economic differences between the developing nation and Canada.
 - remain higher than Canada's until the population has reached a stable distribution of age classes.
60. If we wish to manage a deer population so that a very high number of deer can be harvested, we should manage the population so that:
- the number of deer is far enough below the carrying capacity to support high birth and growth rates.
 - the number of deer is at the carrying capacity to provide the largest sustainable deer population.
 - the deer are rare and have little contact with each other.
 - the number of deer slightly exceeds the carrying capacity so that the excess can be harvested.
 - the number of deer greatly exceeds the carrying capacity to provide a large number of excess individuals.