AP® Biology
2005 Sample Student Responses

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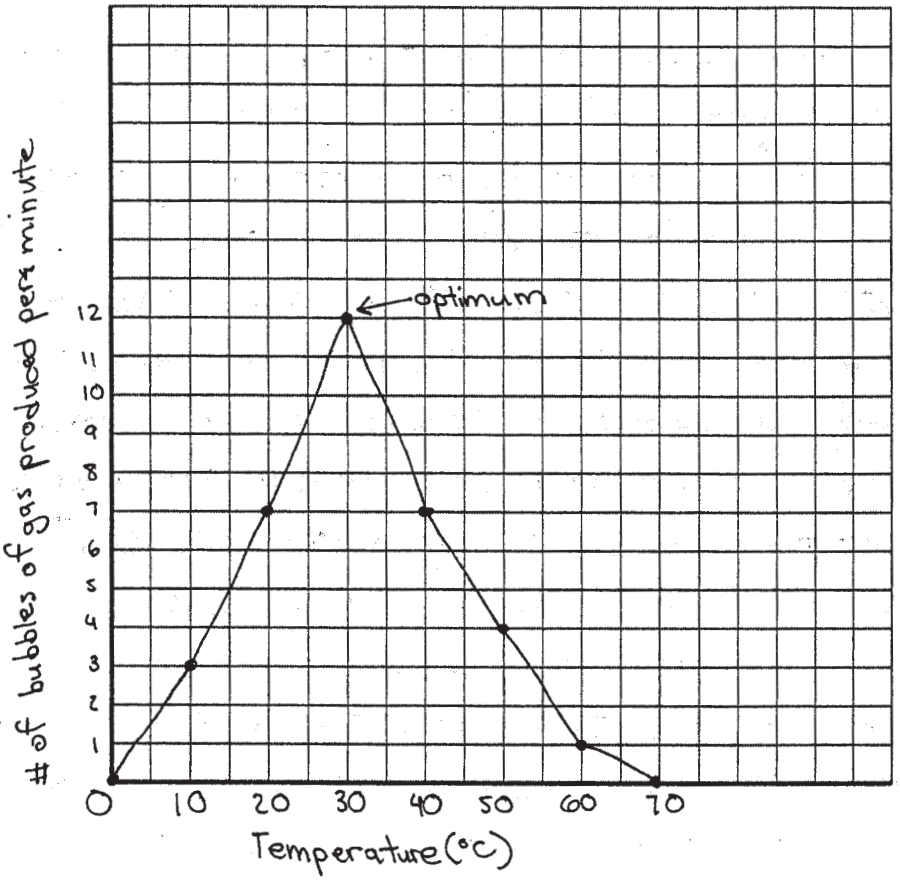
ADDITIONAL PAGE FOR ANSWERING QUESTION 1

1-A1

The Effect of Temperature on the Rate of Respiration



1A.

(the graph is above)

The optimum temperature for respiration in the yeast is 30°C. This is the temperature in which the enzymes involved will denature.

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Enzymes are proteins that speed up reactions by lowering ~~of~~ the ~~level~~ energy of activation. Substrates randomly go into the active sites of enzymes and induced fit occurs. This is when the conformation of the enzymes changes so that the ~~enzyme~~ substrate can fit in the active site. As the ~~rate~~ temperature increases, the number of bubbles of gas produced per minute increases as well until ~~a~~ a temperature optimum is reached. After the optimum is reached, the number of bubbles produced per minutes decreases as the temperature increases. The rate of respiration is increasing as the temperature is increasing b/c of its increased kinetic energy. Increased kinetic energy causes the substrates and the enzymes to bounce faster in a random fashion. Faster movement between these two causes more substrates to enter the active sites of the enzymes, and lowing the the reaction's energy of activation. This cause the the reaction to increase

The optimum temperature is the temperature in which the enzyme denatures causings its conformation to change. The optimum temp. here is 30°C. When the enzyme denatures, its Van der Waals, ionic bonds, hydrogen bonds and the other bonds ~~the~~ cease. When they denature, the substrates can no longer enter the active sites of the enzymes, causing the reaction to slow down. This is why after the optimum is reached, the rate of the reaction decrease.

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The effect of varying the pH of the sugar solution on the rate of respiration can be tested. The independent variable is the different pH levels. The levels of IV are: 1 pH, 4 pH, 7 pH, 11 pH, and 14 pH. The dependent variable is the ~~sugar solution~~ rate of CO_2 being released from the yeast. The control would be the sugar solution with pH of 7 so that it could be used as basis for comparison. It would be used to compare solutions of increasing + decreasing pH. The rate of CO_2 being released would be recorded using a respirometer. 5 trials would be done for each pH level and the results would then be averaged. Possible results could ~~for~~ be for 1 pH: 0.3 $mL/m^2/min$, 4 pH: 5.3 $mL/m^2/min$, 7 pH: 10.7 $mL/m^2/min$, 11 pH: 5.7 $mL/m^2/min$, and 14 pH: 0.8 $mL/m^2/min$. The constant is the ~~sugar~~ type of sugar solution, which much be kept the same throughout the experiment.

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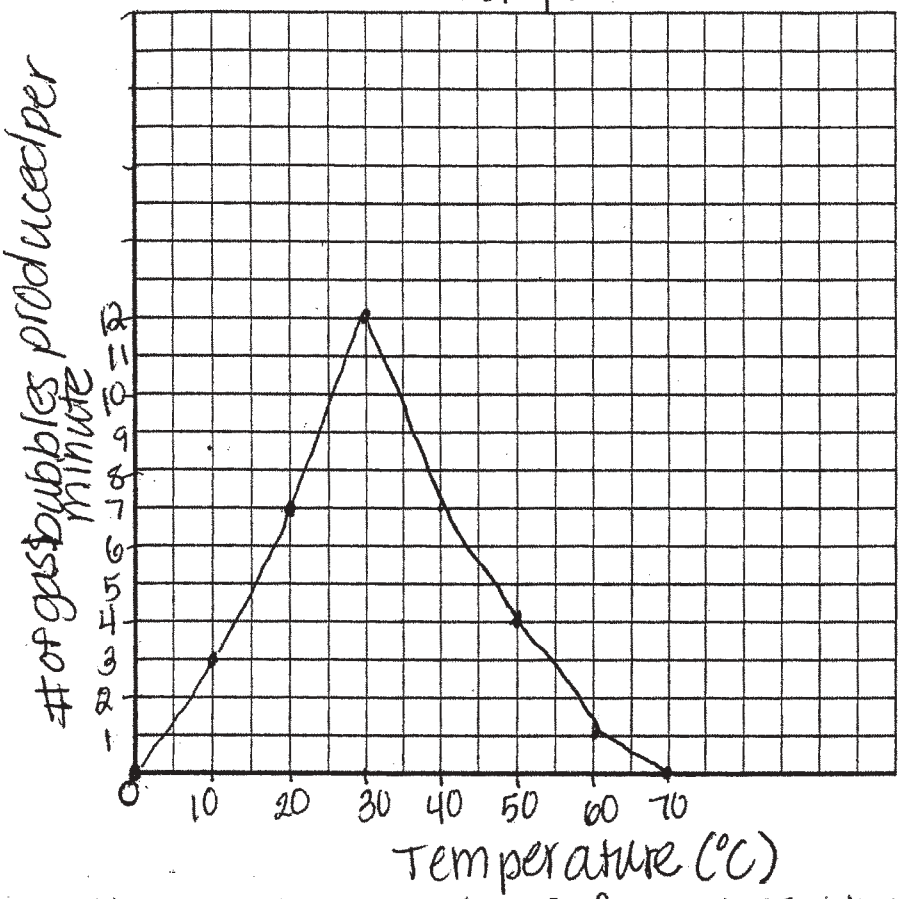
ADDITIONAL PAGE FOR ANSWERING QUESTION 1

Rate of Respiration of Yeast at different temperatures

1-B.



The optimum temperature for respiration by yeast is 30°C because it produced the most gas bubbles indicating a higher rate of respiration.

Initally as the temperature goes up the rate of reaction increases in turn increasing respiration. All enzymes have an optimum temperature where they are able to catalyse reactions the fastest. After that temperature is reached the enzymes start to denature and their bonds break make them unable to function. After 30°C the hydrogen

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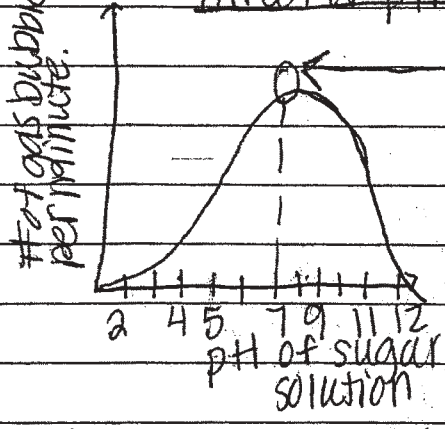
1B2

ADDITIONAL PAGE FOR ANSWERING QUESTION 1

bonds in the quartenary structure of the enzyme start to break and the protein begins to uravel. This is wney there is a decrease in gas bubbles as the temperature continues to increase.

To see the effect pH would have on the rate of respiration there must be different sugar solutions that have different pH levels for the yeast to break down. For example a pH of 2, 4, 5, 7, 9, 11, 12 could be used. There must be acidic and basic pH levels and also neutral (7). Then the yeast would be placed in the solutions and the number of gass bubbles will again be counted. Enzymes have an optimum pH for which they preform the best. If the solution becomes to acidic or to basic the enzyme will denature. Every enzyme may have a different optimum pH for example stomach enzymes work the best in very acidic solutions where as others can't withstand extremely acidic solutions.



The result of the experiment will show that the optimum pH was the most bubbles and the enzymes

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ADDITIONAL PAGE FOR ANSWERING QUESTION 1

1B3

are working at their full potential

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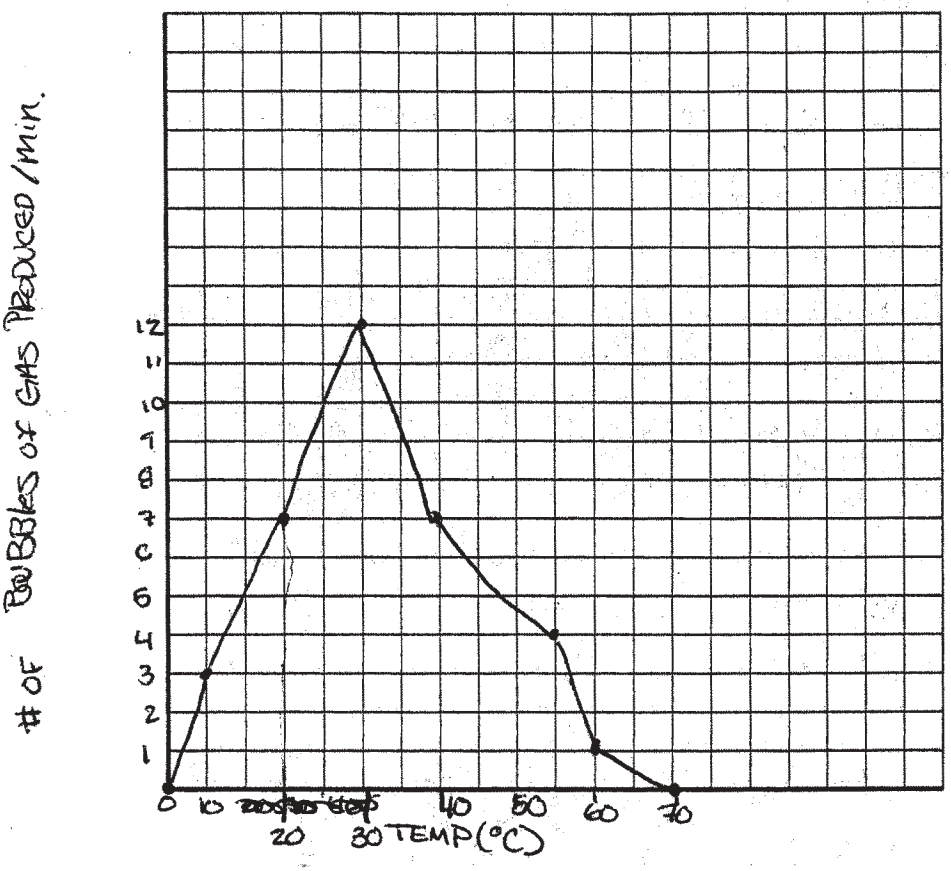

(B) AS THE YEAST IS PLACED IN A SUGAR SOLUTION WITH ~~TEMP~~ A TEMPERATURE OF 0°C THE AMOUNT OF BUBBLES PRODUCED PER MINUTE IS ZERO, BUT AS THE TEMPERATURE INCRESSES THE AMOUNT OF ~~BUBBLES~~ ARE INCRESSED AS WELL. ~~IS~~ THIS AFFECT HAPPENS UNTILL 30°C IS REACHED BY THE YEAST IN THE SUGAR SOLUTION WITH 12 BUBBLES PRODUCED PER MINUTE ONCE 40°C IS REACED THE ~~NUMBER~~ NUMBER OF BUBBLES OF GAS PRODUCED ~~WAS~~ WAS DECRESSED BY 5, THEN AT 50°C BY ~~2~~ TWO. THE BY THE TIME THE SUGAR AND YEAST REACHED 70°C ~~THE~~ THE AMOUNT OF

GO ON TO THE NEXT PAGE.

BUBBLES OF GAS PRODUCED IS ZERO. THESE RESULTS COULD BE DO TO THE YEAST REACHING MAXIMUM RESPERATION PRODUCTION AT 35°C AND STOP RESPERATION PRODUCTION AT 70°C.

(C)

PLACE THE YEAST CELLS INTO 7 DIFFERENT CONSENTRATIONS OF pH OF SUGAR SOLUTION. pH OF 7 FOR NUTRALITY, 6, 5, 4 FOR ACIDIC, AND 8, 9, 10 FOR A BASIC pH. MESURE THE AMOUNT OF GASOUS BUBBLES PRODUCED EACH MINUTE, FOR 20 MINUTES FROM EACH pH CONSENTRATION OF SUGAR SOLUTION. TAKE THE AVERAGE OF THE RESULTS AND COMPARE.

pH	4	5	6	7	8	9	10
No. OF BUBBLES OF GAS PRODUCED/MIN	0	2	4	10	6	3	0

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2A 1

2. The unit of genetic organization in all living organisms is the chromosome.

(a) **Describe** the structure and function of the parts of a eukaryotic chromosome. You may wish to include a diagram as part of your description.

(b) **Describe** the adaptive (evolutionary) significance of organizing genes into chromosomes.

(c) How does the function and structure of the chromosome differ in prokaryotes?

a. The chromosome is the form of genetic material in eukaryotes during cell division. It is a condensed and staining body of DNA. It consists of DNA which is a double helix (curved ladder) bound around proteins called histones. Histones wind and unwind DNA to make certain DNA sequences available for transcription. Chromosomes during cell division consist of two sister chromatids joined by a centromere. Chromosomes exist as chromatin during interphase. They hold DNA which are templates for the production of mRNA which go to ribosomes to produce proteins. Each gene of DNA codes for one polypeptide by theory. Chromatin exists as euchromatin which is loosely bound and available for repeated transcription and heterochromatin which is tightly wound. The Kinetichore of the centromere provides a place for spindle fibers to attach and pull chromosomes to opposite poles during cell division.

b. Organizing genes into chromosomes allows for genetic recombination by crossing over during meiosis. Meiosis is sexual reproduction of 4 nonidentical gametes. During prophase I of meiosis, homologous chromosomes pair during synapsis. They form chiasmata, where the two chromosomes join. Genetic material is exchanged between the two chromosomes during crossing over. This provides for genetic variability.

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ADDITIONAL PAGE FOR ANSWERING QUESTION 2

Chromosomes are also significant as they allow for transcription of multiple part of the genome at once.

c. Eukaryotic chromosomes ~~are~~ consist of DNA wound ~~around~~ around proteinaceous histones. Prokaryotic chromosomes lack histones. Histones allow for the selective activation and deactivation of certain genes and the production of certain polypeptide. Prokaryotic chromosomes have operon ~~genes~~ consisting of a regulator, which produces a repressor, a promoter, which RNA polymerase binds, an operator, where the repressor can bind to shut off transcription, and structural proteins. Prokaryotes do not require histones ~~for~~ to assist in regulation.

Eukaryotes have many chromosomes which prokaryotes have 1 chromosome. Eukaryotes ~~usually have~~ have linear chromosomes, while prokaryotes usually have a circular chromosome.
The chromosome of prokaryotes ~~consists of~~ has less repetitive DNA ~~as~~. Any DNA that is similar is destroyed. For this reason, less chromosomes are not needed.
Eukaryotic chromosomal DNA has introns ~~and~~ and exons, which prokaryotes only have exons.
Introns are ~~untranslated~~ sections of DNA that are not transcribed, and therefore not used by prokaryotes who value efficiency.

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2B1

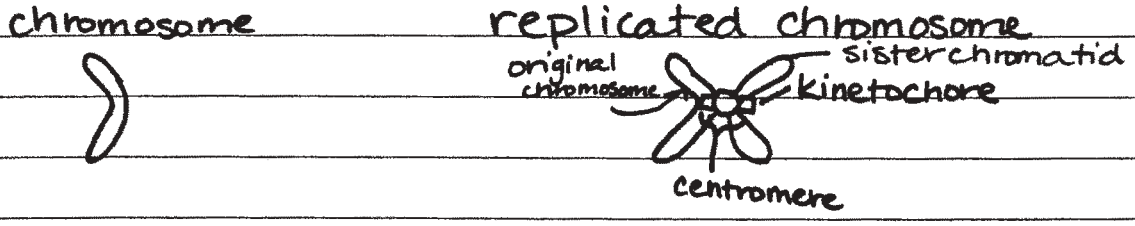
2. The unit of genetic organization in all living organisms is the chromosome.

(a) **Describe** the structure and function of the parts of a eukaryotic chromosome. You may wish to include a diagram as part of your description.

(b) **Describe** the adaptive (evolutionary) significance of organizing genes into chromosomes.

(c) How does the function and structure of the chromosome differ in prokaryotes?

a) A Eukaryotic chromosome is essentially rod-shaped. Chromosomes are formed from chromatin, a stringy substance occupying the nucleus containing DNA and histone proteins, when it condenses. A replicated



chromosome consists of two sister chromatids joined together by a centromere. The centromere has two kinetochores, where two spindle fibers will attach during cell division. The chromosome's function is to carry genetic information (DNA). By arranging in this structure it is easier for DNA to be transferred to daughter cells making the process shorter and more efficient for parent cells.

b) By organizing genetic information into chromosomes, it increases genetic variation in the production of gametes, By promoting crossing over during meiosis and allowing for independent assortment and random separation.

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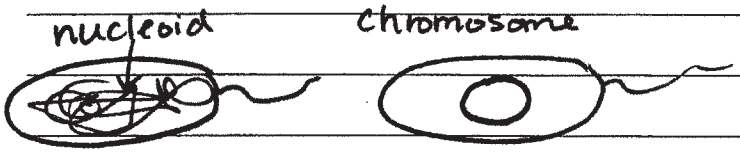
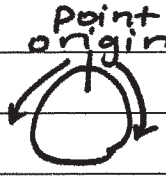
ADDITIONAL PAGE FOR ANSWERING QUESTION 2

This leads to more adaptive species. It also requires less energy to transfer genetic information in chromosomes using minimal energy.

c) Prokaryotic chromosomes serve the same function as Eukaryotic chromosomes. They contain DNA. Their structure, however is dramatically different. ~~Aren~~ Arranged in a circle, the Prokaryotic chromosome also has different ways of replication. After condensing from the nucleoid into a circle replication goes both ways from the point of origin. enzymes





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2C

2. The unit of genetic organization in all living organisms is the chromosome.

   (a) **Describe** the structure and function of the parts of a eukaryotic chromosome. You may wish to include a diagram as part of your description.

   (b) **Describe** the adaptive (evolutionary) significance of organizing genes into chromosomes.

   (c) How does the function and structure of the chromosome differ in prokaryotes?

a) The chromosome is the carrier of all DNA (except mitochondrial) and is very important in controlling how the body works. A chromosome is a dense coil of DNA that has many structure levels. First, the DNA looks like a "string w/ beads", because parts of the DNA strand are wrapped around proteins and form structures called nucleosomes. Next, the DNA attatches to a protein scaffold to form looped domains. Then, the looped domains are more tightly coiled until they form a 30nm chromatin fiber. This fiber continues to coil and fold until it forms the chromosome we see in a microscope.

~~Another part of the chromosome is the~~

~~This~~ The coiling of the chromosome serves as a way to control gene expression. In the tight coil, there are some genes that transcription proteins can't reach. During replication, the chromosome loosens up so that all the DNA can be replicated.

b) By organizing genes into chromosomes, the DNA of an organism is more condensed and tightly packed, taking up less space. The coiling also may protect genes from being worn down.

Chromosomes can control gene expression because of the way they are folded. This ensures that the cell doesn't waste valuable resources in creating something that's not needed.

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$2C_2$

ADDITIONAL PAGE FOR ANSWERING QUESTION 2

Because genes are organized into chromosomes, it is more likely that genetic variation will occur do to crossing over during meiosis.

c) Prokaryotic DNA does not contain introns, parts of DNA that don't code for anything. Prokaryotic DNA is also less condensed, making it easier to access by proteins.

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3A,

3. Angiosperms (flowering plants) have wide distribution in the biosphere and the largest number of species in the plant kingdom.

   (a) **Discuss** the function of FOUR structures for reproduction found in angiosperms and the adaptive (evolutionary) significance of each.

   (b) Mosses (bryophytes) have not achieved the widespread terrestrial success of angiosperms. **Discuss** how the anatomy and reproductive strategies of mosses limit their distribution.

   (c) **Explain** alternation of generations in either angiosperms or mosses.

The stigma is the receptacle of the flower that is sticky so that pollen can stick to it. This provided for a method of fertilization outside of water. The style is the tube that the pollen grain travels down to enter the ovary through the micropyle. The style prevented self pollination in that the flower's own pollen grains do not have the enzymes to digest its way through the tube. This adaptation significantly provided more variation in the gene pool. The pollen was an adaptation for plants to reproduce outside of the water. Wind-pollenated plants produce plenty of light weight pollen while animal-pollinated plants produced incentives for the animal to pollen the plant. The petal is a structure of an angiosperm that brings color to the flower. This attractive color entices animals to

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approach the plant and then pollinate the plant.

b.) Bryophytes do not contain vascular tissue. They remain small and live near/in the water for support, nutrients, and reproduction. The water surrounding a small bryophyte such as moss gives the plant support but also allows diffusion and osmosis to occur so that the plant can obtain nutrients. They depend on water for survival because the need it for nutrients & reproduction. Mosses produce sperm that contain flagellum, & so the sperm need water for mobility to reach the eggs. This external reproduction requires water and limits a mosses distribution.

C.) In angiosperms, the sporophyte is conspicuous. The sporophyte then under goes meiosis to produce haploid spores. The spores ~~divide~~ multiply by mitosis and form the haploid gametophyte, which is dependent upon the sporophyte. The gametophyte is fertilized and produces the diploid zygote, which then undergoes mitosis to form the diploid sporophyte. The cycle keeps repeating.

3. Angiosperms (flowering plants) have wide distribution in the biosphere and the largest number of species in the plant kingdom.

(a) **Discuss** the function of FOUR structures for reproduction found in angiosperms and the adaptive (evolutionary) significance of each. 3B1

(b) Mosses (bryophytes) have not achieved the widespread terrestrial success of angiosperms. **Discuss** how the anatomy and reproductive strategies of mosses limit their distribution.

(c) **Explain** alternation of generations in either angiosperms or mosses.

a. Elevated carpels, and stamen, which produce pollen, allow the plant to use wind to spread the pollen. This means that the plant can pollenate plants farther away, leading to greater genetic variability.

Flowers are usually brightly colored and oriented and enclose the male and female reproductive systems. They serve to attract insects, birds, and other pollenators, who then transfer the pollen to other angiosperms. This also increases genetic variability and increases distribution.

Fruits, which are the ovaries of the plant, are made to taste good and protect the seeds. Animals eat them, then excrete the seed at another location. This introduces new species (and genes) to other areas and increases distribution. It is one of the reasons why we see such a widespread distribution today.

Seeds house the developing zygote. It has a tough coat to withstand harsh environments. This is an evolutionary marvel because it made possible wide-range distribution.

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3B2

~~were no longer limited by the wind or~~

5. Masses do not have seeds or flowers, which greatly limits animals as a source of transporting seeds and ~~pollen~~. They are smaller physically, and are not brightly colored or scented. They normally resort to asexual reproduction, which limits the number of species as well as distribution.

C. In angiosperms, the parent generation is ~~can reproduce~~ haploid, they then make gametes via mitosis (not meiosis). They then reproduce either sexually or asexually to make a diploid angiosperm. The diploid can then produce haploid offspring by going through meiosis ~~(crossover)~~ twice. ~~These gametes are combined to make a haploid~~

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3. Angiosperms (flowering plants) have wide distribution in the biosphere and the largest number of species in the plant kingdom.

(a) **Discuss** the function of FOUR structures for reproduction found in angiosperms and the adaptive (evolutionary) significance of each. 3C1

(b) Mosses (bryophytes) have not achieved the widespread terrestrial success of angiosperms. **Discuss** how the anatomy and reproductive strategies of mosses limit their distribution.

(c) **Explain** alternation of generations in either angiosperms or mosses.

(A) • Angiosperms reproduce with seeds. Seeds are specifically designed to adapt to terrestrial life. They are light and therefore can easily be dispersed throughout a location. They have an endosperm or cotyledon to provide the embryo with nutrition and a hard outer covering called the germ used for protection. These advantages give seeds the ability to grow despite where they are dispersed

• Angiosperms fertilize with pollen. Pollen is advantageous because it is easily transferred to the ovary by insects or birds. This fertilization creates seeds later used to reproduce.

• Angiosperms are unique because they contain flowers. Throughout evolutionary history, these flowers have grown more vibrant in color to attract insects needed for pollination.

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* Angiosperms also grow fruit. The fruit is the mature ovary in which seeds develop. Fruits are designed to be sweet tasting and attractive to animals. By animals taking fruit from trees to other places, they are taking seeds as well. The seeds not eaten by the animal are left to grow and develop into a new plant.

(B) Mosses are found low to the ground, growing on rocks and trees. They reproduce by spores because they are seedless plants. Unlike the Angiosperms, mosses also lack flowers. It was due to flowers and seeds that the Angiosperm was able to become the most abundant on the planet, and because moss lacks both of these significant traits, they are unable to reproduce successfully.

(C) Alteration of Generations is a reproductive trait in angiosperms. This occurs when Each generation of the plant alternates between the diploid stage and the haploid stage. The haploid stage, FS

also called the gametophyte, is ~~[illegible]~~ the dominant stage while the diploid stage, also called the sporophyte, is the recessive stage.

4. An important defense against diseases in vertebrate animals is the ability to eliminate, inactivate, or destroy foreign substances and organisms. **Explain** how the immune system achieves THREE of the following:

- Provides an immediate nonspecific immune response
- Activates T and B cells in response to an infection
- Responds to a later exposure to the same infectious agent
- Distinguishes self from nonself

The immediate nonspecific immune response is mainly the inflammatory response. When a foreign body injures cells they release some proteins that trigger this response. The area becomes red and swollen as vassodilation occurs, a dilation of the capillaries. This provides more blood to the injured area. In this blood are macrophages which are capable of consuming many foreign particles and natural killer cells which also target foreign bodies but usually destroy themselves in the process. While this is attacking the foreign bodies, platelets also in the blood will begin to form a clot to seal the wound. They do so by forming a net of the the protein fibrin which catches the platelets, and also mast cells release histamine which increases the secretions of mucus to wash out large invaders. The hormone prostaglandin is also released to increase the feelings of pain.

When a macrophage consumes a pathogen it will become an antigen presenting cell that will present a piece of the antigen, the response causing particle, to the helper T cells using its major histocompatibility complex class two surface protein. When a helper T cell comes in contact with this it will bind to the major histocompatability complex with its own and become stimulated. Once activated the helper T cell will itself take the piece of the antigen and use it to activate the B cells and cytotoxic T cells with

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ADDITIONAL PAGE FOR ANSWERING QUESTION 4

their major histocompatibility complexes. It also secretes proteins such as the interleukins to help stimulate the B and cytotoxic T cells. The B cells will proliferate into ones producing specific ant. bodies and memory cells.

A later exposure to the same infectious agent will elicit a faster response. This is because during the first exposure when the B and T, both helper and cytotoxic, cells were activated the proliferated creating their active forms and memory cells which have receptors on their membranes specific to that antigen. These memory cells can be stimulated directly by the antigen instead of through the longer process of antigen presenting to helper T and then on. As a result the antibody producing B cells and the cytotoxic T cells are activated faster and can drive off the infection quicker. The cytotoxic T cells will lyse marked infected cells, their major histocompatibility complexes class one will show a piece of the antigen, using ~~the~~ proteins ~~perforin~~ which form a pore in the cell membrane of the infected cells.

4B,

4. An important defense against diseases in vertebrate animals is the ability to eliminate, inactivate, or destroy foreign substances and organisms. **Explain** how the immune system achieves THREE of the following:

   - Provides an immediate nonspecific immune response
   - Activates T and B cells in response to an infection
   - Responds to a later exposure to the same infectious agent
   - Distinguishes self from nonself

A nonspecific response is provided by two nonspecific lines of defenses. After these two lines, a specific response would be provided. The first line of defense is composed of skin and mucous membranes. The skin is very thick, and the outermost layers are dead. In this sense, the skins structure meets its function because the dead outer layers protect the inside, living layers. Also part of the 1st line of defense are mucous membranes. Mucous membranes provide protection by capturing bacteria, and other harmful substances before they penetrate the body. The second line of defense is composed of phagocytosis, fever, and inflammation. Phagocytosis occurs when bacteria inside the body are engulfed by large phagocytotic cells. These cells eat the invading bacteria and then release it once the bacteria is killed. The next defense on the second line is fever. When the body is attacked by invading bacteria, a message is sent to the hypothalamus. The hypothalamus will increase the body temperature in hopes to denature the bacteria. Next is inflammation. When the skin, for example, is

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ADDITIONAL PAGE FOR ANSWERING QUESTION 4

punctured by a knife, capillaries dialate, and blood flow to that area is increased. Phagocytotic cells also travel to this area in order to eat any bacteria that entered the body when the skin was punctured.

- When a bacteria enters the body, it has identifiers called antigens. Memory B and T cells, which patrol the body for the reoccurance of bad antigens, have sites that match the antigens. However, if it is a new disease, and there are no matching antibodies, then antibodies must be made to fight the disease. B cells make the antibodies. The antibodies fit only to the antigens, that is why this 3rd line of defense is specific. Millions of antibodies are made to fight the disease. The antibodies attach themselves to the antigens and are then disposed of by phagocytosis. For T cells, Helper T cells are the "on" switch for the fight of the disease. Suppressor T cells are then the off switch when the fight is done.

- After an infection, memory B cells and memory T cells patrol the body for future infection of the same bacteria or disease. The memory B and T cells have antibodies on the outside of the cells. Since the antibodies are fit to specific antigens,

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ADDITIONAL PAGE FOR ANSWERING QUESTION 4

they are ignited when there is a match. When an antibody runs into an antigen that it fits to, the response to the infection then occurs. This time, unlike the first response to the antigen, a new antibody does not have to be made. Instead B cells produce millions of antibodies identical to the antibody that matched to the antigen.

4. An important defense against diseases in vertebrate animals is the ability to eliminate, inactivate, or destroy foreign substances and organisms. **Explain** how the immune system achieves THREE of the following: 4C, 1

- Provides an immediate nonspecific immune response
- Activates T and B cells in response to an infection
- Responds to a later exposure to the same infectious agent
- Distinguishes self from nonself

- The immune system is initially nonspecific to foreign substances; the body makes several types of cells that attack "not self" organisms. Present to attack and engulf entire cells are macrophages. There are also cytotoxic T cells, which identify the invader as nonself and pump enzymes to destroy it. Also are natural killer cells, which also identify and wipe out the pathogen.
- After the T cells have activated the B cells, the immune system experiences a loss in B cells; the ones that remain after the infection are known as memory cells. These memory cells carry the antibodies for the antigens for an indefinite amount of time, and once the pathogen returns, T cells activate the production of B cells by referring to the memory cells. In this way the illness is destroyed much quicker than the initial immune response.
- Every organism has a unique MHC molecule on the surface of its cells. The immune system uses its B cells and T cells after the MHC is recognized as foreign, and only because the MHC is slightly

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modified. This can make transplants difficult, because of the uniqueness in the MHC molecules on the surfaces of cells from the donor and the receiver. It cannot, however the immune system works, identify self molecules (identical MHC) as dangerous. This is why cancer cells are not often killed. At any rate, if a T cell recognizes a foreign MHC, it stimulates the movement of nonspecific immune cells that often completely destroy the "unsafe" cells.