Biology 111 Practice Final Exam – December 2012

These questions are designed to illustrate the format of exam questions and the scope of the material you are expected to have learned. The content emphasis and mark allocation may differ from the actual exam questions.

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1. One task that many boat owners hate is the chore of scraping the encrusting algae and animals that inevitably attach onto the hull of the boat. These organisms create drag that slows the movement of the boat through the water. Special paints that contain biocide compounds have been developed to prevent 'fouling' of the hulls. Compounds such as tributyltin (TBT) have been banned in many countries, because it is a non-specific toxin. These compounds are usually absorbed by producers and are then passed along a food chain. **(Total 8 marks)**

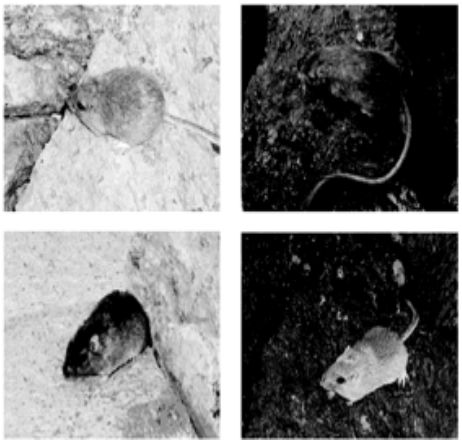
a) As early as the 1970's TBT was linked to a dramatic decline in the population of oysters in France. How would these filter feeding animals acquire TBT? **(2 marks)**

b) There has been further concern about the effect of this toxin on fish and marine mammals. Explain why. **(2 marks)**

c) Laboratory experiments with different levels of TBT will cause female marine snails to develop male reproductive structures. This suggests that TBT interferes with normal sex hormone production. Should parents of young children be concerned about the source of the seafood they eat? Why? **(2 marks)**

d) What recommendations would you make to the Government of France regarding antifouling marine paints? What shellfish harvesting regulations need to be adopted? (2 marks)

2. Rock pocket mice (*Chaetodipus intermedius*) live in the deserts of the American southwest where the majority of the habitat is a light sand colour. The mice have sand-coloured fur allowing them some camouflage from predators like owls. One million years ago there were lava flows across parts of the desert creating regions of black-coloured rock. A black form of the mouse also exists, with the majority of the black mice living in the regions with black-coloured rock. The difference between the two types of mice is due to mutations in one gene. Scientists have been able to calculate that although mutations are rare, there has been enough time for the mutations causing black fur to spontaneously arise many times. **(Total 8 marks)**



a) Did the lava flows cause the black mutation to occur in the population of mice? Explain your answer. **(1 mark)**

b) To determine which allele is dominant you mate the two types of mice. You use a true-breeding female with sandy coloured fur and a true-breeding male with black coloured fur.

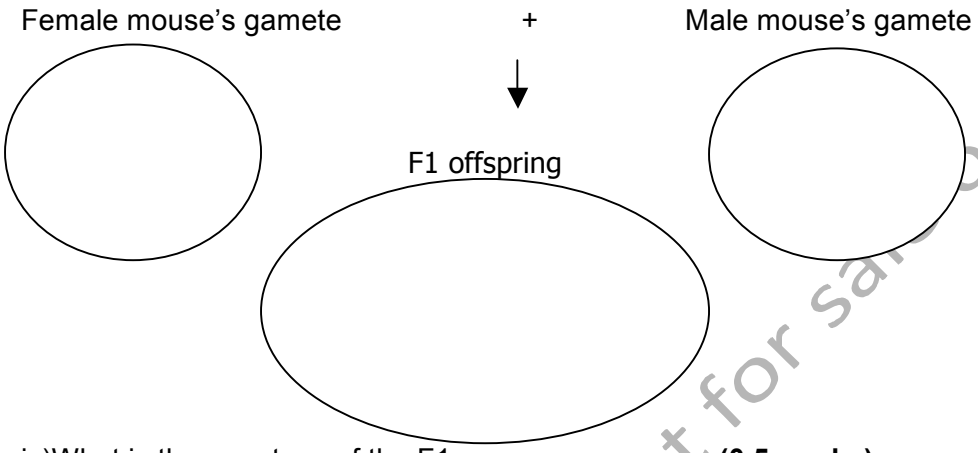
i) Write the genotypes of the two parent mice.

Use the symbols F^s =sandy fur, F^b = black fur. (We do not know which one is dominant and which one is recessive so we are not using the usual capital and lower case letters.) **(1 mark)**

Genotype of female mouse:_____ Genotype of male mouse: _____

ii) In the circle that represents the **gamete** of the female parent draw one condensed chromosome and label it for the fur colour allele. (Although these mice have 2n = 46 chromosomes just draw one chromosome.) Draw the corresponding chromosome from the gamete of the male mouse. **(1 mark)**

iii) Next draw a cell from the resulting F1 offspring that is beginning to go through mitosis [show only the condensed chromosome(s) containing the fur colour gene labeled with the appropriate allele(s)]. **(1 mark)**

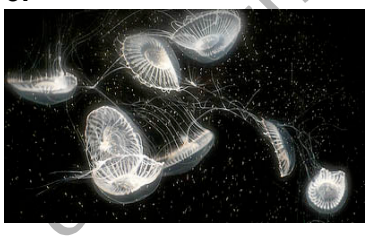


iv)What is the genotype of the F1 mouse:_____ **(0.5 marks)**

v) Why does the phenotype of the F1 mouse allow you to tell which allele is dominant and which allele is recessive? **(1.5 marks)**

c) How has the presence of owls acted to favour the black fur colour phenotype on the lava flows? **(2 marks)**

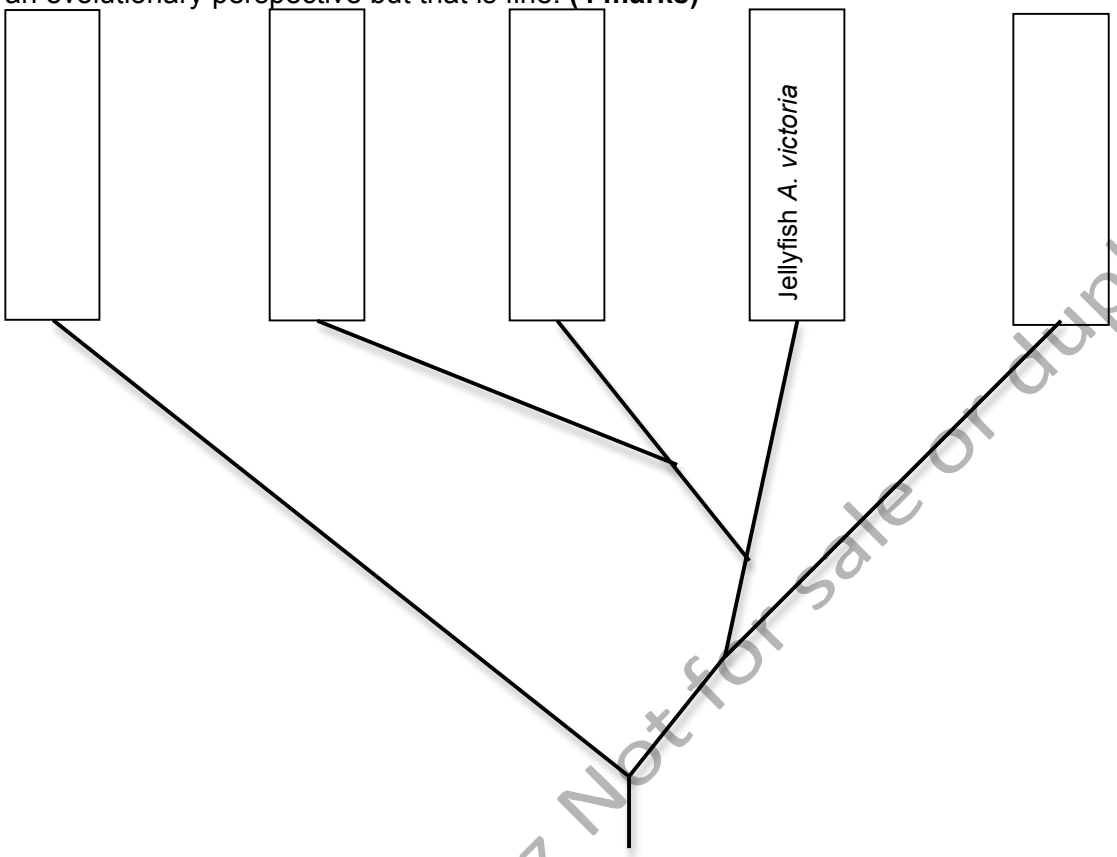
3.



Many organisms living in the deep sea have some type of luminescence. The jellyfish (*Aequorea victoria*) shown on the left make green fluorescent protein. **(Total 13 marks)**

a) Suggest one possible advantage of being luminescent for deep sea organisms besides the ones with eyes being able to see in the dark more easily. **(1 mark)**

b) One gene called GFP (for green fluorescent protein) allows the jellyfish above to glow in the dark. This gene has been added to many other organisms such as bacteria, plants, fish and mice.
Arrange these other organisms on the phylogenetic tree below. Write characteristics that separate organisms after each branchpoint. (For example if we had dogs and cats on our tree we might write "meows" on the cat branch and "barks" on the dog branch.) Note: Your decisions may not be correct from an evolutionary perspective but that is fine. **(4 marks)**



c) Although these organisms differ quite greatly and are separated by millions of years of evolution we are still able to add the GFP gene from the jellyfish into chromosomes from all these different organisms and get the GFP protein to be made. Explain what allows this to happen. What structures and/or processes do they all share that allows the GFP gene to be expressed in all these organisms? **(2 marks)**

d) Even if all the organisms in the tree above are attacked by viruses, explain why would we likely have to use a different type of virus to add the GFP gene to each different organism. **(1 mark)**

e) Below is a short sequence of DNA from the beginning of the GFP gene. First transcribe this sequence into mRNA and then translate it using the codon table provided (next page). **(2 marks)**

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5' CAAAGATGAGTAAAGGAGAAGAACTTTTC 3'
3' GTTTCTACTCATTTCCTCTTCTTGAAAAG 5' template strand
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f) When the first marked nucleotide is mutated from an T to a C the colour of the GFP protein changes from fluorescent green to fluorescent yellow. Using the codon table provided explain why this is. When the second marked nucleotide is mutated from a A to a G a normal GFP protein is still made. Also explain why that occurs. **(2 marks)**

g) Identify two potential health or environmental concerns about adding this GFP gene from the jellyfish to a food plant like lettuce which people grow in their gardens. **(2 marks)**

Second base

First base	U	C	A	G	Third base
U	UUU, UUC: Phenylalanine (phe) UUA, UUG: Leucine (leu)	UCU, UCC, UCA, UCG: Serine (ser)	UAU, UAC: Tyrosine (tyr) UAA: Stop codon UAG: Stop codon	UGU, UGC: Cysteine (cys) UGA: Stop codon UGG: Tryptophan (trp)	U C A G
C	CUU, CUC, CUA, CUG: Leucine (leu)	CCU, CCC, CCA, CCG: Proline (pro)	CAU, CAC: Histidine (his) CAA, CAG: Glutamine (gln)	CGU, CGC, CGA, CGG: Arginine (arg)	U C A G
A	AUU, AUC, AUA: Isoleucine (ile) AUG: Methionine (met) Start codon	ACU, ACC, ACA, ACG: Threonine (thr)	AAU, AAC: Asparagine (asn) AAA, AAG: Lysine (lys)	AGU, AGC: Serine (ser) AGA, AGG: Arginine (arg)	U C A G
G	GUU, GUC, GUA, GUG: Valine (val)	GCU, GCC, GCA, GCG: Alanine (ala)	GAU, GAC: Aspartic acid (asp) GAA, GAG: Glutamic acid (glu)	GGU, GGC, GGA, GGG: Glycine (gly)	U C A G

Table 8-1 Biology: Science for Life, 2/e

4. A tribe of indigenous Indians in a remote region of Papua New Guinea was isolated from the outside world. An exotic bacterial pathogen was accidently introduced to the tribe by a visitor. All individuals in the tribe were exposed to the bacteria; all were infected and fell ill (100% infection rate). Nobody died from the illness and everybody began to get better after 10 days and eventually recovered fully. Lacking susceptible hosts, the bacterial pathogen disappeared from the population. **(Total 16 marks)**

(a) **Identify** two types of immune cells or proteins involved in fighting the pathogen during the infection and **describe** how each component fought the pathogen **(4 marks)**

(b) Ten years later the same pathogen was introduced to the same tribe of people. Only children under 10 got sick this time and the rest of the tribe was not affected. The infection rate in the entire Indian population was 20% this time. Explain if evolution through natural selection has taken place in the population during the 10 year period between the two bacterial outbreaks. Explain why the infection rate changed between the two invasions by the same bacterial pathogen. **(2 marks)**

c) Another viral pathogen was introduced shortly after the above episodes; many people became seriously ill and died of the viral infection. Some ill people recovered fully. In the end, 80% of the population died of the virus. The same virus returned 50 years later. Although most people fell ill again, only 15% of the population died of the same viral disease.

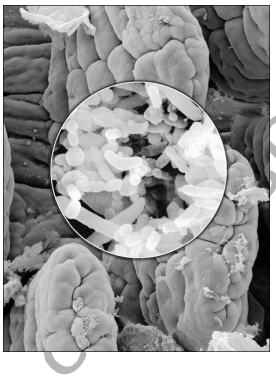
i) Explain if evolution through natural selection has taken place during the 50 years between the two viral invasion episodes. Also explain why the infection rate changed between the two invasions caused by the same viral pathogen. **(2 marks)**

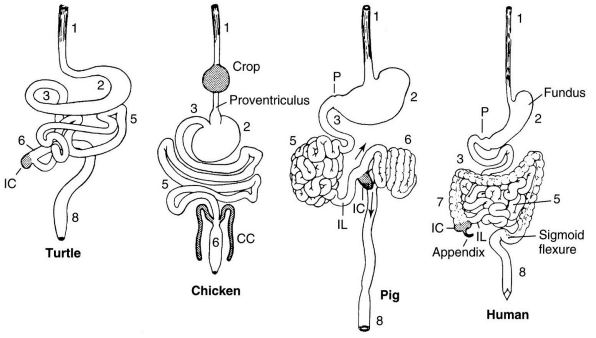
ii) Of the people who the survived this second virus, some become ill with a rare type of cancer in old age. During the initial outbreak of the disease, the virus caused severe swellings of the lymph nodes in their necks. In the elderly survivors cancer also seems to initially arise within the lymph nodes of their necks causing rapid cell division there. Explain why it is possible for viral DNA to still be present in cells of the lymph nodes so many years later. **(1 mark)**

iii) Explain what kind of gene the viral DNA likely contains so that when the gene is expressed it stimulates uncontrolled cell division (normal cell cycle controls are bypassed). **(1 mark)**

d) Many people believe that the human population has reached or likely exceeded its carrying capacity on earth. Discuss in a paragraph (written in ~ 6 to 8 complete sentences) whether the outbreak of a new highly virulent virus would be able to infect and kill enough people to cause a significant reduction in today's global population. Consider what you know about carrying capacity and whether humans have reached it or not. Also consider density dependent factors affecting populations and lastly, trade-offs in pathogens between virulence vs. infectivity. Remember virulence ≠ infectivity. **(6 marks)**

5.





Our ability to sequence entire genomes of different organisms has become very fast. Several ambitious projects are underway where all DNA from all the microorganisms inside the guts of various animals has been sequenced. A diverse array of genes has been found including genes which make enzymes for metabolizing amino acids, carbohydrates, cellulose, lignin and other plant materials that animals themselves lack enzymes to metabolize. Genes have been found for synthesizing vitamins, produce methane etc. Although some genes are shared between microorganisms found in the guts of different animals, what is more noticeable is the many differences among them. **(Total 9 marks)**

a) One interesting discovery has been how different the microorganisms can be between different individuals of the same species. They even found great differences between the guts of two identical (human) twins. Considering the ecology you have learned in this course describe two factors that could

explain observed differences in the microorganisms (as measured by the presence of different genes) between different animals of the same species. **(2 marks)**

b) What two questions could you ask to help identify why there are different gut microorganisms in different species of animals? **(2 marks)**

c) Although we have many digestive enzymes to breakdown our food we still rely on microorganisms to do a lot of the work for us. When we pass gas ("farts") this is the by-product of bacterial digestion of the foods we eat. Similarly cows expel a considerable amount of methane gas for the same reason. Do we also contribute to green house gases? **(1 mark)**

d) Explain whether you think carnivores (meat eaters) or omnivores (meat, plants, fungi etc eaters) would have a more diverse array of gut microorganisms. **(1 mark)**

e) Why would you have difficulty digesting your food after taking a full 2 week prescription of antibiotics? **(1 mark)**

f) When decomposers like bacteria and fungi decompose logs and dead plant matter in the forest they secrete enzymes outside of their cells to breakdown the organic matter and then they absorb the smaller molecules for their metabolism and growth.
i) How does this activity of decomposers effect the growth of plants? **(1 mark).**

ii) Compare the actions of helpful gut microorganisms to the decomposers microorganisms in the forest. **(1 mark)**

6 In preparation for the final exam consider the impact of the proposed Northern Gateway pipeline on some species that live in British Columbia.

Investigate **ONE** of the following animals:
Northern boreal woodland caribou,
Grizzly bear,
Pacific humpback whale,
or Nechako white sturgeon (fish)

Research answers for the following questions on the ONE animal you have chosen:
a) What foods does your animal eat and how does it obtain these foods?
b) Identify two species with which your animal competes. For what factor do they compete?
c) Identify two predators that can affect the abundance of your species.
e) What is the reproductive behaviour of your species?(how old are they, do they migrate for breeding, how many offspring do they have, how frequently do they mate?)?
f) What has caused population declines in your species?
g) How could the construction of the Northern gateway pipeline or an increase in tanker traffic out of Kitimat BC affect your species?

Be prepared to identify the references that you have used and their level of credibility.

7. Describe one aspect of biology that you learned in this course that was interesting to you and explain why. **(2 marks)**