Final Exam Biology 1002B

Exam Date:	**Monday, April 23, 2012, 9:00 am to noon**
Rooms:	As posted on WebCT
Review:	Watch for WebCT announcements.
Office Hours:	Watch WebCT announcements; contact Denis and Tom directly.
Conflicts:	Contact the academic counselors in the Faculty of Science to obtain a "Special Exam Form". Inform Dan Lajoie at dlajoie@uwo.ca.

The Final Exam will be cumulative. This means that you may be expected to work with any of the fundamental principles of biology addressed in the course. For example, the Final Exam may contain questions that assume a basic understanding of the following concepts that have already appeared on previous Term Tests.

the relevance of the two laws of thermodynamics to biological systems.
living cells as open systems.
the concept of free energy relating to exergonic vs endergonic reactions.
characteristics of enzyme structure and function.
the synthesis and function of ATP.
membrane structure and mechanisms by which various molecules move across them.
general function of the light reactions of photosynthesis as well as the Calvin cycle.
the overall physiology of the *Vaucheria/Elysia* kleptoplastic system.
the types of molecules that move into, and out of, organelles.
general function of the citric acid cycle and respiratory electron transport chain
evolutionary origin of various membranous organelles in eukaryotic cells
role of lateral gene transfer in evolution of eukaryotic cells
basic structure of coding and regulatory DNA sequences in eukaryotic and prokaryotic genes
overall mechanism of expression of genes coding for protein or RNA
role of epigenetics in gene regulation
various mechanisms of regulation of gene expression (and dysregulation associated with cancer)

Similar to the structure of the Final Exam of Biology 1001A in the first term, the breakdown below indicates that roughly two hours of the Final Exam for Biology 1002B will be a test of material presented in lecture/lab since the second Term Test. That is, roughly 2/3 of the Final Exam can be thought of as the "third Term Test". Outcomes for this section are listed below. You can expect to be asked to apply general concepts to novel or unfamiliar situations. Of course, you will be expected to understand the relevant specialized vocabulary.

The remaining 1 hour of the Final will consist of questions designed to integrate material in non-multiple-choice format. In general, these questions may ask you to draw, label, graph, compare/contrast, explain, interpret, define in your own words etc. etc. In particular, the Case Study will involve interacting with scientific literature as you have done in Tutorial.

Section A: Material not covered by previous Midterms (120 min.)

About 40 multiple choice questions from lectures.
About 2 multiple choice questions from each of the final two labs.

Section B: "Comprehensive" (60 min)

Part 1. Case Study (40 min)
Part 2. Non-MC overview questions (20 min.)

Overall, Section A will contribute 70% of the Final Exam grade; Section B will contribute 30%.

Major Outcomes for Lectures 18 through 25

Lecture 18: DNA Replication

In multiple choice format questions, identify

components necessary for DNA synthesis.
structure of DNA with respect to polarity and complementarity.
5' and 3' end of a DNA strand.
relationship between DNA synthesis and chromosome duplication during S phase.
structure of replication fork and replication bubble.
problem that arises during replication of the ends of linear chromosomes.
how telomerase addresses the above problem.

Lecture 19: Gene Mutation

characteristics of the Ames Test as a screen for chemical mutagens
characteristics of mutation vs. DNA damage
mechanisms of spontaneous substitution mutation arising from errors in replication
mechanisms of spontaneous indel mutation arising from errors in replication
mechanism by which base analogues, such as 5-bromouracil, increase mutation frequency
likely effects of silent, missense and nonsense mutations on protein function
mechanism of frameshift mutation and likely effect on protein function
likely effects of mutations outside of coding regions

Lecture 20: Chromosome Mutation

mechanism of action of DNA damage by non-ionizing radiation (UV)
mechanism of action of DNA repair enzymes
mechanism of action of DNA damage by ionizing mutagenesis
mechanism of production of aneuploid gametes during meiosis
difficulties of studying effects of radiation exposure on large populations

Lecture 21: Immunogenetics

role of phagocytosis in immune response
characteristics of innate vs. adaptive immune response
mechanism of generation of diverse antibody genes
structure of antibodies and corresponding B cell receptor (BCR)
role of chromosomal rearrangements of antibody sequences in activation of oncogenes
mechanism giving rise to immunological memory
plausible explanations for why different cell lines in chimeras do not mount immune responses against each other

Lecture 22/23: DNA Technologies I and II

Recall that the surprising ability of the "solar slug" *Elysia* to maintain functional chloroplasts stolen while feeding on *Vaucheria* algal cells (kleptoplasty) is an unsolved mystery in science. One possibility is that genes required for plastid maintenance have undergone evolutionary lateral gene transfer from the nucleus of the algae to the nucleus of the slug. These two lectures were designed to analyze a primary research article and showcase how the authors used selected DNA technologies to generate data in support of their hypothesis that a particular photosynthetic gene (*psbO*) from the nucleus of *Vaucheria* is also present in *Elysia*. Overall, you should be able to i) identify the various types of data shown by this paper; ii) explain how these data were obtained; and iii) conclude whether each type of data does, or does not, support the hypothesis.

location of PsbO gene in photoautotrophic organisms
location and role of PsbO gene product in photosynthetic electron transport
purpose of molecular size markers in electrophoresis
interpretation of agarose gel data
mechanism of polymerase chain reaction
role of thermal cycling in polymerase chain reaction
role of primers in polymerase chain reaction
role of *Taq* polymerase in polymerase chain reaction
implications of lack of proofreading in *Taq* polymerase
why primers are seldom less than 16 bases or longer than 30 bases
how to make primers to amplify an unknown gene sequence
role of gene duplication in genome evolution
usefulness of orthologues and paralogues in PCR primer design
inferences that can be drawn from sequence similarity
relative use of global (CLUSTAL) vs. local (BLAST) alignment
interpretation of CLUSTAL results
why some regions of genes are more conserved than others
why it is necessary to make degenerate primers for PCR
how to use RTPCR to amplify particular mRNA
usefulness of Northern blots in addition to standard RTPCR
role of RACE in identifying full length sequence
role of tripartite target sequences in localizing proteins to sub-organellar compartments (ie. thylakoid lumen)
mechanism and result of secondary endosymbiosis

Lecture 24: Oxygen and Ageing

factors that influence ageing
why obligate anaerobes die in presence of oxygen
dangers associated with hyperoxia
proportion of oxygen in air
reactions catalyzed by SOD and catalase
role of cytochrome oxidase in production of ROS
role of quinone pool in production of ROS
how defects in mitochondrial function might lead to disease
human diseases associated with mitochondrial dysfunction
how defects in cytochrome complex lead to increased oxygen toxicity in *C. elegans*
relationship between mitochondrial ROS and ageing
evidence in support of ROS ageing hypothesis
conditions that increase life span
reasons why caloric restriction *might* extend lifespan: evidence for each?
relationship between Sir2 expression and lifespan
relationship between glucose and oxygen concentration and flow of carbon through glycolysis, Kreb cycle/rates of respiration
relationship between Sir2 expression and glycolysis and NAD/NADH ratio for *ad libitum* vs caloric restriction
mechanism of action of Sir2 to regulate transcription and extend lifespan
evolutionary context of caloric restriction extension of life span
principles of the disposable soma hypothesis as an explanation caloric restriction effect on life span

Lecture 25: Biological Time keeping

examples of diurnal physiological/behavioural rhythms
characteristics of circadian rhythms
ways to distinguish circadian from non-circadian diurnal rhythms
evidence that circadian clocks are genetic
mechanism of oscillating gene expression in *Neurospora* biological clock
relationship between oscillating clock gene expression and clock-controlled genes
use of *psbA* reporter gene in cyanobacteria to measure gene expression.
how to determine the advantage to having a biological clock matching the environment
how mammalian clocks are entrained
role of melatonin in clock control