**BIOL 1005 – Concepts in Biology**

Outline of topics covered for Midterm II (October 20, 2011) – *Final version! Posted 18 October 2011*

**DISCLAIMER**: This outline is meant to help you organize your lecture notes. It is not intended to be a substitute for your lecture notes! Furthermore, it is NOT EXHAUSTIVE. Just because a word or phrase does not appear on this study guide, doesn't mean you "don't have to know it." In general, you are best off studying your lecture notes and letting this outline serve as a guide to help you get your notes organized.

Overriding topic for this portion of class: what makes living things different from each other?

I. Protein synthesis
   A. DNA & RNA: history and structure
      1. Historical review: When did Hershey and Chase show DNA is the hereditary material? When did Watson and Crick determine the double-helix structure of DNA?
      2. Structure of DNA double-helix: what are the four bases in DNA? what is complementary base-pairing? which nucleotide base pairs with which? how do the complementary base pairs hold onto each other?
      3. Structure of RNA: what are the four bases in RNA? which nucleotide base pairs with which? what are the three types of RNA?
   B. Genes, proteins, and chromosomes
      1. What's the relationship between chromosomes, DNA, and proteins? What is a gene?
      2. Your cells are genetically identical, so how can they look different and have different functions?
      3. Why are proteins important? What are they made of?
   C. Two main events of protein synthesis
      1. Transcription: roles of DNA, RNA polymerase, mRNA, promoter, terminator. Where in the cell does it occur? Does it require energy (ATP)?
      2. Translation: roles of mRNA, codon, ribosome, tRNA, amino acids. Know how to use the dictionary of the genetic code! (You do not have to memorize the dictionary). Where in the cell does translation occur? Does it require energy (ATP)? How can antibiotics kill prokaryotic cells without harming eukaryotic cells?
   D. Mutations
      1. Types: insertion, deletion, and substitution of one or more bases; understand the cystic fibrosis and sickle cell anemia examples presented in class
      2. Give examples for each of the reasons that genetic mutations are important
      3. Where the mutations in your own DNA may have come from
      4. How scientists used genetic mutations to discover the role of genes in aging (from film clip)

II. Viruses
   A. What all viruses have in common
   B. How viruses are similar to life; why they're not considered life
   C. Events common to every viral replication cycle; what do viruses have to do with DNA and protein production in cells?
   D. Why antibiotics don't work against viruses; why viral diseases in general are hard to cure
   E. HIV (human immunodeficiency virus) as the cause of AIDS
      1. What's a retrovirus? What does reverse transcriptase do?
      2. Events of the viral replication cycle that occur when HIV infects a human immune system cell (see the HIV handout)
      3. How HIV spreads and how it affects the body; what is the difference between being HIV-positive and having AIDS?
      4. HIV's proteins and their relationship to how anti-HIV drugs work
      5. Why an AIDS cure or vaccine is especially hard to develop

III. Introduction to reproduction and inheritance
   A. Where mitosis and meiosis fit into a multicellular, eukaryotic organism's life cycle
   B. Similarities and differences between asexual and sexual reproduction
   C. Advantages of asexual reproduction; advantages of sexual reproduction
   D. The importance of genetic variability in a changing environment

IV. Cell division in more detail
- A. What are the functions of cell division throughout an organism's life?
- B. Events of DNA replication (same for prokaryotes and eukaryotes). What does DNA polymerase do? Does it ever make mistakes?
- C. Prokaryotic cell division: events in binary fission, including how the duplicate chromosomes separate
- D. Eukaryotic cell division: mitosis (when does a eukaryote use mitosis?)
  1. Eukaryotic chromosome structure: chromosome, chromatid, and centromere
  2. Cell cycle overview: interphase → mitosis → cytokinesis → repeat …
  3. Interphase: what happens? Is DNA coiled into visible chromosomes or unwound? Why does it matter?
  4. Know general events in, and be able to recognize, the stages in mitosis: prophase, metaphase, anaphase, telophase/cytokinesis *[note that you will learn the names of the stages in lab during week 8's genetics lab]*
  5. Why both cell division and controlled cell death ("apoptosis") are required for development
  6. Cancer as a disorder of cell division; why tumors are harmful; the difference between a benign and a malignant tumor; the relationships among mutations, proteins that control the cell cycle, and cancer; why cancer is hard to treat/cure
- E. Eukaryotic cell division: meiosis (when and where does meiosis occur?)
  1. Overview of meiosis:
     a. difference between diploid vs. haploid cells; homologous chromosomes (what does "homologous" mean, anyway? And how do you know if two chromosomes are homologous?); which chromosomes determine sex
     b. two characteristics of gametes that make them different from your body's "regular" cells
     c. where in the human body does meiosis occur?
  2. Know general events in, and be able to recognize, the stages of meiosis *[note that we will skip this in lecture, but is covered in detail in week 8's genetics lab]:*
     a. Interphase and DNA replication precede meiosis
     b. meiosis I: prophase I, metaphase I, anaphase I, telophase I and cytokinesis
     c. meiosis II: prophase II, metaphase II, anaphase II, telophase II and cytokinesis
  3. How can two people theoretically create more than 64 trillion genetically different offspring?
  4. Difference between identical and fraternal twins; what are conjoined ("Siamese") twins?
  5. How nondisjunction gives rise to gametes with too few or too many chromosomes *(this was actually covered during the week of Oct. 11, but it kind of belongs here)*

V. Patterns of inheritance
- A. How Mendel used breeding experiments with purple- and white-flowered pea plants to deduce the "patterns" of genetics. What did he deduce about alleles, about the number of alleles of a given gene that a gamete can carry, and about dominant vs. recessive alleles?
- B. What's the difference between heterozygous vs. homozygous? genotype vs. phenotype?
- C. What's the functional difference between a dominant and a recessive allele?
- D. How to use a "test cross" to determine the genotype of an individual with the dominant phenotype
- E. Under what circumstances do "Mendelian" rules of inheritance apply?
- F. How patterns of inheritance can be more complicated than Mendel showed in his experiments
  1. X-linked traits (Why do males usually express X-linked recessive traits more often than do females? What is the role of X chromosome inactivation in female mammals?)
  2. Multiple genes contributing to a single trait (what's an example?)
  3. More than 2 alleles per gene (ABO blood typing – why is this an example?)
  4. Codominance (ABO blood typing – why is this an example?)
  5. Incomplete dominance (what's an example?)
  6. Effects of the environment on gene expression

VI. DNA technology
- A. How to use transgenic technology ("genetic engineering") to move DNA into bacteria & plants
- B. Gene therapy – how we can use DNA to treat certain genetic diseases
- C. Cloning technology for animals – how "somatic cell nuclear transfer" works & why it's important
- D. Stem cell research: what are stem cells? Why are they simultaneously promising and controversial?