BIOL 1005 – Concepts in Biology
Outline of topics covered for Midterm II (October 22, 2015) – final version! posted October 20, 2015

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. Genes, proteins, and chromosomes
      1. What’s the relationship between chromosomes, DNA, and proteins? What is a gene?
      2. Why are proteins important? What are they made of?
      3. Your cells are genetically identical, so how can they look different and have different functions?
   B. DNA & RNA structure – a review
      1. Structure of the DNA double-helix: What are the four nitrogenous bases in DNA? What is complementary base-pairing? Which nucleotide forms base-pairs with which? How do the complementary base pairs hold onto each other?
      2. Structure of RNA: How is the function of RNA different from that of DNA? What are the four bases in RNA? Which nucleotide forms base-pairs with which? What are the three types of RNA?
   C. Two main events of protein synthesis
      1. Transcription: Describe the roles of DNA, RNA polymerase, mRNA, promoter, and terminator. Where in the cell does transcription occur? Does transcription require energy (ATP)? Why or why not?
      2. Translation: Describe the roles of mRNA, codon, ribosome, tRNA, amino acids, anticodon. 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)? Why or why not? How can antibiotics kill prokaryotic cells without harming eukaryotic cells?
   D. Mutations
      1. How insertions, deletions, and substitutions of one or more bases may affect a gene and its encoded protein; how the specific mutations associated with cystic fibrosis and sickle cell trait cause illness
      2. What is the relationship between genes, mutations, and alleles?
      3. Give examples for each of the reasons that genetic mutations are important
      4. What causes mutations? Where might the mutations in your own DNA have come from?
      5. How scientists used genetic mutations to discover the role of genes in aging (from film clip) – trace the events from the mutagenic chemicals to the changes in the proteins on the worm cell surfaces.

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 the reverse transcriptase enzyme do?
      2. Events of the viral replication cycle that occur when HIV infects a T cell (see the HIV handout)
      3. How HIV spreads to new hosts 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? Do all cells divide at the same rate?
   B. Events of DNA replication. What does DNA polymerase do? What happens if it makes a mistake?
   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. Main events in the cell cycle: 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 the names of the stages are covered in 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
      a. How proteins control cell division; what happens when those proteins “break”
      b. Why tumors are harmful; difference between a benign and a malignant tumor
      c. Trace the sequence of events from mutation to cell cycle control proteins to cancer
      d. 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 (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 skipped this in lecture, but was 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 twins?
      5. How nondisjunction gives rise to gametes with too few or too many chromosomes [covered on 10/15]

V. Patterns of inheritance
   A. What’s the relationship between the events of meiosis and a Punnett square?
   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 patterns of inheritance can be more complicated than one gene/two alleles/two phenotypes
      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? in Rett syndrome?)
      2. Codominance (ABO blood typing – why is this an example, and how does it work?)
      3. Incomplete dominance (what’s an example?)
      4. Polygenic traits (what’s an example?)
      5. Effects of the environment on gene expression

VI. DNA technology [Krystal’s lecture]
   A. Transgenic bacteria & plants: How do they do it, and why are transgenic bacteria and plants useful? What are the pros and cons of transgenic crops? See section 11.2A, especially figures 11.2 and 11.3.
   B. Gene therapy: How could we use DNA to treat certain genetic diseases? Why is it so hard to implement? See section 11.4D, especially figure 11.13.
   C. Stem cells: How are stem cells different from differentiated cells and why might stem cells be useful in medicine? Why are they controversial? See section 11.3A, especially figure 11.9.
   D. Cloning mammals: How cloning (“somatic cell nuclear transfer”) works & why it could be useful. See section 11.3B, especially figure 11.10.