

BIOL 1005 – Concepts in Biology

Outline of topics covered for Midterm II (October 23, 2008) – *final version! posted 20 Oct. 2008*

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. 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?
- B. 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?
- C. Your cells are genetically identical, so how can they look different and have different functions?
- D. Why are proteins important? What are they made of?
- E. What's the relationship between chromosomes, DNA, and proteins? What is a gene?
- F. Two main events of protein synthesis
 - a. Transcription: roles of DNA, RNA polymerase, mRNA, promoter, terminator. Where in the cell does it occur? Does it require energy (ATP)?
 - b. 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)?
- G. How antibiotics can kill prokaryotic cells without harming eukaryotic cells
- H. Mutations
 1. Types: insertion, deletion, and substitution of one or more bases
 2. Give examples for each of the three main 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 forms
- C. Events common to every viral replication cycle
- 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 is reverse transcriptase?
 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. How anti-HIV drugs work
 5. Why an AIDS cure or vaccine is 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. Prokaryotic cell division: events in binary fission, including how the duplicate chromosomes separate
- C. Events of DNA replication (same for prokaryotes and eukaryotes). What does DNA polymerase do? Does it ever make mistakes?
- 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
 5. Why both cell division and controlled cell death (“apoptosis”) are required for development
 6. Cancer as a cell cycle disorder; why tumors are harmful; the difference between a benign and a malignant tumor; the relationship between genetic 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. homologous chromosomes (what does “homologous” mean, anyway? And how do you know if two chromosomes are homologous?)
 - b. which chromosomes determine sex
 - c. difference between diploid vs. haploid cells
 - d. two characteristics of gametes that make them different from your body’s “regular” cells
 - e. 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 you will cover it in detail in 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. Why are mules sterile, and what does it have to do with meiosis?
 4. Three ways meiosis creates new gene combinations: crossing-over, independent orientation of tetrads during metaphase I, random fertilization. What does each of those mean, and how do they influence the variety of offspring produced in sexual reproduction?
 5. How nondisjunction during meiosis I or II can lead to gametes (and kids!) with wrong number of chromosomes; consequence of child inheriting wrong number of chromosomes
 6. Difference between identical and fraternal twins; what are conjoined (“Siamese”) twins?

V. Patterns of inheritance

- A. Mendel’s experiments with purple- and white-flowered pea plants: P, F₁, and F₂ generations; what “true-breeding” means in practice and in terms of genetic makeup
- B. What Mendel concluded from his breeding experiments: about alleles, about the number of alleles of a given gene that a gamete can carry, and about dominant vs. recessive alleles
- C. What’s the difference between heterozygous vs. homozygous? genotype vs. phenotype?
- D. What’s the functional difference between a dominant and a recessive allele?
- E. How to use a “test cross” to determine the genotype of an individual with the dominant phenotype
- F. Under what circumstances do “Mendelian” rules of inheritance apply?
- G. How patterns of inheritance can be more complicated than Mendel showed in his experiments
 1. X-linked traits (Why do males express X-linked recessive traits more often than do females? – *Dr. Hobson stopped here, but I will continue with this story in class on Tuesday: -- 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?)

VI. DNA technology – Ashleigh Sosebee’s talk (Thursday) plus whatever we get to on Tues./Wed.

- A. Ashleigh Sosebee’s talk: What kinds of evidence do criminalists examine? What is the difference between a presumptive and a confirmatory test? What is the goal of DNA analysis? What is the role of population statistics in the criminalist’s work?
- B. Goals of human genome project
- C. How to use transgenic technology (“genetic engineering”) to move DNA into bacteria & plants
- D. Cloning technology for animals – how “somatic cell nuclear transfer” works & why it’s important
- E. Stem cell research – what it is and what it can accomplish