Advanced Genetics: Bio 5491

Problem Set #1: Genetics Review – Mendel, Mutations, Chromosomes and Heredity

Due: Tuesday, 28 January 2020

Type all short answers in your own words. Add diagrams where necessary.

Chapter 2: Mendel

1. Besides his famous peas, name five other organisms Mendel studied. Why was Hieracium a poor choice for studying segregation and recombination?
2. What new procedures did Mendel use for his experiments? Why was this approach so effective?
3. What is Fisher’s most serious criticism of Mendel’s ratios? What does Fishre show is true of Mendel’s whole series of data?
4. How do the results of replications of Mendel’s experiments conflict with Fisher’s criticisms? What is the overall impression of these results?

Chapter 11: Mutation

5. What was the first question regarding the origin of new genes? As late as 1914, how were newly arisen forms explained?
6. What two types of mutations can be studied easily in diploid organisms? What types of mutations are difficult to study in diploid organisms and why?
7. Muller’s experimental design in Drosophila fulfilled what two requirements necessary to establish a quantitative study of mutation? What is the significance of the “CIB” chromosome?
8. How did Muller and Stadler independently show the effect of ionizing radiation on mutation rates? Is the relationship linear or exponential?

The Chromosomes in Heredity

9. What possibility does Sutton raise on page 8, regarding chromosomes and allelomorphs? What evidence does he present to support his hypothesis?
10. What are Bateson’s three cases of non-Mendelian inheritance? Describe them in your own words.
11. What is Sutton’s key contribution (theory) to the field of genetics? What does his theory state? What aspects of biology support this?

General Genetics Review

12. With a single sentence for each (or possibly less), define the following common genetic terms:
   a. Homozygous
   b. Heterozygous
   c. Aneuploidy
   d. Linkage
   e. Linkage disequilibrium
   f. Synteny
   g. Expressivity
   h. Penetrance
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1. Pleiotropy
2. Epistasis
3. Epigenetics
4. Inheritance
5. Heritability
6. Hardy-Weinberg Equilibrium
7. Evolution

13. Consider flower color as a hypothetical monogenic trait in peas. Flowers can be red or white, and the red allele (R) is dominant. If you cross a homozygous red (RR) plant with a homozygous white (rr) plant:
   a. What are the expected phenotypic and genotypic ratios for the F₁ generation?
   b. If you cross two of the F₁ plants, what are the expected phenotypic and genotypic ratios of the F₂ generation?
   c. What phenotypic ratios would you expect from both the F₁ and F₂ generations if the red allele is incomplete dominant and heterozygotes have pink flowers?

14. Draw the steps of meiosis in an animal cell – including one instance of crossing over. Please use color. Label all relevant cellular components and processes. Include: Meiosis I, Meiosis II, diploid, haploid, gametes, Interphase, Prophase, Metaphase, Anaphase, Telophase, cytokinesis, cell membrane, nuclear envelope, nuclear envelope breakdown, chromatin, homologous chromosome, sister chromatid, tetrad, centromere, metaphase plate, spindle, centriole, chiasma, synapsis, kinetochore. NOTE: many of these structures are close together and may become difficult to label – make sure to label them at least once throughout your entire diagram as they may appear more than once.