

Biology Homework Week 2

Due Wednesday, October 3 – (I will collect them prior to the exam.)

Your responses should be relatively brief, providing only the necessary information to answer the question.

1. An *E. coli* is a rod-shaped bacterium about $2\mu\text{m}$ long. If you placed *E. coli* end-to-end, how many *E. coli* would it take to cross the center of the field of view when using the 100X objective? (Please base your calculation on the following information: when using the 4X objective and a 10X ocular, the diameter of the field of view measured 5mm.)

Total magnification is $(4)(10) = 40$; $(100)(10) = 1000$

mm of field of view at 100X = $40/1000$ (5mm) = 0.2mm or $200\mu\text{m}$

$200\mu\text{m}/(2\mu\text{m}/E.coli) = 100 E.coli$

2. Darwin and Wallace's theory of evolution by natural selection failed to explain what?

Darwin and Wallace failed to explain how heritable traits are passed on to subsequent generations. This was later explained through the work of Mendel, Sutton and Boveri.

3. Is evolution a random process? Explain your reasoning.

Evolution is not a random process. Evolution is an outcome of natural selection. It is defined as changes in allele frequencies that occur in populations from one generation to the next. Although changes in a specific allele or allele frequencies can occur randomly due to events such as mutations, those events do not necessarily lead to greater fitness.

4. Provide an example to support the following statement: Natural selection does **not** occur in order to benefit a population or a species.

There are several examples where a given trait contributes to reproductive success of selected individuals but it is not necessarily benefit a population. If an organism with a particular trait can obtain food more successfully than individuals without the trait, then only those organisms are benefit, not the entire population.

5. A true-breeding pea plant with wrinkled, yellow seeds was crossed with a true-breeding pea plant with round, green seeds. What are the genotypes of all the possible gametes that one individual from the F1 generation could produce?

If you were to draw out meiosis I and II with alternative possibilities for independent assortment, you would find that one individual (with the genotype $RrYy = F1$) could produce the following gametes:

$RY RY Ry Ry rY rY ry ry$

6. What is the frequency of each phenotype in the F2 generation of a cross between two true-breeding parent pea plants, one with yellow seeds and the other with green seeds?

First do the cross to obtain the F1 generation with the genotype Yy . Next, Cross two F1 individuals to get the F2 genotypes of $YY, Yy, Yy, \text{ and } yy$. The frequency of each phenotype is 3:1 (yellow to green).

7. If a mother and father are heterozygous for a single given trait, what is the probability that they will produce an offspring that is heterozygous for that trait? If they are heterozygous for two different traits, what is the probability that they will produce an offspring with the same genotype?

Mother: $Rr \rightarrow p(R) = \frac{1}{2}$ or $p(r) = \frac{1}{2}$

Father: $Rr \rightarrow p(R) = \frac{1}{2}$ or $p(r) = \frac{1}{2}$

For both mother and father: $(\frac{1}{2})(\frac{1}{2}) = \frac{1}{4}$

1) $\frac{1}{4} + \frac{1}{4} = \frac{2}{4} = \frac{1}{2}$

You can also prove this by using a Punnet square

2) $P(Rm \text{ and } rf) = p(Rm) \times p(rf) = (\frac{1}{2})(\frac{1}{2}) = \frac{1}{4}$

$P(fm \text{ and } Rf) = p(rm) \times p(Rf) = (\frac{1}{2})(\frac{1}{2}) = \frac{1}{4}$

$$P(\text{Rm rf } \underline{\text{or}} \text{ rmRf}) = \frac{1}{4} + \frac{1}{4} = \frac{2}{4} = \frac{1}{2}$$

8. A pea plant that is heterozygous for seed shape, seed color, and flower color was crossed with a true-breeding pea plant that produced round, yellow seeds and purple flowers (purple is dominant over white). What proportion of progeny will phenotypically resemble a) the first parent and b) the second parent?

All progeny will have at least one dominant allele for seed shape, seed color, and flower color. Therefore, all progeny will resemble both the first and second parents.

9. In a certain plant, blue (B) flower color is dominant to white (b). You have a blue flowered plant and a white flowered plant.

a. What do you know about the genotype and phenotype of each plant?

Blue Plant = BB or Bb

White Plant = bb

b. After crossing the plants you find that all the offspring are blue. What have you learned about the genotypes of the original plants?

You've confirmed that the blue parent must have been homozygous dominant, BB.

10. How is binary fission of bacteria similar to mitosis in eukaryotic cells? What is the major difference between these two processes?

Both binary fission of bacteria and mitosis involve exact replication of the cell and result in two daughter cells.

The major difference between these two processes is that bacteria typically only have one chromosome that is located in the cytoplasm, as they lack a nucleus which is present in eukaryotic cells. Additionally, the final result of the two daughter cells is through a similar process of cell division, but the terminology is fission for bacteria and cytokinesis for eukaryotic cells.

11. Which of following statements about crossing over is true?

a. Chiasmata form between sister chromatids.

b. It occurs in prophase of Meiosis II.

c. It decreases the genetic variability of gametes produced by meiosis.

d. Chromosomes that result from crossing over have a mixture of paternal and maternal alleles.

The answer is D.

12. In which stage of meiosis does a fruit fly have 8 chromosomes (see table 12.1 in your book)?

Fruit flies have 8 chromosomes as long as the cell is diploid ($2n=8$). After cytokinesis in Meiosis I the cell is haploid. No chromosome replication occurs between Meiosis I and II. So at the beginning of meiosis II, each chromosome consists of two identical sister chromatids. Because only one member of each homologous pair is present, the cell is haploid.

13. Cells from an organism with a diploid number of 6 undergo meiosis. Draw a sketch of a cell in metaphase I and a cell in metaphase II. Label your drawing appropriately.

Metaphase I: Your drawing should contain: centrosomes at opposite poles of your cell, microtubules in contact with a TOTAL of 6 chromosomes which are aligned as homologous pairs at the metaphase plate.

Metaphase II: Your drawing should contain: centrosomes at opposite poles of the cell, microtubules in contact with a TOTAL of 3 chromosomes (with sister chromatids) aligned at the metaphase plate.