

Biology 4, Exam 1

*In compliance with the Dartmouth honor principle, all the work you hand in on this exam is to be your own. Please remember to be **precise** in your wording – scientific descriptions rely on accurate use of specific terms. Also, try to keep your answers **concise**. If you can say something briefly there is no need to create a lengthy answer just to fill up space. Use the space provided and the point values for each question as indicators of the amount of detail your answer should contain. If you really need extra space for an answer, turn the page over and continue your answer on the back of the same piece of paper. To facilitate grading, we separate the exam by page; if your answer is on a different sheet of paper we will not see it. **Please put your name on each page now.***

If something is not clear to you, please ask me during the exam. That is why I stay in the room. Good luck. - Prof. Gross

1. We watched a video called “Who Are You?” Part of this video presented a sheepdog trying to herd sheep for the first time. Discuss how genes and environment/nurture both influence the dog’s chance of success. **(10 points)**
(you can use the back of this page if you absolutely must, but please try to keep your answer brief)

Answer should include the fact that the dog has genes that allow him to hunt and track animals from his wolf heritage and that the dog also can learn new behavior. The new behavior allows the dog to apply its genetic behavior towards a new task - it can learn.

Biology 4, Exam 1

2. What is meant by genotype and phenotype? **(4 points)** Which of these did Mendel study? **(1 point)**

Genotype is the set of genes an organism possesses. Phenotype is the set of measurable or recognizable traits that result from the genotype. Mendel studied phenotype.

3. Give an example of a trait that does not follow Mendel's laws and explain why it does not. **(5 points)**

several examples are possible but they include the following (only one answer needed):

multigenic/polygenic traits that are the result of many genes contributing to the trait - such as height, shape of nose, etc.

incomplete dominance is the result of each allele making a product that contributes to the observed trait so that if only one allele is present, the trait is incomplete - such as in flowers that are red because they have two red alleles. If only one allele is present, half as much red pigment is made and the flower is pink

codominance results when each allele is expressed and that expression does not have an influence on the other allele. An example is the ABO blood types - each allele can make either A antigen, or B antigen, or no antigen. Red blood cells can therefore be AA, AB, AO, BB, BO, or OO.

sex linked traits are associated with gender - not a Mendelian inheritance

4. Describe what a centromere is and how it functions during mitosis. **(5 points)**

The centromere is the structure that holds sister chromatids together after the DNA has been replicated. It is used to help align the chromosomes along the metaphase plate, and after the centromere is cleaved, allows the chromosomes to be pulled towards the poles of the cell by the spindle fibers.

5. In what way does the quality of ear wax relate to incidence of breast cancer? Explain your answer. **(6 points)**

Wet ear wax correlates with a higher incidence of breast cancer than does dry ear wax. Ear wax is produced by the apocrine gland system which includes the mammary glands as well. Apparently, the different alleles in the apocrine gland system that lead to ear wax "quality" also influence susceptibility to breast cancer.

Biology 4, Exam 1

6. What happens during S-phase of the cell cycle? **(2 points)**

The main event is chromosome duplication, which includes DNA replication.

7. Explain the process of crossing over during meiosis. **(4 points)** Why is it important? **(2 points)**

Crossing over is a process in which corresponding parts of chromosome pairs (sister chromatids) can swap genetic information by having their DNAs cut and reconnected. It is important because it leads to more genetic diversity.

8. Describe two different membrane bound organelles inside eukaryotic cells and explain their cellular roles. **(4 points)**

many organelles: nucleus (contains genetic information, chromosomes), mitochondria (responsible for energy production from food), chloroplasts (responsible for photosynthesis), endoplasmic reticulum (involved in protein synthesis and processing, steroid biosynthesis), Golgi apparatus (modification of proteins), lysosomes (contain digestive enzymes and can digest food)

9. Cancer cells are immortal. Explain what is meant by this statement. **(3 points)**

Normal cells can be placed in a Petri dish and allowed to grow and divide. After a fixed number of divisions (usually 50-100), these cells will be unable to divide any further - thus the cells are mortal. On the other hand, cancer cells can keep dividing indefinitely and so are said to be immortal.

Biology 4, Exam 1

10. Describe the experiment done by Avery and his colleagues to demonstrate that DNA is the genetic material. (5 points)

R and S pneumonia bacteria; S is lethal to mice, R is not. Heat killing S makes them non-lethal. Mixing heat killed S with R, and then injecting into mice is lethal. The R strain picked up something from the cell debris of the killed S strain. Treating the killed S with DNAase eliminated the "transforming" ability of the extract, but proteinase did not - the "transforming factor" therefore had to be DNA.

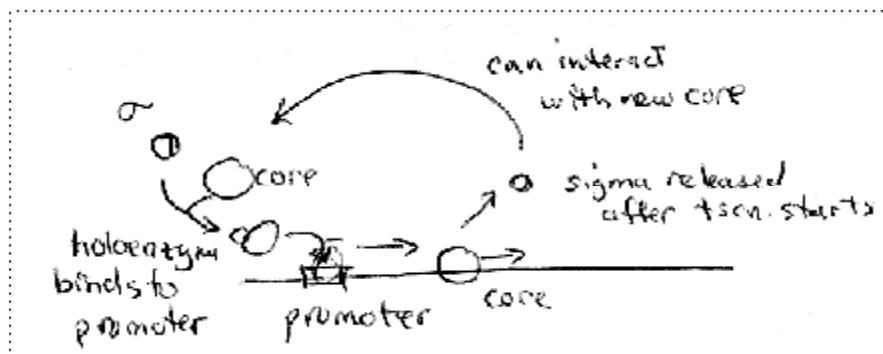
11. In chromatin, DNA only represents about 1/3 of the mass. What components make up the remaining 2/3? (2 points)

histones and non-histone proteins

12. Diagram and label how sigma-factor functions in prokaryotic transcription. (5 points)

This is shown in slide#34 of topic 0405. Basically, sigma factor interacts with core RNA polymerase to provide the polymerase with the ability to recognize a promoter sequence on the DNA (without the sigma factor, core does not recognize the promoter). Once the RNA polymerase-sigma complex binds to the promoter, transcription starts and sigma factor is released while the core RNA polymerase continues along the DNA making new RNA.

OR... can draw something like this.



Biology 4, Exam 1

13. What are telomeres? Why are they important to the life of the cell? **(4 points)**

Telomeres are the ends of chromosomal DNAs. They consist of 100s to 1000s of repeats of a short DNA sequence (typically 6 nts). They are important to life because after each DNA replication, the length of the telomeres gets shorter. After a certain number of cell divisions the telomeres are too short and the cell will no longer divide.

14. We discussed the disorder phenylketonuria (PKU), which leads to the inability to metabolize phenylalanine, and therefore to higher phenylalanine levels in the bloodstream. Testing of newborns for high phenylalanine levels can result in them being placed on special (low phenylalanine) diets to avoid most of the complications of the disorder. When this approach was taken back in the 1970s it led to some unexpected consequences years later. Explain what happened later on and how you think the situation should be dealt with. [note that there is no particular "right" answer, but you are expected to explain your thoughts clearly.] **(15 points)**

Women with PKU reached reproductive age and started having children (previously, they were in mental institutions and did not have children). Because of the elevated phenylalanine levels in their blood, the fetuses suffered damage and the children of these women had some serious difficulties. There are many possible answers to what to do about this situation... ranging from forced sterilization of the women to nothing being done, and almost every idea in between these two.

Biology 4, Exam 1

15. Define apoptosis (**2 points**) and explain why it is important. (**3 points**)

Apoptosis is programmed cell death. It is important because it is an essential part of normal embryological development and is important in other processes like wound healing in individuals.

16. Growth and differentiation are both important to development. Explain what these processes are and why they are important to development. (**6 points**)

Growth is the process of cell division which allows the developing embryo to become larger, including the growth of all of its component organs. Differentiation is the process of cells becoming more specialized and acquiring the ability to perform specific tasks unique to that particular cell type.

17. What is a nucleosome? (**2 points**) What function does it serve? (**2 points**)

A nucleosome is a particle consisting of 8 histone molecules and about 150 bp of DNA wrapped around the outside of the histone core. It is important because it allows the DNA to be compacted in the nucleus into a more orderly arrangement.

18. tRNA plays an important role in translation. It is an interesting molecule in that it has two functional sites on it. What function does each of these sites perform? (**4 points**)

One site is responsible for binding to an amino acid and thereby bringing the amino acid to the site of protein synthesis. The second site is responsible for binding the tRNA to the next codon of the mRNA.

19. Meselson and Stahl performed experiments to determine if DNA replication was conservative, dispersive, or semiconservative. State which of these hypotheses turned out to be correct (**2 points**) and simply explain what the process is. (**2 points**)

Replication is semiconservative. This means that the original DNA double helix splits into two strands, with each strand remaining intact and serving as a template for the synthesis of a new DNA strand.