

MCDB 1111: Biofundamentals
Fourth midterm and IKIN exams

Name: _____

Spring 2006

For each multiple choice question there is only one correct answer. On the fourth midterm, which everyone should take, we will use our standard grading scheme.

On the "I know it now!" (IKIN!) exams, there is no "no idea" option. Each IKIN! exam consists of multiple choice and essay questions for a total of 20 to 40 points each.

If you are taking one or more IKIN exams, you must check it here, or we will not grade it! (don't worry about your original score, this is to make determining your final grade simpler for us).



"Don't worry, Howard. The big questions are multiple choice."

I am taking a	ORIGINAL SCORE	IKIN SCORE	Total Exam Pts (380 possible)
<input type="checkbox"/> Midterm 1			
<input type="checkbox"/> Midterm 2			
<input type="checkbox"/> Midterm 3			
Final (80 Possible)		X	
		Total Exam Pts (380 possible)	
		Labs (90 Pts possible)	
		Participation (70 Pts possible)	
		Letter grade	

Note: if you want to argue about, or expand upon a specific question, you can write your argument on the back of the page.

Final MidTerm Exam 4 (80 points total)

1A. At the end of a mitotic cell division, the two daughter cells have the same number of chromosomes as the original (mother) cell. By the end of meiosis, the number of chromosomes in the cells produced is

- A. the same as in the mother cell
- B. twice that found in the mother cell
- C. one-half of that found in the mother cell
- A or B B or C A or C no idea

2. (3 points): Consider a cell that is the product of meiosis. What must occur before the progeny of that cell could possibly undergo meiosis again?

- A. syngamy
- B. DNA replication
- C. cell growth, division and differentiation
- A or B B or C A or C no idea

2B (4 points): What are two possible benefits of sexual reproduction to a species.

3A. In the mutation lab it was concluded that the presence of phage

- A. selected phage-resistant bacteria that already existed in the population
- B. induced the appearance of mutations that lead to phage resistance in the population
- C. increased the rate of mutation
- A or B B or C A or C no idea

3B. (3 points): What would happen to both a phage and the bacteria it infects if, the bacteria could not possibly develop resistance to, or survive phage infection?

4. In most species of bacteria there is a single origin of DNA replication, the site in the DNA where replication begins. You genetically engineer a mutation into a bacterial cell that removes this origin sequence, what is most likely to happen?

- A. the cell would die
- B. the cell would never divide
- C. a second mutation would occur that would allow DNA replication to occur
- A or B B or C A or C no idea

4B (3 points). Briefly explain your choice:

5. You are studying amoeba, cells that normally divide after they reach a certain critical size. In a version of a classic experiment, you inject cytoplasm from one cell into another. Compared to unmanipulated cells, you might expect...

- A. the injected cell will divide earlier than unmanipulated cells.
- B. the injected cell will divide at the same time as unmanipulated cells, but produce larger daughter cells.
- C. the injected cell will divide later than unmanipulated cells, and produce larger daughter cells.
- A or B B or C A or C no idea

5B (3 points). Briefly explain your choice:

5C. (4 points). Consider a population of single celled organisms that divide only after they reach a certain genetically determined size. Describe environmental conditions in which a mutation that causes a cell to divide when it was smaller than the "normal size" might have a reproductive advantage.

6. When a stem cell goes through mitosis, the result is ...

- A. two stem cells
- B. one stem cell and one differentiating cell
- C. two differentiating cells
- A or B B or C A or C no idea

7. In animals, once an egg cell is fertilized, through fusion with a sperm cell, the process of embryonic development begins. Which process is involved in building the body of the organism?

- A. syngamy
- B. mitosis
- C. meiosis
- A or B B or C A or C no idea

8A. During the course of embryonic development many different cell types are produced. These cells differ in ...

- A. DNA
- B. mRNAs and proteins
- C. tRNAs and amino-acyl tRNA synthases
- A or B B or C A or C no idea

8B. (3 points) Briefly (very briefly), describe how the differences between somatic cells arise from what was originally a single cell.

9. It is now possible to produce a new organism asexually, via nuclear transplantation. In such an experiment, a somatic cell nuclei is used. This type of experiment demonstrates that...

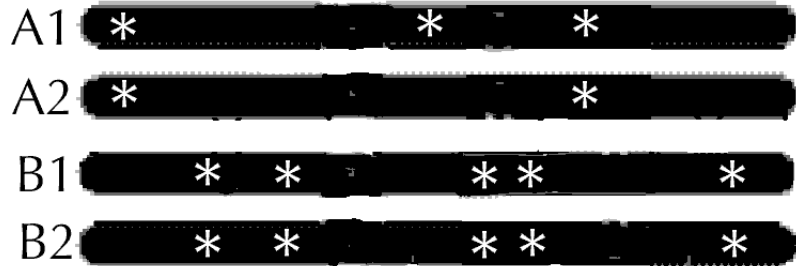
- A. no genetic information was lost during the formation of somatic cells
- B. genetic information in the egg cytoplasm can be moved into the transplanted nucleus
- C. the genetic information required to form an embryo is located in the egg's cytoplasm
- A or B B or C A or C no idea

9B (3 points): Why wouldn't we use a sperm nucleus (if the donor were a male) or an egg nucleus (if the donor were a female), rather than a somatic nucleus, to generate a clone?

10. What process makes it unlikely that any of your children will inherit a chromosome that is identical to the chromosome you inherited from your mother?

- A. mitosis
- B. recombination
- C. fertilization
- A or B B or C A or C no idea

11. In the picture, homologous chromosomes A and B are shown aligned early in meiosis. Differences in the sequences of the homologs are marked by "*"s, these sites are not wild type. During the final replication of DNA prior to meiosis, a mutation occurred.



11A (2 points). Circle the asterix that corresponds to this mutation.

11B (3 points). Why do we assume that that the mutation occurred during the final round of DNA replication and not earlier?

11C (3 points): With "X"s indicate where cross-overs would have to occur to produce one chromosome that was free of mutations.

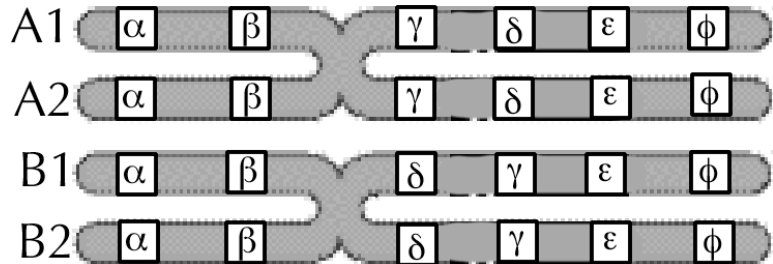
11D (3 points): Now assume that this process occurred in a male; which of the four gametes that result would be the most unlikely to produce a reproductively successful organism and why?

12. Consider an organism, like some species of ladybugs, which can reproduce both sexually and asexually. In one particular asexual population, a chromosomal inversion occurs that has no obvious phenotypic effect. We might be safe in assuming that

- A. there were no genes in the inverted region
- B. the inversion did not disrupt either coding or regulatory sequences
- C. the inversion did not alter genes involved in sexual reproduction
- A or B B or C A or C no idea

12B (3 points) How could a chromosomal rearrangement, like an inversion, produce a mutation?

13: Consider a sexually reproducing organism; it produces gametes with "A" type chromosomes. It mates with an organism that produces gametes that contain a homologous chromosome of the "B" type. Now the offspring of this mating starts to produce gametes.



13A (3 points) Why does the presence of the inversion in B not effect the somatic development of the offspring?

13B (3 points). Using the diagram and an "X" mark where a cross-over event would lead to a gene duplication and gene deletion

14. (4 points). How might you use germ line genetic engineering to produce offspring with enhanced traits, such as improved athleticism or greater intelligence?

The "I KNOW IT NOW!" EXAM #1 (40 points possible)



1A. The cell theory of life implies that ...

- A. there is an unbroken line of descent from our cells to the earliest cells
- B. all organisms are linked together through their place in the biosphere
- C. there was a single origin of life
- A or B B or C A or C

1B (3 points): Explain why the cell theory of life is a theory, rather than a fact.

2. Assume that we can visit a large number of planets, throughout the universe. We find no evidence that life exists or ever existed anywhere else but on the earth. From a scientific perspective, we would be justified in concluding that...

- A. the origin of life requires a supernatural event
- B. the natural events that lead to origin of life are extremely improbable.
- C. life itself cannot be studied scientifically
- A or B B or C A or C

3A. The theory of evolution is based on the observation that most natural populations are generally at steady state with respect to population size. What factor is involved in establishing this steady state?

- A. Organisms consciously limit the number of offspring they produce
- B. On average only each individual produces only a single offspring that successfully reproduces
- C. Competition for mates limits the offspring produced.
- A or B B or C A or C

3B (3 points): It is possible to argue that humans can avoid this "rule of nature"; what do you think will determine the long term steady state of the human population?

4. Assume that there are two alleles of gene N (N1 and N2) in a population, and that there is no selective advantage associated with either allele. Due to the effects of genetic drift, which will happen?

- A. one or the other allele will disappear from the population
- B. the frequency of each allele will approach 50%
- C. mutations will cause one or the other allele to change
- A or B B or C A or C

5. Which of the following statements is most correct

- A. Evolution always proceeds in the direction of increasing complexity
- B. A primitive looking organism may be descended from a more complex predecessor.
- C. Based simply on morphology, it is possible to determine whether an organism is primitive
- A or B B or C A or C

4A. The importance of natural selection in understanding biological systems is that it ...

- A. provides a mechanism to circumvent the laws of thermodynamics, and so makes living organisms possible
- B. provides an explanation for the many homologies between organisms
- C. explains why human beings exist
- A or B B or C A or C

4B (4 points). If mutations occur at random, how is it that information can accumulate in living organisms?

5. The importance of Wohler's in vitro synthesis of urea was

- A. that it proved that all organic molecules could be synthesized outside of cells
- B. it suggested that there was nothing necessarily "special" about organic molecules
- C. it suggested that evolutionary processes were at work in the synthesis of more complex organic molecules.
- A or B B or C A or C

6. As far as we know, all organisms store information in DNA and express that information using the same basic molecular mechanisms. This implies that this DNA-based information system is ...

- A. an ancestral trait
- B. an example of evolutionary convergence
- C. the only possible way biological systems could storage and express genetic information
- A or B B or C A or C

7. Evolutionary processes rarely produce perfect designs or adaptations because ...

- A. processes like sexual selection move populations away from optimal design
- B. evolution depends upon mutation and a mutation implies imperfection
- C. perfection does not produce a great enough reproductive advantage to justify its "cost"
- A or B B or C A or C

8. Under what conditions might you expect to see selection for sex-specific traits (like the peacock's tail) in females

- A. the successful raising of offspring is greatly enhanced by a loyal (monogamous) mate
- B. the female supplies more genetic information to the offspring than does the male
- C. the act of mating puts males at greater risk than the female

Explain your reasoning....

THIS IS THE "I KNOW IT NOW!" EXAM #2 (30 points).

1. If a molecule can make hydrogen bonds

- A. it cannot interact with other molecules through van der Waals interactions
- B. it will not dissolve in water
- C. its boiling point will be higher than a molecular of similar molecular weight that cannot make H-bonds.
- A or B B or C A or C

2. Consider an amoeba, which lives in fresh water but does not have a cell wall. You poison the energy generating system of the cell. What happens?

- A. the cell swells and bursts because it no long has the energy needed to pump the water that flows in out.
- B. the cell shrinks, as it is no longer able to pump water into the cell.
- C. the cell remains the same size, since water movement is due to diffusion, a passive process that does not require energy.
- A or B B or C A or C

3. For a covalent bond to be polar the two atoms of the bond must have....

- A. similar electronegativities
- B. different sizes
- C different electronegativies
- A or B B or C A or C

4. Oils are totally hydrophobic and insoluble in water, while lipids form complex structures, such as micelles and bilayers – why?

- A. lipids have both hydrophilic and hydrophobic domains
- B. lipids are shaped so that their van der waals interactions favor micelle/bilayer formation
- C. lipids have smaller hydrophobic domains than do fats
- A or B B or C A or C

5. Electrons move through the electron transport chain and generate a H⁺ gradient. In a bacterial cell, the concentration of H⁺ is highest...

- A. inside the cell
- B. outside the cell
- C. at the end of the electron transport chain
- A or B B or C A or C

6. You carry out a series of measurements and find that it takes approximately one minute for a set of particles to diffuse an average of 10 μm. Based on your experiences with diffusion [in the water lab], estimate how long will it take for particles to diffuse an average of 100 μm

- A. much less than 10 minutes
- B. about 10 minutes
- C. much longer than 10 minutes
- A or B B or C A or C

7. Consider the purple bacterium *Halobium*. What happens to the rate of ATP synthesis when you add the H⁺ channel-forming molecule tridodecylamine ?

- A. It remains unchanged
- B. It is increased
- C. It is decreased
- A or B B or C A or C

8. During aerobic respiration, the electrons that exit the electron transport chain are used to form (that is, become part of)...

- A. NADH
- B. H₂O
- C. ATP
- A or B B or C A or C

9. Increasing the temperature increases the reaction rates because

- A. The energy of the 'activation' state is reduced
- B. a larger proportion of the molecules have enough energy to pass through the 'activation' state
- C. the nature of the activation state of the reaction is altered.
- A or B B or C A or C

10. The active site of an enzyme contains a weakly basic group. For the enzyme to function as a catalyst, this group must be charged. What will happen to the activity of the enzyme if we place it in a strongly acidic environment?

- A. it will increase
- B. it will be unaffected
- C. it will decrease
- A or B B or C A or C

THIS IS THE "I KNOW IT NOW!" EXAM #3 (worth 20 points)

1. Griffith discovered a version of Streptococcus, the R-strain that was no longer virulent. Yet, when live-R strain bacteria were inoculated into mice together with dead S (virulent) strain bacteria, virulent S-type bacteria could be recovered from the dying mice. This was because....

- A. the original S cells returned to life
- B. the R cells captured the slimy coat material previously associated with the S cells
- C. R cells were now able to make their own slimy material
- A or B B or C A or C

2B (3 points): Predict (and justify your predication). What would have happened if instead of using dead S strain bacteria, Griffith had used dead bacteria of a completely different strain - would he have recovered virulent, S-strain like bacteria from his mice?

3. In an α -helix, the polypeptide is wound around a central axis. In which direction do the R-groups of the amino acid residues point?

- A. Inward
- B. Outward
- C. Toward one another
- A or B B or C A or C

4. Protein phosphorylation is analogous to an allosteric effector because ...

- A. it is irreversible
- B. it adds a charge
- C. it alters protein structure and activity
- A or B B or C A or C

5. In DNA, where does the hydrophobic effect most directly influence structure?

- A. base stacking
- B. base pairing
- C. the interactions between sugar-phosphate groups
- A or B B or C A or C no idea

6. (6 points). Gene **A** encodes protein **A**; **A** is normally off, in the absence of other inputs. Gene **B** encodes protein **B** and is normally off in the absence of other inputs. **A** and **B** have similar stabilities. Protein **C**, which is encoded by gene **C** is unstable, and can be detected only when gene **C** is actively transcribed. Expression of **C** occurs only when both **A** and **B** are present (it is normally off).

Now assume that at time 0, a stimulus from the outside world leads to the turning on of gene **A**; this stimulus is constant. On the graph below, draw and label the levels of **A**, **B** and **C**, over a time period that is at least three times the half-life of **A/B**.

