

Homework 1 for Cell Biology--- 2017

1. You have begun to characterize a sample obtained from the depths of the oceans on Europa, one of Jupiter's moons. Much to your surprise, the sample contains a life-form that grows well in a rich broth. Your preliminary analysis shows that it is cellular and contains DNA, RNA, and protein. When you show your results to a colleague, she suggests that your sample was contaminated with an organism from Earth. What approaches might you try to distinguish between contamination and a novel cellular life-form based on DNA, RNA, and protein?

2. In the 1940 Erwin Chargaff made the remarkable observation that in samples of DNA from a wide range of organisms the mole percent of G/[G/ (A+T+C+G)] was equal to the mole percent of C, and the mole percent of A and T were equal. This was an essential clue to the structure of DNA. Nevertheless, Chargaff's 'rules' were not universal. For example, in DNA from the virus ϕ X174, which has a single-stranded genome, the moles percent are A=24, C=22, G=23, and T=31. What is the structural basis for Chargaff's rules, and how is it that DNA from ϕ X174 doesn't obey the rules?

3. Which of the following correctly describe the coding relationships (template- \rightarrow Product) for replication, transcription, and translation, respectively?
 - A. DNA \longrightarrow DNA
 - B. DNA \longrightarrow RNA
 - C. DNA \longrightarrow protein
 - D. RNA \longrightarrow DNA
 - E. RNA \longrightarrow DNA
 - F. RNA \longrightarrow RNA
 - G. RNA \longrightarrow protein
 - H. Protein \longrightarrow RNA
 - I. Protein \longrightarrow protein

4. Match each definition below with its term from the list below:

Archaea	model organism	procaryote
Bacteria	mutation	ortholog
Eucaryote	paralog	virus
Homolog		

- 1) A small packet of genetic of genetic material that has evolved as a parasite on the reproductive and biosynthetic of host cells.
- 2) Organism selected for intensive study as a representative of a large group of species.
- 3) One of the two division of procaryotes, typically found in hostile environments such as hot springs or concentrated brine.
- 4) A homologous chromosome or, more generally, a macromolecule that has a close evolutionary relationship to another.

- 5) Living organism composed of one or more cells with a distinct nucleus and cytoplasm.
 - 6) Major category of living cells distinguished by the absence of a nucleus.
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5. Which one of the processes listed below is NOT thought to contribute significantly to the evolution of the new genes? Why not?
 - A. Duplication of genes to create extra copies that can acquire new functions.
 - B. Formation of new genes *de novo* from noncoding DNA in the genome.
 - C. Horizontal transfer of DNA between cells of different species.
 - D. Mutation of existing genes to create new functions.
 - E. Shuffling of domains of genes by gene rearrangement.
 6. Giardiasis is an acute form of gastroenteritis caused by the protozoan parasite *Giardia lamblia*. *Giardia* is a fascinating eukaryote; it contains a nucleus but no mitochondria and no recognizable endoplasmic reticulum or Golgi apparatus—one of the very rare examples of such a cellular organization among eukaryotes. This organization might arise because *Giardia* is an ancient lineage that separated from the rest of eukaryotes before mitochondria were acquired and internal membranes were developed. Or it might be a stripped-down version of a more standard eukaryote that has lost these structures because they are not necessary in the parasitic lifestyle it has adopted. How might you use nucleotide sequence comparisons to distinguish between these alternatives?
 7. A common step in the isolation of cells from a sample of animal tissue is to treat it with trypsin, collagenase, and EDTA. What does each component accomplish?
 8. Did you suppose it would be possible to raise an antibody against another antibody? Explain.
 9. You are using aameleon indicator to measure intracellular concentrations of Ca^{2+} . The indicator is composed of a central calmodulin domain, which converts from an extended form to a much more compact form upon calcium binding. And two flanking fluorescent proteins, with CFP attached at one end and YFP attached at the other. You have expressed this indicator in cells and now wish to measure intracellular changes in Ca^{2+} concentration in response to the biological process you are studying. The instruction says to excite theameleon at 440nm and to measure emission at 535nm. How do you suppose theameleon indicator works?
 10. For separation of proteins by two-dimensional polyacrylamide-gel electrophoresis. What are the two types of electrophoresis that are used in each dimension? Do you suppose it makes any difference which electrophoretic method is applied first? Why or why not?