This exercise is worth **4 extra credit points**, which will be added to your exam points. Please turn this in at the beginning of class on Tuesday Nov 27th. If you work with a partner during class today**, I will give you a 5th extra point.**

Readings are from the pdf of Ch.12. Also review the PowerPoint of Chapter 12 from slide 54 to 102.

1. Read the Gene Editing section from 220 to 221. The CRISPR-cas9 system is a new DNA technology that can be used to edit the DNA of living organisms.

* What organism was CRISPR discovered in and what is the natural purpose of CRISPR in that organism?

*CRISPR was originally discovered in the bacterium Escherichia coli, a prokaryote. The system is for* ***defense****. It is unusual for bacteria to have repeated regions of DNA. The CRISPR describes a region of the bacterial chromosome where repeated regions punctuate viral DNA. The viral DNA is attached to an enzyme called cas-9. The viral DNA template can recognize invading virus and the enzyme can cut their DNA and destroy the virus.*

* Cas9 is like a guided missile, with an ­ **RNA** molecule as the guidance system.
* CRISPR can ‘knock out’ a gene. What does that mean and how does CRISPR do that?

*When a gene is ‘knocked out’ that means it is mutated, so it will no longer express the protein it codes for. CRISPR can make cuts in a coding gene that introduce mutations that disrupt the genetic code. The gene is then transcribed into a non-functional version of the polypeptide.*

* In figure 12.5 what is CRISPR doing?
* *The CRISPR-Cas9 system is editing the nucleotide sequence within in a living cell to inactivate a gene or change a nucleotide. The Cas9 enzyme is able to cut DNA in a very specific place as dictated by the guide RNA sequence. The CAS9 protein is like a guided missile, with an RNA molecule as the guidance system.*
* Listen to the Radiolab mp3 called ‘antibodies part1’ from 25:30 minutes from the start. The mp3 is embedded on slide 55 of the Ch12 ppt. Has CRISPR been used to modify a human embryo? Do you think we will modify human embryos with CRISPR in the future and then allow those embryos to develop? Have humans been reproductively cloned?

*Yes, CRISPR has been used to modify human embryos. At least one, and possibility up to four different labs in China have modified human embryos. According to this Radiolab story, these embryos have not been allowed to develop into humans.*

*Human have not been reproductively cloned because it is currently illegal in all countries that might have the technology to accomplish human cloning.*

*I think it will be very hard to prevent humans from using CRISPR in conjunction with in vitro fertilization (IVF) to edit genetic disorders from the genomes of embryos. The science writer gives the example of a gene that is associated with reduced incidence of Alzheimer’s disease in populations of Icelandic people. Already, large numbers of kids are born through IVF. (As of this Monday, two babies have been born from CRISPR-modified embryos).*

* How is reproductive cloning different from in vitro fertilization (possible extra credit)?

1. Read pages 225 through 228 on ‘DNA Profiling’ and ‘Forensic Science,’ then answer the questions below.

* What are the steps of DNA profiling?

1. *DNA is sampled from a crime scene, suspect or victim*
2. *Certain regions of DNA are copied many times, so they will be visible when combined with a fluorescent dye.*
3. *Fragments of DNA are compared to identify individuals – DNA fingerprint…*

* DNA Profiling uses three important techniques. What are they? Describe each step in one or two sentences.

1. ***polymerase chain reaction (PCR)*** *- DNA polymerase is used to make copies of certain parts of the DNA. Many copies of DNA are needed, so that we can see the DNA when dyes that fluoresce are added to it.*
2. ***short tandem repeat analysis (STR)*** *– The DNA of most humans is 99.9% identical. How do we find the places that make individuals unique? There are super variable regions of DNA that do not code for genes or make proteins. These regions called STRs can act as a DNA fingerprint. Every person has a unique profile and there is less than a 1 in a billion chance that two unrelated people will be exactly identical. These regions are short and repeat variable numbers of times. Why are these repeats so variable among individuals? Because DNA polymerase is not the best counter in the world…*
3. ***gel electrophoresis*** *– This is how we can look at the DNA that has been amplified with DNA polymerase during PCR. DNA is mixed with a molecule that will make it fluoresce under an ultraviolet light. The gel then separates the DNA fragments based on size. Shorter fragments move through the gel faster than longer pieces of DNA. The lengths of the STR molecules are used to determine the identity of an individual.*

* How genetically similar are most humans to each other? What is the CODIS?
  + *Most humans are 99.9 percent identical. The Combined DNA Index System (CODIS) is a database of STR regions that is used to compare the remaining 0.1% of the human genome that is variable.*
* Who is Earl Washington?
  + *Earl Washington is a man who spent 20 years in prison for a murder he did not commit. STR analysis was used to show that his DNA did not match the DNA found at the scene of the crime. STR evidence was also used to match the crime scene DNA to a different person.*
* As of 2017, the ‘Innocence Project’ has exonerated how many people?
  + *At least 350 people*

1. Read pages 229 to 232 on Bioinformatics.

* What is genomics?
  + *The study of the complete set of genes and nucleotides in an organism. The first organism to be completely sequenced was* ***Haemophilus influenzae****, a bacterium that can cause pneumonia in humans.*
  + *Yeast, Saccharomyces cerevisiae, was the first eukaryote to have its full sequence determined*
  + *Roundworm, Caenorhabditis elegans, was the first multi-cellular organism*
  + *Humans - the first human genome took 13 years and cost $100 million, an individual's genome can be sequenced in a matter of hours for less than $1,000.*
* Figure 12.20 compares whole genomes of organisms. Which organisms have approximately the same number of coding genes as humans?
  + *Roundworm/nematode, Caenorhabditis elegans; duck-billed platypus, Ornithorhynchus anatinus; Giant Panda, Ailuropoda melanoleuca; lab rat, Rattus norvegicus; wallaby, Macropus eugenii; chimpanzee, Pan troglodytes*
* What time period did Neanderthals live in Europe and Asia?
  + *300,000 to 30,000 years ago*
* When did modern humans move from Africa to Europe and Asia?
  + *Approximately 50,000 years ago.*
* When did Neanderthals disappear from the fossil record in Europe and Asia?
  + *30,000 years ago*
* What explains the disappearance of Neanderthals from Europe and Asia?
  + *DNA evidence suggests that starting as far back as 70,000 years ago modern humans ancestors (early Homo sapiens) acquired genes from Neanderthals by interbreeding with them. It is likely that the ancestors of modern humans out-competed Neanderthals and displaced them.*