General instructions: Don't Panic. Be sure your name is on every page and that you write your exam in ink. Answer the questions in the space provided. Clearly state your reasoning; if I can understand what you are saying during the grading, there is a greater chance that you will get at least partial credit. The value of each question is indicated.

1. (20 points) Forward and backward movement requires the motor neurons in the ventral cord along the length of C. elegans. In a screen for dominant mutations, fourteen mutations were found that result in animals that cannot move forward (the FUnc phenotype). The first five mutations (a-e) map to very different positions in the genome. For each mutation and the additional data provided, make your best guess as to the **nature of the dominant defect** and the **nature of the null phenotype** for the mutated gene. Explain your answer **AND** describe an experiment (not involving molecular biology) and its outcome that would confirm your hypothesis.
   a. Recombination does not separate mutation a from a gene with many recessive alleles producing the FUnc phenotype.
   b. Recombination does not separate mutation b maps gene with many recessive alleles that result in animals that cannot go backward (the BUnc phenotype).
   c. Animals containing mutation c reverts to wild type at a relatively high rate with ethyl methanesulfonate (EMS).
   d. Recombination does not separate mutation d maps from a gene needed for the proper production of sensory neurons in the head.
   e. Mutation e and the remaining mutations map to the same position and no recombination is seen with trans-heterozygotes between them.
2. (20 points) Which of the following (if either) would you expect to occur significantly more frequently? In each case explain your answer.
   a. Loss of \textit{lacZ} expression vs. constitutive expression of \textit{lacZ} expression.

b. The production of any EMS mutation in a gene vs. its reversion.

c. \textit{i} vs. \textit{O} mutations.

d. Transition mutations vs. transversion mutations after treatment with EMS.

e. Excision of a transposon like the \textit{Drosophila} \textit{P} factor or the \textit{C. elegans} TC1 transposon in individuals homozygous for the transposon insertion vs. in individuals heterozygous for the insertion.
3. (12 points) The following genetic elements are important for the growth. Describe the role each plays and indicate the consequences of a loss of function mutation on (i) the lysis/lysogeny decision upon infection and (ii) induction by UV light. Also indicate whether the element acts in \textit{cis} or \textit{trans}.

   a. \textit{sib}

   b. \textit{recA}

   c. \textit{cIII}

4. (12 points) Programmed cell death in \textit{C. elegans} occurs when cells are engulfed and die during normal development. Mutations in several genes are known to affect this process. Two of these genes are \textit{ced-3} and \textit{ced-9}. The following results were obtained with loss-of-function (lf) and gain-of-function (gf) mutations of these genes.

   \begin{tabular}{|c|c|}
   \hline
   mutation & phenotype \\
   \hline
   \textit{wildtype} & some cells die \\
   \textit{ced-3(lf)} & all cells live \\
   \textit{ced-9(gf)} & all cells live \\
   \textit{ced-9(lf)} & more cells die than in wild-type animals \\
   \textit{ced-9(lf); ced-3(lf)} & all cells live \\
   \hline
   \end{tabular}

   a. (4) What two possible genetic pathways are suggested by the single gene mutations? Explain your answer.

   b. (4) Which pathway is more likely given the double mutant result? Explain.

   c. Explain the action of the \textit{ced-9(gf)}. 
5. (8 points) Explain the nature of control for both negative repressibility and positive inducibility in bacterial systems. Be sure to describe all necessary components needed for such control and how these components regulate activity. Give examples from E. coli of both types of regulation.

6. (16 points) Compare and contrast the following.
   a. An enhancer element and an enhancer mutation.

   b. Physiological and informational suppression

   c. The cro and cl genes

   d. Dominance and epistasis
7. (12 points) Explain the following.
   a. Attenuation assures that expression from the \textit{trp} operon is off when tryptophan is present.

   b. The temperature-sensitive \textit{sevenless} mutation could be used to obtain mutations in genes that \textbf{prevent} \textit{sevenless} function (note: they were not used in this way in the experiments described in class).

   c. Temperature-sensitive mutations can be used to determine when a gene must be expressed to determine the adult phenotype.