Mutation, Mutational Repair

Problem set #4 (not for credit):

1. A mutation that occurred in a plant petal would be best termed:
(a). Germinal
(b). Somatic
(c). Suppressor
(d). Dominant
(e). Recessive

2. If an incorrect base is incorporated during DNA synthesis and is not corrected by DNA polymerase, it is corrected through a postreplication repair mechanism. This involves:
(a). Detection of the mismatch.
(b). A recognition of the methylation status of the DNA strands.
(c). A process similar to excision repair.
(d). All of the above.
(e). None of the above.

3. Although products resulting from somatic mutations, like the delicous apple and navel orange have become widespread in apple orchards and citrus groves, somatic mutations have not made a contribution to animal breeds. Why?

4. Wild type *Drosophila* fruit flies have red eyes. You have conducted an experiment in which a wild type male *Drosophila* fruit fly has been irradiated with X-rays and mated to a red-eyed female bearing the clB chromosome (which carries a recessive lethal mutation, the Dominant eye marker Bar, and chromosomal rearrangements preventing recombination). One red-eyed daughter with Bar eyes is selected and mated to a wild type male. This cross produces the following offspring in the following ratios:
1/3 clB females
1/3 wild type females
1/3 white-eyed males

Explain this ratio in terms of the genetic effect of X-rays

5. A man employed by a toxic chemical waste disposal service becomes the father of a male child with hemophilia (a disorder caused by recessive mutations on the X-chromosome). There is no history of hemophilia in the man's or his wife's ancestors. Another man, also employed by the same toxic chemical waste disposal service has an achondroplastic dwarf child (caused by an autosomal dominant mutation) - a condition nowhere recoded in his, or in that of his wife's ancestry. Both men sue their employer for damages claiming that the mutations resulting in the conditions of their children

were induced by the toxic waste. You are asked to testify in court. What do you say in each case?

Facts that may be helpful in answering this question:

-hemophilia is caused by a recessive mutation on the X-chromosome.

-achondroplasia is caused by an autosomal dominant mutation.

-human females have two X-chromosomes; human males have one X-chromosome.

6. One of the jobs of the Hiroshima-Nagasaki Atomic Bomb Casualty Commission was to assess the genetic consequences of the bomb blasts. One of the first things they studied was the sex ratio in the offspring of the survivors. Why do you think they did so?

7. The genes responsible for UV-induced DNA damage repair in *E. coli* were identified through genetic analysis (the identification of mutants defective in repair). The major assumption underlying the screens that were carried out to identify *E. coli* mutants defective in UV-induced DNA damage repair was that these mutants would be particularly sensitive to UV light. With this assumption in mind, what steps would you follow to obtain such mutants?

8. Imagine that the first dam$^-$ mutant of *E. coli* has been discovered through a screen in which colonies from mutagen-treated cells were plated on petri dishes, and many individual colonies assayed for deoxyadenosine methyltransferase activity using DNA as a substrate. Nothing else is known about the mutant. You wish to determine if the dam$^-$ mutation results in an increased mutation rate (i.e., results in an increase in the spontaneous frequency of mutation in other genes). Write a brief description of how you could test for such a "mutator" phenotype. Assume, if it would be helpful, that you can easily introduce mutations in other genes into the dam$^-$ strain.

9. The Ames test is a simple low cost method for detecting chemical mutagens. In its original form this test was carried out by uniformly plating a his$^-$ strain of the bacterium Salmonella typhimurium (bearing a mutation in the gene encoding an enzyme involved in synthesis of the amino acid histidine) onto agar plates lacking histidine, and then spotting a drop of the chemical to be tested onto the center of the plate. If the chemical is not a mutagen, typically only a few colonies will arise on the plate, and the locations of these colonies will be random with respect to the location of the chemical spotted onto the plate (figure A below). These colonies correspond to rare His$^+$ reversion mutations which restore function to the histidine biosynthetic gene. If, on the other hand, the chemical being tested is a mutagen, a great many more colonies will arise (due to the increased chance of reverting the mutation reponsible for the his$^-$ phenotype), and these colonies will be clustered in the vicinity of the chemical under investigation (because the concentration of the chemical will be highest where it is spotted onto the plate; figure B below). Although for many chemicals there was good correspondence between the results of the Ames test and the known ability of the

chemical to induce mutations in higher eukaryotes (i.e., mice, humans, etc.), there were also many chemicals that did not act as mutagens in the Ames test, but were well known to act as mutagens in higher eukaryotes. Can you propose an explanation for this observation?