2. Nitrogen-base additions can be more harmful than nitrogen-base substitutions, because a nitrogen-base substitution can result in the expression of a different amino acid codon. Depending on where the amino acid falls within the protein, it may play a minor role in altering protein performance. A nitrogen-base addition changes the reading frame, resulting in a completely new sequence of amino acids being expressed, which can render the protein inactive. There are some exceptions to the nitrogen-base substitution scenario. If a nitrogen-base substitution results in a nonsense mutation, the results are similar to a nitrogen-base addition scenario.

3. A nonsense mutation is more harmful than a missense mutation. A nonsense mutation results in the termination of translation and therefore the protein that is to be translated is not fully synthesized, rendering it inactive. A missense mutation results in one amino acid change. The result is a protein that may or may not function to full capacity, depending on where the amino acid substitution has fallen. A missense mutation can be just as harmful as a nonsense mutation, but there is the slight chance that it will not.

4. Three factors that produce gene mutations are UV radiation, X rays, and chemicals such as pesticides.

5. The stop codons are UGA, UAA, and UAG. Using Figure 7, Section 5.2, p. 240 of the Student Text, the following codons can be changed by one base and become stop codons: UAU, UAC, UGU, UGC, UGG, UUA, UCA, UUG, UCG, CGA, AGA, GGA, CAA, CAG, AAA, AAG, GAA, and GAG. These codons differ by one nitrogenous base from a stop codon.

   met–phe–leu–pro–tyr–his–arg
      The mutation has no effect since UAU and UAC both code for tyrosine.  
   (b) New protein: met–phe–leu–pro–STOP  
      The mutation is a nonsense mutation. UAA is a stop codon so the protein is not fully translated and is therefore nonfunctioning.  
      The addition causes a frameshift mutation resulting in different amino acids.  
      The deletion causes a frameshift mutation resulting in different amino acids.  
      The inversion results in a different protein being synthesized.

7. (a) Arginine can change to leucine with the following substitutions: CGU to CUU, CGC to CUC, CGA to CUA, and CGG to CUG.  
   (b) Cysteine to glutamic acid cannot be changed with one base pair substitution.  
   (c) Serine can be changed to threonine with the following substitutions: AGU to ACU and AGC to ACC.  
   (d) Isoleucine can be changed to serine with the following substitutions: AUU to AGU and AUC to AGC.

8. A food dye that has been identified as a chemical mutagen poses greater dangers for a developing fetus than for an adult.  
A fetus is undergoing rapid developmental growth within the uterus. The rate of mitosis for all cells is much faster than that within an adult. The effects of the mutagen can vary depending on which stage of development the fetus is in. If the mutagen affects nondifferentiated cells (cells that will eventually become specialized cells such as liver, heart, kidney etc.), it may impart a serious mutation that will lead to abnormal development. An adult also undergoes mitosis but does so to replace existing cells. If a mutation takes place in an adult, chances are it will be limited to the one cell and its daughter cells in the future; therefore, it will be localized to one area. In a fetus, a mutation will affect all cells since undifferentiated cells can become many different types of cells.