Section 18.3 Review Answers

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1. A germ line mutation will likely affect all the daughter cells of that stem cell line, and is potentially more dangerous for the tissue than a mutation in a mature non-stem somatic cell. That cell will likely die as part of its natural aging process, or as a result of the mutation. Mutations that occur in spermatogonial or oogonial cells that do not affect the development of viable sperm or eggs are likely to contribute to the variations among organisms because they may be transmitted to the offspring.

2. A frameshift mutation occurs when a gene is altered by the insertion or deletion of one or two nucleotides, and it is usually more serious than a substitution mutation. The resulting shift in the reading frame usually causes a nonsense mutation, a mutation that results in a non-functional protein. On the other hand, a substitution mutation of a single nucleotide may lead to a slightly altered, but still functional polypeptide (mis-sense mutation). Mis-sense mutations can be harmful, but generally less so than frameshift mutations.

3. Older people are at a higher risk of developing cancers because they likely have accumulated more mutations in their cells. There is also a chance of more mutations because over time they have been exposed to more mutagens than a younger person.

4. DNA analysis allows scientists to study genetic variations among individuals of the same species, as well as species suspected of being closely related. This helps scientists develop an understanding of ancient ecosystems, and track the evolution of a species through time. For example, the analysis of non-coding stretches of DNA tends to show a higher mutation rate than the DNA within genes. The higher mutation rate leads to extensive genetic variations among individuals of the same species.

5. A restriction endonuclease is an enzyme that "recognizes" a short sequence of DNA nucleotides (called the target sequence) on a strand of DNA. The restriction endonuclease cuts the strand at a particular point within the nucleotide sequence, known as a restriction site. Many different endonucleases have been isolated, and each recognizes a different target sequence.

Two characteristics of restriction endonucleases that make them useful to genetic researchers are specificity and staggered cuts. Specificity refers to the cuts made by an endonuclease in the target sequence of DNA, resulting in nucleotides that are specific and predictable. That is, the same enzyme will cut a particular strand of DNA at the same location each time, producing an identical set of small DNA fragments, called restriction fragments.

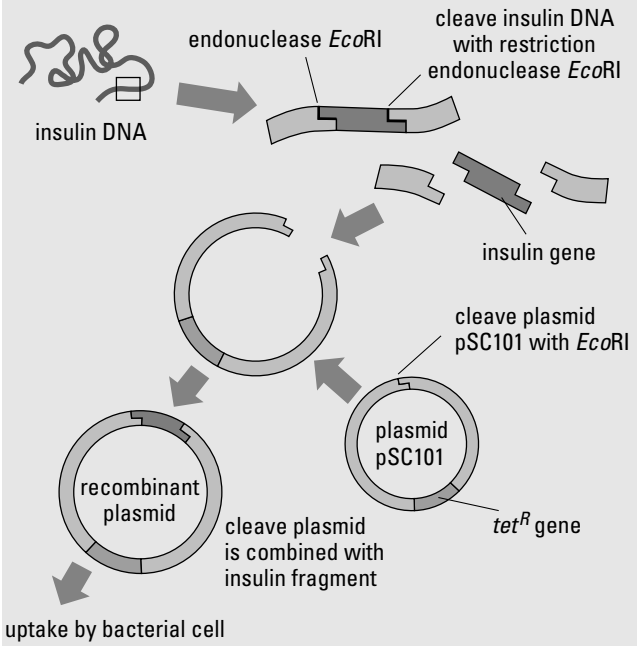
When restriction endonucleases produce a staggered cut, a few unpaired nucleotides are left on a single strand at each end of the restriction fragment. These short strands, often referred to as "sticky ends", can then form base pairs with other short strands that have a complementary sequence.

6. (a) A silent mutation results if the substitution causes coding of the same amino acid.

(b) A mis-sense mutation results when the substitution causes coding of a different amino acid, resulting in a slightly altered protein.

(c) A nonsense mutation results when the substitution causes coding of a different amino acid, and the resulting polypeptide is non-functional, such as if the mutation produces a "stop" codon prematurely before the entire polypeptide is synthesized.

7.



Students' diagrams should show how a restriction endonuclease can target a starting sequence of DNA nucleotides coding for the polypeptide for human insulin. The DNA segment of insulin can be excised and inserted into a bacterial cell. There the "sticky ends" pair with a complementary nucleotide in the bacterial cell, and are joined with DNA ligase to seal the break between them. The bacterial cell with the human insulin gene will be grown to produce insulin that can be extracted from the culture.