

White: Oral Radiology, 6th Edition

Chapter 2: Radiobiology

Test Bank

Multiple Choice

1) Which of the following statements is true concerning *direct* effects of radiation on living systems?

- A. Exposure to radiation initiates a complex series of chemical changes in water that result in the radiolysis of water.
- B. The energy of a photon or secondary electron ionizes biologic macromolecules.
- C. The interaction of hydrogen and hydroxyl free radicals with organic molecules results in the formation of organic free radicals.
- D. Approximately two thirds of the biologic effects of x-ray exposure result from direct effects.

ANS: B

The energy of a photon or secondary electron ionizes biologic macromolecules. The biologic molecules form unstable free radicals that are extremely reactive and quickly transform into stable configurations by dissociation or cross-linking. Approximately one third of the biologic effects of x-ray exposure result from direct effects. Indirect effects are those in which hydrogen and hydroxyl free radicals, produced by the action of radiation on water, interact with organic molecules. About two thirds of radiation-induced biologic damage results from indirect effects.

REF: Page 18

2) The primary cause of radiation-induced cell death, heritable (genetic) mutations, and cancer formation (carcinogenesis) is damage to a cell's:

- A. protein.
- B. lipid.
- C. carbohydrate.
- D. DNA.

ANS: D

The primary cause of radiation-induced cell death, heritable (genetic) mutations, and cancer formation (carcinogenesis) is damage to a cell's DNA. Radiation-induced changes in protein, lipids, and carbohydrates following low or moderate doses of radiation are so slight that they do not contribute to radiation effects.

REF: Page 19

3) For deterministic effects:

- A. the severity of the clinical effect is independent of dose.
- B. it is an all-or-none response; an individual either has the effect or does not have the effect.
- C. all individuals show the effect when the dose is above the threshold.
- D. the frequency of the effect is proportional to the dose.

ANS: C

For deterministic effects, all individuals show the effect when the dose is above the threshold. For stochastic effects, the severity of the clinical effect is independent of the dose. Stochastic effects are an all-or-none response; an individual either has the effect or does not have the effect. The frequency of the effect is proportional to the dose.

REF: Page 19

4) If a radiation-induced break occurs in Stage ___ of mitosis, before the DNA in a chromosome has replicated, the damage manifests as a break in both arms at the next mitosis.

- A. G1
- B. G1 or early S
- C. mid- and late S or G2
- D. G2

ANS: B

If a radiation-induced break occurs before the DNA in a chromosome has replicated in Stage G1 or early S of mitosis, the damage manifests as a break in both arms (chromosome aberration) at the next mitosis. If radiation exposure occurs after DNA synthesis (i.e., in G2 or mid- and late S0), only one arm of the affected chromosome is broken (chromatid aberration).

REF: p. 19

5) When a population of slowly dividing cells is irradiated, _____ are required for induction of _____ effects than when a rapidly dividing cell system is involved.

- A. smaller doses and longer time intervals; deterministic
- B. larger doses and shorter time intervals; stochastic
- C. larger doses and longer time intervals; deterministic
- D. larger doses and longer time intervals; stochastic

ANS: C

When a population of slowly dividing cells is irradiated, larger doses and longer time intervals are required for induction of deterministic effects than when a rapidly dividing cell system is involved. The rate of cell replication, and thus the rate of reproductive death, accounts for the varying radiosensitivity of tissues.

REF: Page 20

6) The most radiosensitive cells are those that have a:

- A. low mitotic rate, undergo many future mitoses, and are most primitive in differentiation.
- B. high mitotic rate, undergo many future mitoses, and are the most primitive in differentiation.
- C. high mitotic rate, undergo many future mitoses, and are the most advanced in differentiation.
- D. low mitotic rate, undergo few future mitoses, and are the most advanced in differentiation.

ANS: B

The most radiosensitive cells are those that have a high mitotic rate, undergo many future mitoses, and are the most primitive in differentiation. Alterations in mesenchymal cells will affect the vitality of many different tissues.

REF: Page 20

7) Which of the following cells have the greatest radiosensitivity?

- A. Striated muscle cells
- B. Basal cells of oral mucous membrane
- C. Parenchymal cells of liver, kidney, and thyroid
- D. Fibroblasts

ANS: B

Spermatogenic and erythroblastic stem cells and the basal cells of oral mucous membrane have high radiosensitivity. Vascular endothelial cells, fibroblasts, acinar and ductal salivary gland cells, and parenchymal cells of liver, kidney, and thyroid have intermediate radiosensitivity. Neurons, striated muscle cells, squamous epithelial cells, and erythrocytes all have low radiosensitivity.

REF: Page 22

8) When considering deterministic effects, often a clinical threshold dose exists below which no adverse effects are seen. In all individuals receiving doses above the threshold level, the amount of damage is proportional to the dose.

- A. Both statements are true.
- B. Both statements are false.
- C. The first statement is true; the second statement is false.
- D. The first statement is false; the second statement is true.

ANS: A

Both statements are true. Often a clinical threshold dose exists below which no adverse effects are seen. In all individuals receiving doses above the threshold level, the amount of damage is proportional to the dose.

REF: Page 22

9) Fractionation of a total x-ray dose into multiple small doses during radiation therapy:

- A. decreases cellular repair of normal tissues, which are believed to have less capacity for recovery than tumor cells.
- B. decreases cellular repair of normal tissues, which are believed to have a greater capacity for recovery than tumor cells.
- C. provides less tumor destruction than possible with a single large dose.
- D. increases the mean oxygen tension in an irradiated tumor, rendering the tumor cells more radiosensitive.

ANS: D

Fractionation of a total x-ray dose into multiple small doses during radiation therapy increases the mean oxygen tension in an irradiated tumor, rendering the tumor cells more radiosensitive. The greater cell damage sustained in the presence of oxygen is related to the increased amounts of hydrogen peroxide and hydroperoxyl free radicals formed. Fractionation characteristically allows for increased cellular repair of normal tissues, which are believed to have a greater capacity for recovery than tumor cells. Fractionation into multiple small doses provides greater tumor destruction than is possible with a single large dose.

REF: Page 23

10) Which of the following statements is true concerning the effects of irradiation on major salivary glands?

- A. The stroma of the glands is rather radiosensitive, and the parenchyma is not.
- B. The extent of reduced salivary flow is independent of dose.
- C. The residual saliva is more viscous than usual because serous cells are more radiosensitive than mucous cells.
- D. The small volume of saliva that is secreted usually has a pH value above normal.

ANS: C

The residual saliva is more viscous than usual because serous cells are more radiosensitive than mucous cells. It is the parenchymal component of the salivary glands that is rather radiosensitive, and the parotid gland is more radiosensitive than the submandibular or sublingual glands. The extent of reduced flow is dose dependent and reaches essentially zero at 60 Gy. The small volume of saliva that is secreted usually has a pH value 1 unit below normal (i.e., an average of 5.5 in irradiated patients compared with 6.5 in unexposed individuals).

REF: Pages 23-24

11) Which of the following statements is true regarding radiation therapy to the jaws of children?

- A. If radiation therapy precedes dental calcification, it may destroy the tooth bud.
- B. The eruptive mechanism of teeth is extremely sensitive to radiation; irradiated teeth with normal root anatomy will not erupt.
- C. Irradiated teeth with altered root form will not erupt.
- D. Irradiation after calcification will accelerate general growth.

ANS: A

If radiation therapy precedes calcification, it may destroy the tooth bud. The eruptive mechanism of teeth is relatively radiation resistant. Exposure may retard or abort root formation, but irradiated teeth with altered root formation still erupt.

REF: p. 24

12) The best method of reducing radiation caries is:

- A. prophylactic removal of all previously restored teeth.
- B. daily application of a viscous topical 1% neutral sodium fluoride gel in custom-made applicator trays.
- C. rinsing daily with an alcohol-containing mouthwash.
- D. applying a fluoride-containing cavity varnish to all exposed root surfaces.

ANS: B

The best method of reducing radiation caries is daily application for 5 minutes of a viscous topical 1% neutral sodium fluoride gel in custom-made applicator trays. Use of topical fluoride causes a 6-month delay in the irradiation-induced elevation of *Streptococcus mutans*. Teeth with gross caries or periodontal involvement are often extracted before irradiation.

REF: Page 25

13) Osteoradionecrosis is:

- A. more common in the maxilla than in the mandible.
- B. primarily caused by radiation-induced damage to the vasculature of the trabecular bone.
- C. caused by an insult, such as infection in bone compromised by radiation therapy.
- D. less likely to occur, the higher the radiation dose absorbed by the bone.

ANS: C

Osteoradionecrosis is primarily caused by radiation-induced damage to the vasculature of the periosteum and cortical bone, which suffers an insult such as infection. This bone infection may result from radiation-induced breakdown of the oral mucous membrane, mechanical damage to the weakened oral mucous membrane (e.g., from denture sore or tooth extraction), periodontal lesion, or radiation caries. It is more common in the mandible than in the maxilla. The higher the radiation dose absorbed by the bone, the greater is the risk for osteoradionecrosis.

REF: Page 26

14) Whenever possible, patients who have had radiation therapy should avoid having intraoral radiographs during the first _____ after completion of radiotherapy, to allow time for mucous membrane to heal.

A. 2 weeks

- B. 2 months
- C. 6 months
- D. There is no minimal suggested time; the question is incorrect.

ANS: C

Patients who have had radiation therapy should avoid having intraoral radiographs during the first 6 months after completion of radiotherapy, to allow time for mucous membrane to heal. The issue is not the added exposure but rather the potential for trauma to the oral mucosa from the periapical radiograph.

REF: Page 26

15) Gastrointestinal symptoms will be seen as a component of acute radiation syndrome when the dose is _____ Grays (Gy).

- A. 2 to 4
- B. 4 to 7
- C. 7 to 15
- D. 50

ANS: C

Gastrointestinal symptoms will be seen as a component of acute radiation syndrome when the dose is 7 to 15 Gy. From 1 to 2 Gy will induce prodromal symptoms; 2 to 4 Gy, mild hematopoietic symptoms; 4 to 7 Gy, severe hematopoietic symptoms; and 50 Gy, cardiovascular and central nervous system symptoms.

REF: Page 27

16) Which of the following blood cells are *least* affected by whole-body exposure to radiation 10 days after exposure?

- A. Granulocytes
- B. Platelets
- C. Erythrocytes
- D. Lymphocytes

ANS: C

Erythrocytes are least affected 10 days after whole-body radiation exposure. Although granulocytes, platelets, and erythrocytes themselves are radioresistant because they are nonreplicating cells, their precursors are radiosensitive. The rate of fall in the circulating level of a cell depends on the life span of that cell in the peripheral blood. Granulocytes, with short lives in circulation, fall off in a few days, whereas red blood cells, with long lives in circulation, fall off slowly.

REF: Page 27

17) Which of the following organs has the *lowest* susceptibility to radiation-induced cancer?

- A. Lung
- B. Thyroid
- C. Stomach
- D. Salivary glands

ANS: D

Bone surface, brain, salivary glands, and skin all have low susceptibility to radiation-induced cancer. The bladder, liver, and thyroid have intermediate susceptibility. The colon, stomach, lung, bone marrow, and female breast all have high susceptibility.

REF: Page 29

18) Which of the following statements reflects basic principles of radiation genetics?

- A. Radiation causes increased induction of new mutations rather than increased frequency of spontaneous mutations.
- B. There is evidence of a minimal threshold of mutations caused by radiation.
- C. Dose rate is not important.
- D. Males are much more radiosensitive than females.

ANS: D

Males are much more radiosensitive than females. Radiation causes increased frequency of spontaneous mutations rather than inducing new mutations. The frequency of mutations increases in direct proportion to the dose, even at very low doses, with no evidence of a threshold. Dose rate is important. At low dose rates the frequency of induced mutations is greatly reduced.

REF: Page 30