

BLM – From the Outside In: Biological Effects of Radiation

Radiation in the Body Guide Sheet

Below is the type of information that should be included in the students' **Radiation in the Body Assignment BLM**.

Questions	
Properties of ionizing radiation	
What are the properties of alpha, beta and gamma radiation?	<p>Alpha particles – particles, relatively large, double positive charge, high energy</p> <p>Beta particles – particles (electron or positron), small, negative or positive charge</p> <p>Gamma rays – waves, pure energy, no mass or charge, high frequency (high energy)</p>
How ionizing radiation enters the body	
Can alpha, beta and gamma radiation travel through skin?	<p>Alpha – Minimal (up to 0.3 mm)</p> <p>Beta – Yes (up to 17 mm)</p> <p>Gamma – Yes</p>
Can alpha, beta and gamma radiation pass through the body?	<p>Alpha – No</p> <p>Beta – No</p> <p>Gamma – Yes, can reach internal organs and bones</p>
Can ionizing radiation enter the body in any other ways? (Provide examples.)	<ul style="list-style-type: none"> • Can enter the body through cuts, nose, mouth, around eyes, under fingernails • Can be ingested with food and water that has been contaminated • Can be inhaled with contaminated dust (smokers inhale polonium-210 in cigarettes)
How ionizing radiation affects cells	
The energy from alpha, beta and gamma radiation can be transferred over what volume of cells?	<p>Alpha – small volume (few cells)</p> <p>Beta – greater volume (many cells)</p> <p>Gamma – large volume (potentially all cells in the body)</p>
How much damage can the energy from alpha, beta and gamma radiation do to each cell?	<p>Alpha – relatively large amount of damage to each nearby cell (5-20 times more damage than the same absorbed dose of beta or gamma radiation)</p> <p>Beta – Less damage to each cell than alpha particles (energy is spread over a greater volume)</p> <p>Gamma – Less damage to each cell than either alpha or beta particles (energy is spread over the greatest volume)</p>

How ionizing radiation affects cells

What can happen when ionizing radiation strikes a cell?

1. May pass through the cell without doing damage
2. The cell is damaged but is able to repair itself
3. The cell is damaged and loses some functions (could be destroyed by immune system, could survive and uncontrollably reproduce itself – this can lead to cancerous tumors)
4. The cell dies (apoptosis – cell detects damage and self-destructs; necrosis – cell dies while trying to divide)

Are some types of cells more sensitive to ionizing radiation than others? Which?

- Yes – cells which divide more rapidly (such as cells in bone marrow, gonads, intestines)
- Cells that perform specialized functions are less sensitive than cells which do not
- Cells in babies and children divide rapidly so are very sensitive

How ionizing radiation affects genetic material

What are the direct and indirect effects of ionizing radiation on DNA?

- Direct** – DNA is a primary target for cell damage from ionizing radiation
- Ionization creates ions which can physically break the sugar phosphate backbone (may be single or double-strand breaks) – can lead to the creation of tumour cells – unrepaired double-strand breaks are very damaging
 - Can affect bonding of base pairs as well as damage bases themselves
- Indirect** – radiation can impair or damage cells by ionizing water which creates free radicals

How can cells repair DNA damage?

- Base and nucleotide excision repair
- Blunt end ligation (ligases link together DNA strands that have double-strand breaks)
- Homologous recombination (repair double-strand breaks in DNA)

What can happen if DNA is repaired incorrectly?

- Mutations (change in the base sequence in DNA)
- **Base substitutions** (replacement of one base by another) – transitions and transversions
 - **Frameshift mutations** (change triplet code) – insertions and deletions

What is the difference between somatic and reproductive effects of ionizing radiation?

- **Somatic effects** – damage that occurs due to high levels of ionizing radiation (does not include reproductive cells). Effects like sickness, hair loss or internal bleeding are visible shortly after exposure. Other illnesses, such as cancer, may take a number of years to appear.
- **Reproductive (genetic) effects** – damage to the reproductive cells due to exposure to high levels of ionizing radiation and can be passed down to an organism’s offspring, perhaps generations later. Some potential illnesses could include birth abnormalities and cancer.