



College of Health and Medical Technologies

Department of Radiology Technologies

Radiobiology

The first stage

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Types of cellular Damage by Radiation

Lecture No.6

1. Cell Killing

Radiation can kill cells by two distinct mechanisms:

- ❖ The first is **apoptosis**, also called **programmed cell death** or **interphase death**.
 - Cells undergoing apoptosis as an immediate consequence of radiation damage usually die in **interphase** within a few hours of irradiation.
 - Loss of **apoptotic** control is thought to be an important factor in **tumor** development.
- ❖ The second mechanism for cell killing is radiation-induced **reproductive failure**.
 - Radiation in sufficient doses can inhibit **mitosis**, that is, the cell's ability to divide and proliferate indefinitely.
 - As Radiation kills cells by **inhibiting their ability to divide**, its effects in human beings occur primarily in tissues with high cell turnover or renewal rates characterized by a large amount of proliferative activity.

2. Mutagenesis

- ❖ DNA structural analyses show that the majority of radiation-induced **mutations** in human cells result from large-scale genetic events involving loss of the entire active gene and often extending to other loci on the same chromosome.
- ❖ The major potential consequence of radiation-induced **mutations** in human populations is heritable genetic effects resulting from **mutations** induced in germinal cells

3. Chromosomal Aberrations

A **chromosomal abnormality**, or **chromosomal aberration**, is a disorder characterized by a morphological or numerical alteration in single or multiple chromosomes, **affecting autosomes, sex chromosomes, or both**.

Radiation can induce two types of **chromosomal aberrations** in mammalian cells:

- ❖ The first have been termed “**unstable**” aberrations in that they are usually lethal to dividing cells.
They include such changes as **dicentrics**, **ring chromosomes**, **large deletions**, and **fragments**.
- ❖ The second type has been termed “**stable**” aberrations.
These include changes such as **small deletions**, **reciprocal translocations**, and **aneuploidy**—changes that do not preclude the cell from dividing and proliferating.

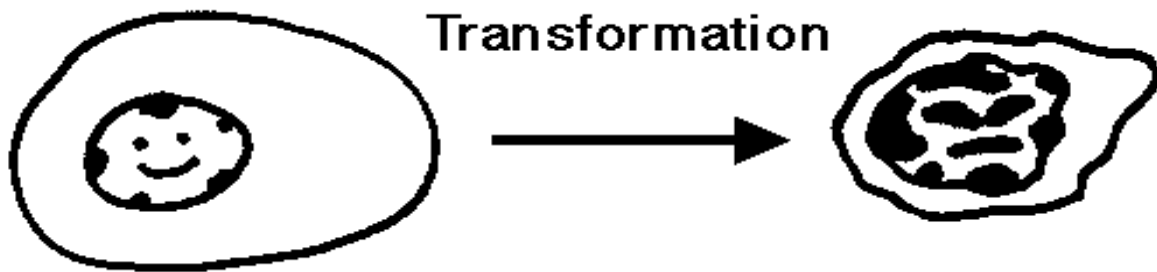
4. Neoplastic Transformation In Vitro

(Abnormal and uncontrolled cell growth).

Tumors can occur almost anywhere in the body. There are three main types of tumor; **benign**, **pre-malignant**, and **malignant**.

Benign and **pre-malignant** tumors can be harmless, whereas **malignant** tumors are cancerous.

An important cellular effect of radiation is **neoplastic** transformation, or the conversion of a normal cell to one with the phenotype of a **cancer cell**, including the ability to form an invasive, **malignant tumor** upon re-injection into syngeneic hosts.



5. Radiation-Induced Genomic Instability

The increased tendency for **DNA mutations** (changes) and other genetic changes to occur during cell division.

Genomic instability is caused by defects in certain processes that control the way cells divide. It occurs in many types of **cancer**.

This term refers to a phenomenon observed in a number of different cellular systems whereby radiation exposure appears to induce a type of **transmissible genetic instability** in individual cells that is transmitted to their progeny, leading to a persistent enhancement in the rate at which **genetic changes** arise in the descendants of the irradiated cell after many generations of replication.

6. Bystander Effects in Irradiated Cell Populations

is the phenomenon in which un-irradiated cells exhibit **irradiated effects** as a result of signals received from nearby irradiated cells.

It has long been thought that the cell nucleus is the target for the important biologic effects of radiation; these effects occur in the irradiated cell as a direct result of **DNA damage** that has not been correctly restored by **enzymatic repair processes**.