



# **SNS COLLEGE OF TECHNOLOGY**

## **(AN AUTONOMOUS INSTITUTION)**

Approved by AICTE & Affiliated to Anna University  
Accredited by NBA & Accredited by NAAC with 'A+' Grade,  
Recognized by UGC saravanampatti (post), Coimbatore-641035.



## **Department of Biomedical Engineering**

### **RADIOLOGICAL EQUIPMENT**

**III Year : V Semester**

**TITLE: Effects of radiation- direct and indirect.**



# Direct and Indirect Effects



Two general categories of radiation effects:

V2

Vision Title 3

- Direct effects
- Indirect effects



# Direct Effects

❑ Direct effects of radiation involve a transfer of energy from the radiation (e.g., alpha or beta) directly to the target molecule (typically DNA). Direct effects are believed to be the most important type of effect for high LET radiation (e.g., neutrons and alpha particles).

V2

Vision Title 3

❑ Direct effects are caused by radiation when radiation interacts directly with the atoms of the **DNA** molecule or some other cellular component critical to the cell's survival. The probability of the radiation interacting with the DNA molecule is very small since these critical components make up such a small part of the cell.



# Indirect Effects



- Indirect effects occur when radiation produces free radicals which react with the target molecule (typically DNA). The free radicals must be produced very close to the target (e.g. within a few nm) since they have such short lifetimes. Indirect effects seem to be most important for low LET radiation (e.g., gammas, x-rays and betas). About 65% of low LET damage has an indirect component whereas 35% is exclusively direct (UNSCEAR 2000).



- Indirect effects are caused by the interaction of radiation, usually with **water molecules**. Each cell, just as is the case for the human body, is mostly water. Ionizing radiation may break the bonds that hold the water molecule together, producing **radicals** such as hydroxyl OH, superoxide anion  $O_2^-$  and others. These radicals can contribute to the destruction of the cell.





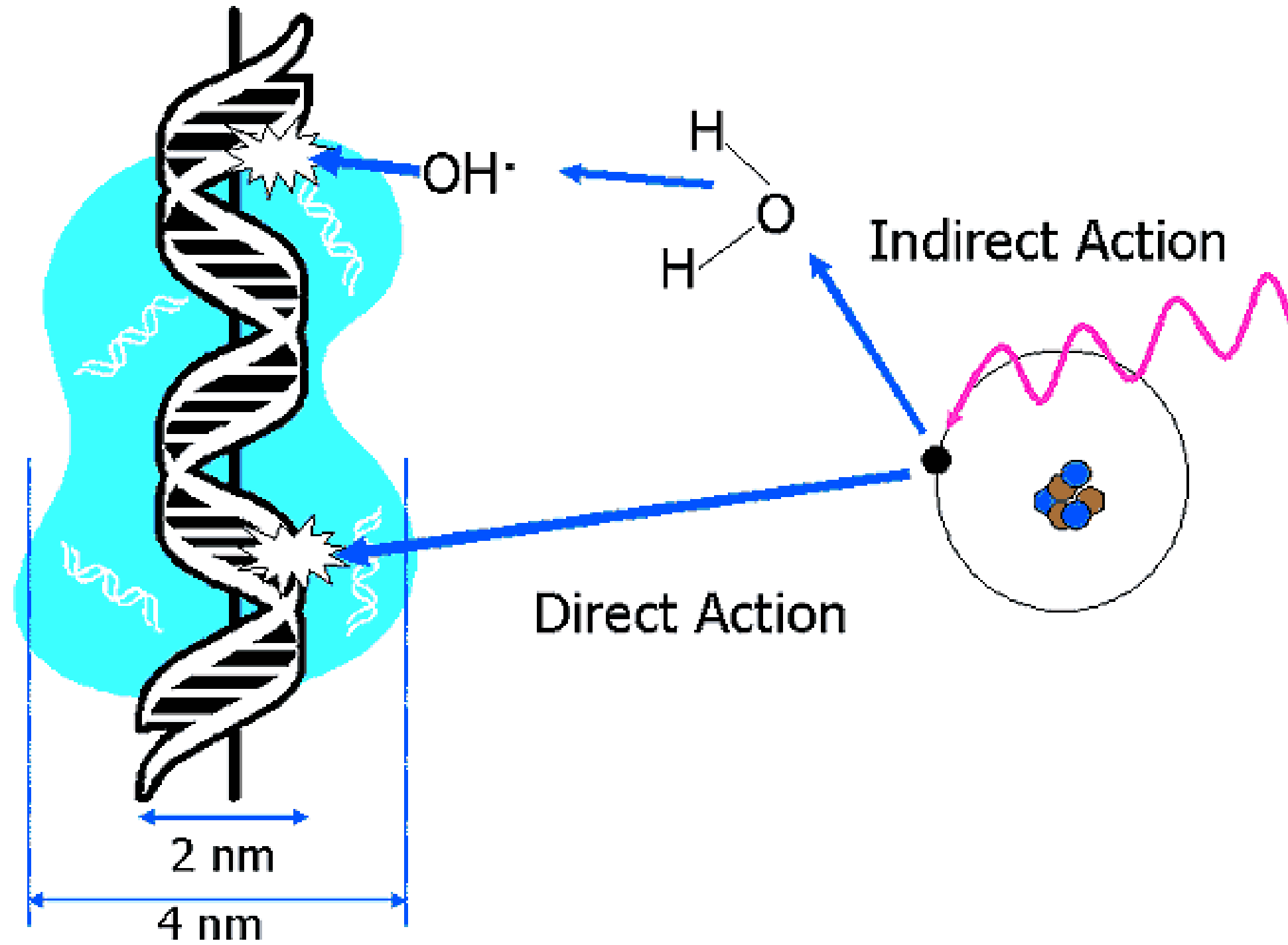
# Direct/Indirect Effect

## Direct Effect

- Photon ionizes "master molecule"
- Master molecule is destroyed, cell dies, damaged

## Indirect Effect

- Photon ionized non-critical molecule
- Transfer energy to master molecule
- Most frequently water molecules



Vision Title 3



## Direct action

Radiation



DNA damage



Cell death

## Indirect action

Radiation



Free radicals



DNA damage



Cell death

Vision Title 3





THANKYOU