Lab-9 **Practical Bacterial physiology**

Effect of radiation on growth.

Radiation, both ionizing and non-ionizing, can significantly impact bacterial growth. Ionizing radiation, like gamma rays, can directly damage bacterial DNA, leading to cell death or impaired growth. Non-ionizing radiation, such as ultraviolet (UV) light, can also damage DNA, inhibiting bacterial replication and potentially killing cells.

What radiation is used for microbial growth control?

Radiation sterilization uses ultraviolet (UV) light or ionizing radiation like gamma rays and electrons to kill microorganisms. Ionizing radiation creates free radicals that damage cells, while UV radiation excites electrons and destroys cellular structure.

The extent of the effect depends on the

1-radiation type.

2- dose.

3- bacterial species.

Ionizing Radiation(gamma rays and X-rays):

- **Mechanism:**

Ionizing radiation, like gamma rays and X-rays, carries enough energy to knock electrons out of atoms, creating ions and free radicals. These reactive species can damage DNA, proteins, and other cellular components, leading to cell death or mutations.

- **Effects on Bacteria:**
  - **DNA Damage: Ionizing radiation can cause DNA single-strand breaks and double-strand breaks, which can disrupt DNA replication and transcription, ultimately inhibiting bacterial growth.**
  - **Cellular Damage: Free radicals generated by ionizing radiation can damage other cellular**

molecules, such as proteins and lipids, further contributing to cell damage and death.

- **Growth Inhibition:** Studies have shown that ionizing radiation can inhibit the growth of bacteria, with some species being more sensitive than others.
- **Bacterial Killing:** At higher doses, ionizing radiation can effectively kill bacteria.
- **Examples:** Ionizing radiation is used in food irradiation to reduce bacterial contamination and extend shelf life.

Note: ionizing radiation is also used to kill molds and viruses and many harmful microorganisms in food.

This process is called **food irradiation**.

Food irradiation is a food safety technique that involves exposing food to ionizing radiation to reduce germs that can cause food poisoning.

Note:

Gamma irradiation has the ability to inactivate gram-positive and gram-negative bacteria, however, some microorganisms are shown to be able to withstand high dose of ionizing radiation . γ irradiation is a simple sterilization technique which is both rapid and effective.

Non-ionizing Radiation (UV Light):

- **Mechanism:**

UV light, particularly UV-C, has sufficient energy to be absorbed by DNA, causing the formation of pyrimidine dimers (primarily thymine dimers). These dimers distort the DNA structure, interfering with replication and transcription.

- **Effects on Bacteria:**
  - **DNA Damage:** UV light primarily damages DNA by forming pyrimidine dimers, which can halt DNA replication and lead to cell death.
  - **Growth Inhibition:** UV radiation can significantly inhibit bacterial growth, and the extent of inhibition depends on the UV dose and bacterial species.
  - **Bacterial Killing:** At higher doses, UV radiation can effectively kill bacteria by disrupting their DNA and preventing them from replicating.
  - **Examples:** UV light is commonly used for sterilizing surfaces and disinfecting water.

Factors Influencing the Effect:

- **Radiation Type:**

Different types of radiation have different energy levels and can affect bacteria differently.

- **Radiation Dose:**

Higher doses of radiation generally lead to greater damage and a stronger inhibitory effect on bacterial growth.

- **Bacterial Species:**

Different bacterial species have varying sensitivities to radiation due to differences in their cellular structures and repair mechanisms.

- **Environmental Factors:**

Temperature, humidity, presence of oxygen and the presence of other substances can also influence the effectiveness of radiation on bacteria.

Which radiation has the most antibacterial effect?

Ultraviolet –C (UVC) is radiation with a wavelength between 200–280 nm .UVC has a strong antimicrobial effect.

Note : Bacterial species and strain?????

Some bacteria are more resistant to radiation than others. Gram-negative bacteria are generally more sensitive to radiation than Gram-positive bacteria.

which bacteria is resistant to radiation?

Deinococcus radiodurans **has been nicknamed "Conan the Bacterium" for its ability to withstand intense levels of radiation. This microscopic organism can radiation thousands of times the level known to kill a human**

The bacterium *Deinococcus radiodurans* is able to tolerate the lethal effects of ionizing radiation (15 kGy) and UVR (>1000 J/m2).

What radiation is used for microbial growth control?

Radiation sterilization uses ultraviolet (UV) light or ionizing radiation like gamma rays and electrons to kill microorganisms. Ionizing radiation creates free radicals that damage cells, while UV radiation excites electrons and destroys cellular structure.

General procedure for studying the effects of radiation on bacterial growth:

1. Preparation:

- **Choose a bacterial strain:**

Select the bacterial strain you want to study. Consider factors like its relevance to your research (e.g., a common pathogen) *Escherichia coli* and *Staphylococcus aureus*.

- **Prepare bacterial cultures:**

Grow the bacteria in a suitable liquid medium (like nutrient broth) until they reach a desired density.

- **Prepare agar plates:**

Pour nutrient agar plates and allow them to solidify. These will be used for colony counting after irradiation.

2. Irradiation:

- **Choose a radiation source:** Select the appropriate radiation source (UV lamp, gamma source, etc.).
- **Control the radiation dose**: Precisely control the radiation dose (e.g., using different exposure times

for UV, or different intensities for gamma radiation). 0 min, 1 min , 5 min , 10 min .

- Irradiate bacterial samples: Expose the bacterial cultures or agar plates to the radiation source for varying durations, creating different radiation dose levels.

3. Post-Irradiation:

- **Dilution series:**

Prepare serial dilutions of the irradiated bacterial samples, especially if the radiation is expected to significantly reduce the bacterial population.

- **Plating:**

Spread or streak the diluted samples on agar plates to allow individual colonies to form.

- **Incubation:**

Incubate the plates at a suitable temperature (37°C for many common bacteria) for a specific period (24 hours).

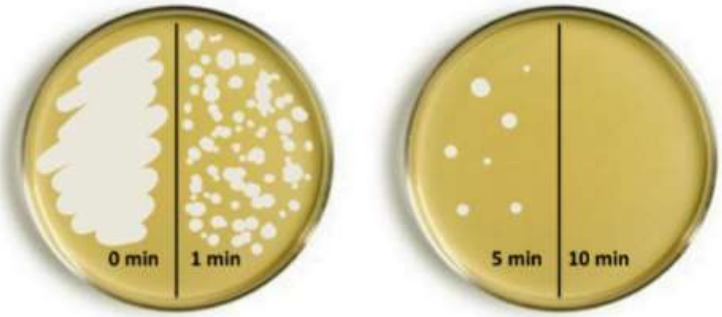
- **Colony counting:**

Count the number of colonies on each plate to determine the survival rate or growth rate of the bacteria after irradiation.

- **Data analysis:**

Compare the colony counts from irradiated samples to control samples (not exposed to radiation) to assess the effect of radiation on bacterial growth

UV Radiation Experiment

	E. coli
Plate was exposed at a *far distance* from the UV lamp	
Plate was exposed at a *close distance* from the UV lamp