



Al-Mustaqbal University
College of Science
Department of Medical physics



جامعة المستقبل
AL MUSTAQBAL UNIVERSITY

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Lecture (11 -12)

The greenhouse effect and Solar

Thermal Energy

Second stage

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The greenhouse effect:

Temperature of Earth

- If the Earth had no atmosphere, the average temperature on the surface would drop to about $-18\text{ }^{\circ}\text{C}$.
 - This would happen because the surface would be emitting all the radiation from the Sun into space
- The temperature of the Earth is affected by factors controlling the balance between incoming radiation and radiation emitted.
- The Earth receives the majority of its heat in the form of thermal radiation from the Sun.
 - At the same time, the Earth emits its own thermal radiation, with a slightly longer wavelength than the thermal radiation it receives (this is caused by difference in surface temperature of the Earth and the Sun).

The greenhouse effect:

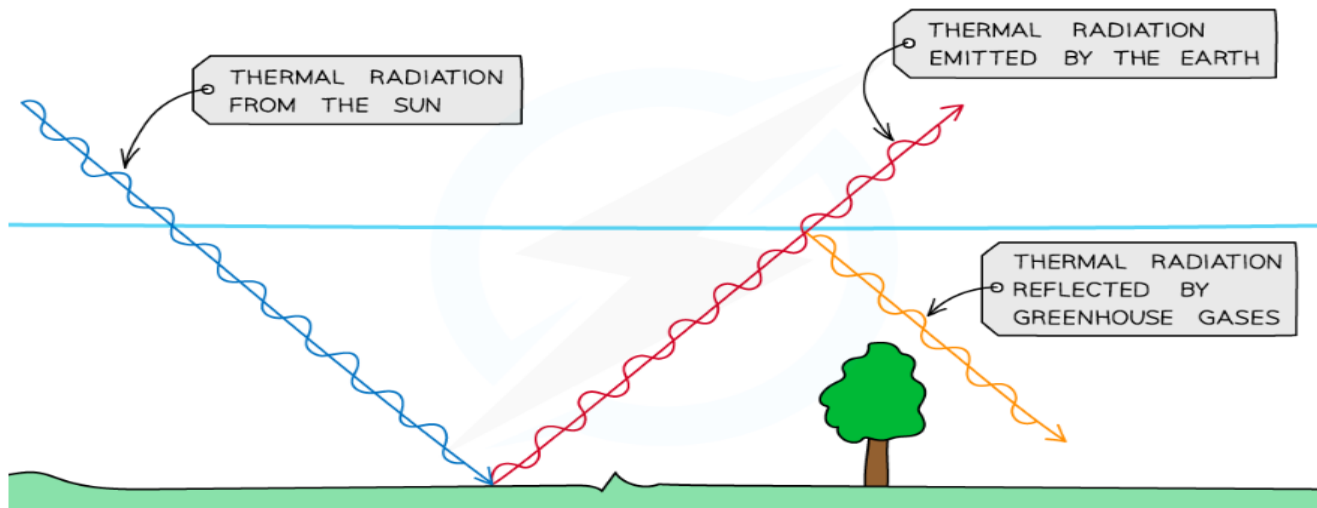
- Some gases in the atmosphere, such as water vapour, methane, and carbon dioxide (greenhouse gases) absorb and reflect back



longer-wavelength infrared radiation from the Earth and prevent it from escaping into space.

- These gases absorb the radiation and then emit it back to the surface.
- These gases keep the Earth's temperature at a reasonable level, and the process is called the greenhouse effect
- This process makes the Earth warmer than it would be if these gases were not in its atmosphere.

Radiation and the greenhouse effect:





The Earth receives thermal radiation from the Sun but emits its own thermal radiation at the same time. The greenhouse effect is where this radiation is trapped by gases.

- The temperature of the Earth, therefore, depends on several factors, such as the rate that infrared radiation is:
 - **Reflected** back into space
 - **Absorbed** by the Earth's atmosphere or by the Earth's surface
 - **Emitted** from the Earth's surface and from the Earth's atmosphere into space.
- **Physical Mechanisms of Action:**
- The fundamental physics of the greenhouse effect—long-wave infrared radiation being absorbed by atmospheric trace gases and re-emitted back to the surface—is the same mechanism that drives global warming.
- In medical applications, the "trapping" principle is metaphorically used to describe the retention of heat in artificial environments (like incubators) or the absorption of gases in anesthetic equipment.



Solar Thermal Energy

refers to the application of solar radiation, converted into heat, to meet the specialized thermal, energy, and therapeutic needs within healthcare environments and medical treatments.

Key applications include sustainable hot water and space heating for hospitals, as well as advanced photothermal techniques for treating diseases such as cancer or managing wounds.

1. Sustainable Hospital Infrastructure (Building Physics)

- **Service Hot Water (SHW):** Hospitals are intense consumers of hot water (for hygiene, laundry, and kitchens). Solar thermal collectors (flat-plate or vacuum tube) are used to pre-heat water to high temperatures, often reducing dependency on conventional fuels by 50% to 80%.
- **Sterilization and Sanitization:** Solar thermal systems can provide the high temperatures needed to pasteurize water, helping to manage *Legionella* risks in hospital plumbing networks.
- **Sustainable Design and Modeling:** Medical physicists and engineers use software (e.g., TRNSYS) to model and optimize



solar installations, considering the thermal losses in long pipe networks typical of hospitals.

2. Therapeutic Applications (Biomedical Physics)

- **Photothermal Therapy (PTT):** This technique uses local heating to treat cancer. Photothermal materials are introduced into tumors and then irradiated with light (often near-infrared), converting this light into heat (solar thermal effect) to destroy cancer cells.
- **Wound Care and Management:** Passive radiative heating (PRH) technologies are utilized to maintain optimal temperatures for wounds. These materials can enhance blood circulation and accelerate healing by providing targeted warmth.
- **Thermal Disinfection:** In some wound care scenarios, temperatures above 53°C are used for thermal disinfection of infected wounds to eliminate pathogens.



3. Future Directions: Energy-Free Management

- **Passive Radiative Heating (PRH):** Research is developing intelligent textiles or films that can provide solar heating during the day and cooling at night, providing a self-regulating, zero-energy thermal management solution for patients or wound care.