

# Electromagnetic Spectrum Overview

## Full Electromagnetic Spectrum



Radio

Microwave

IR

**Visible**

UV

X-ray

Gamma

← Lower Energy

$\lambda$ : km → pm

Higher Energy →

## Spectrum Range

Radio waves → Microwaves → IR → Visible → UV → X-rays → Gamma rays

Frequency:  $10^3$  Hz to  $10^{20}$  Hz | Wavelength: km to pm



### Biological Windows

**Visible:** 400-700 nm

Vision, photosynthesis

**NIR:** 700-1000 nm

Deep tissue penetration

**UV-A:** 320-400 nm

Minimal DNA damage



### Atmospheric Transmission

**Transparent:** Visible light, radio waves

**Absorbed:** Most UV, IR, X-rays

**Ozone layer:** Blocks harmful UV-C radiation



## Medical Imaging Regions

**X-ray:** 0.01-10 nm

Radiography, CT scanning

**Gamma:** <0.01 nm

PET, SPECT imaging

**Optical:** Microscopy, endoscopy

## Interactive Applications

- Spectral databases for reference
- Wavelength calculators
- Interactive spectrum explorers
- Energy conversion tools