Fundamental Physics for Food Technology and Innovation (4011106)

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Modern Physics for Food Technology and Innovation

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Overview of topics to be covered:

A. Introduction to Modern Physics
B. Quantum Physics Basics
C. Wave-Particle Duality
D. Electromagnetic Spectrum
E. Radioactivity and Food
F. Modern Measurement Technologies
G. Applications in Food Industry

Introduction to Modern Physics

- Transition from Classical to Modern Physics
- Einstein's Special Relativity ($E = mc^2$)
- Planck's Quantum Theory
- Relevance to Food Technology

  Where:

  - *E = Energy*
  - *m = mass*
  - *c = speed of light*

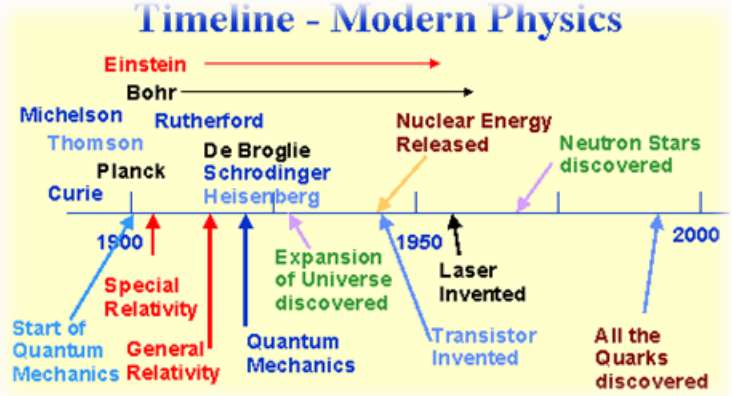

Figure 1: Modern physics timeline

Quantum Physics Basics

- Quantum States
- Energy Levels
- Molecular Bonding
- Applications in Food Chemistry
- Equation:

$$E = hf$$

Where:

E = Energy

h = Planck's constant

f = frequency

Figure 2: Quantum physics food molecules

Wave-Particle Duality

Applications in Food Technology:

- *Light Interaction with Food*
- *Spectroscopy Techniques*
- *Color Analysis*
- *Quality Control*

De Broglie Equation:

$$\lambda = h/p$$

Where:

- λ = *wavelength*
- *h = Planck's constant*
- *p = momentum*

Figure 3: Spectroscopy food analysis

Electromagnetic Spectrum

Applications:

- *Microwave Heating*
- *IR Food Analysis*
- *UV Sterilization*
- *X-ray Food Inspection*

Frequency Range: 10^4 - 10^{20} Hz

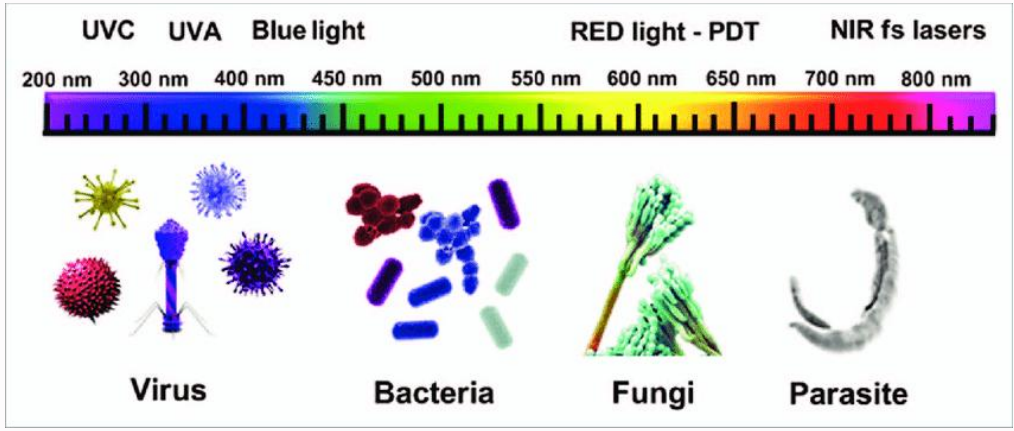

Figure 4: Electromagnetic spectrum food applications

Radioactivity and Food

- Food Irradiation
- Preservation Techniques
- Safety Measures
- Regulatory Standards

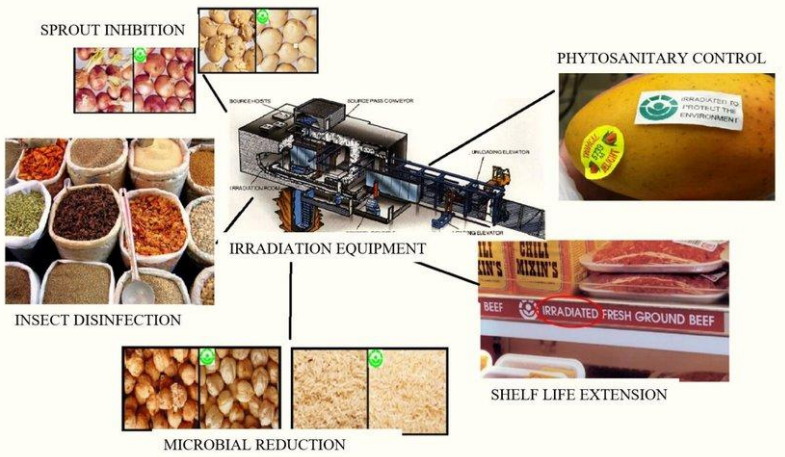

Figure 5: Food irradiation process

Radioactivity and Food

Decay Equation:

$$N(t) = N_0 e^{(-\lambda t)}$$

Where:

- *N(t) = number of radioactive nuclei at time t*
- N_0 *= initial number*
- λ *= decay constant*
- *t = time*

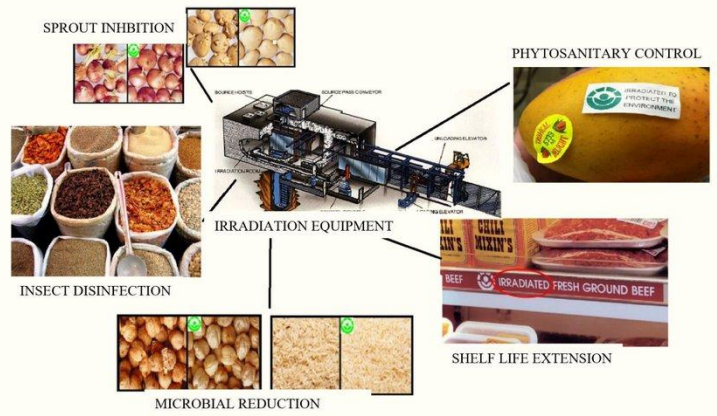

Figure 5: Food irradiation process

Modern Measurement Technologies

Equipment:

- *Mass Spectrometry*
- *NMR Spectroscopy*
- *X-ray Diffraction*
- *Electron Microscopy*

Figure 6: Food analysis equipment modern

Applications in Food Industry Part 1

Processing Technologies:

- *High-Pressure Processing*
- *Ultrasonic Treatment*
- *Pulsed Electric Fields*
- *Plasma Technology*

Figure 7: Modern food processing technologies

Applications in Food Industry Part 2

Quality Control:

- *Non-destructive Testing*
- *Optical Sorting*
- *Chemical Analysis*
- *Texture Analysis*

Figure 8: Food quality control modern physics

Future Trends

Emerging Technologies:

- *Quantum Sensors*
- *Nanomaterial Applications*
- *Smart Packaging*
- *AI Integration*

Figure 9: Future food technology physics

Case Studies

Real-world Applications:

- *Milk Homogenization Physics*
- *Meat Processing Technologies*
- *Fruit Ripening Analysis*
- *Packaging Innovation*

Figure 10: Physics food industry cases

Summary

Key Takeaways:

- *Modern Physics in Food Industry*
- *Current Applications*
- *Future Developments*
- *Career Opportunities*

Figure 12: Modern physics food technology summary

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