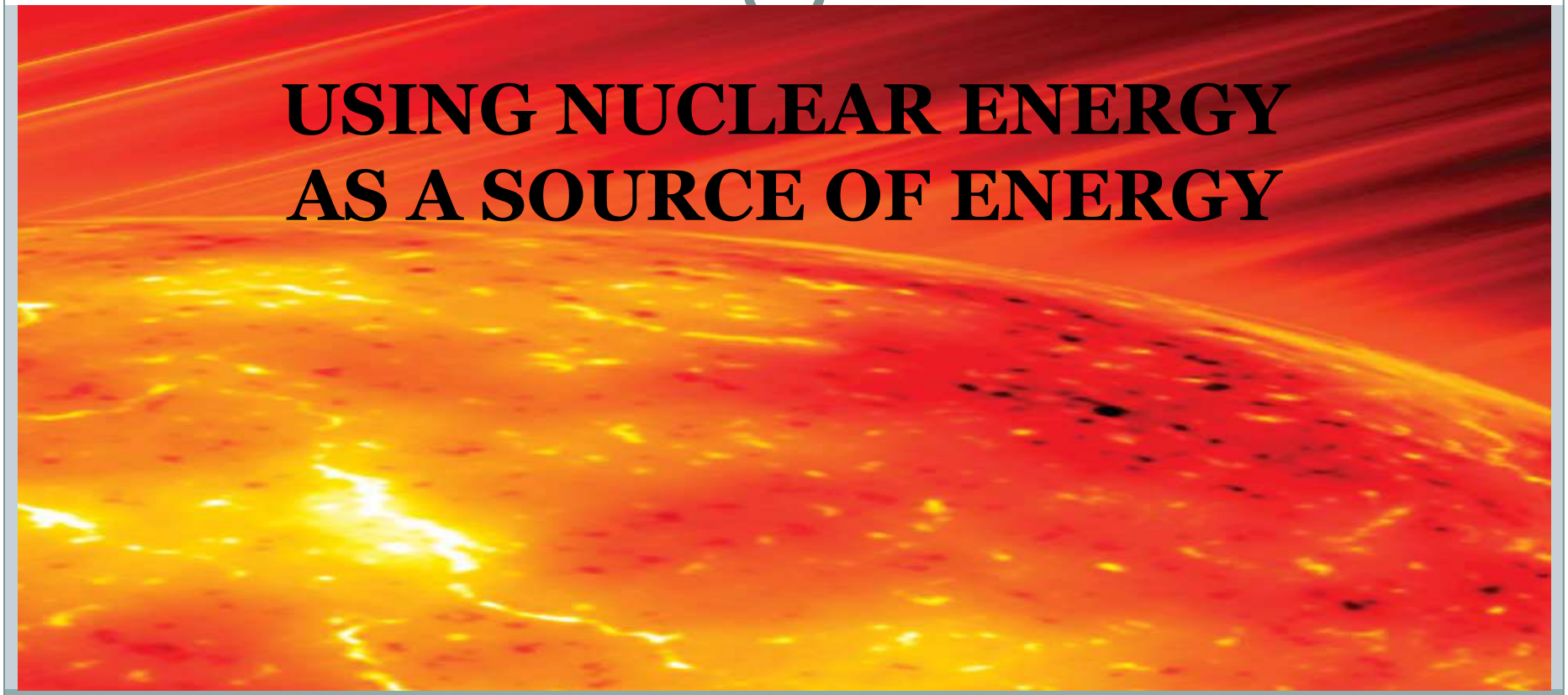
Radioactivity and Nuclear Energy



Using Nuclear Energy

Objectives

- To introduce fusion and fission as sources of energy
- To learn about nuclear fission
- To understand how a nuclear reactor works
- To learn about nuclear fusion
- To see how radiation damages human tissue

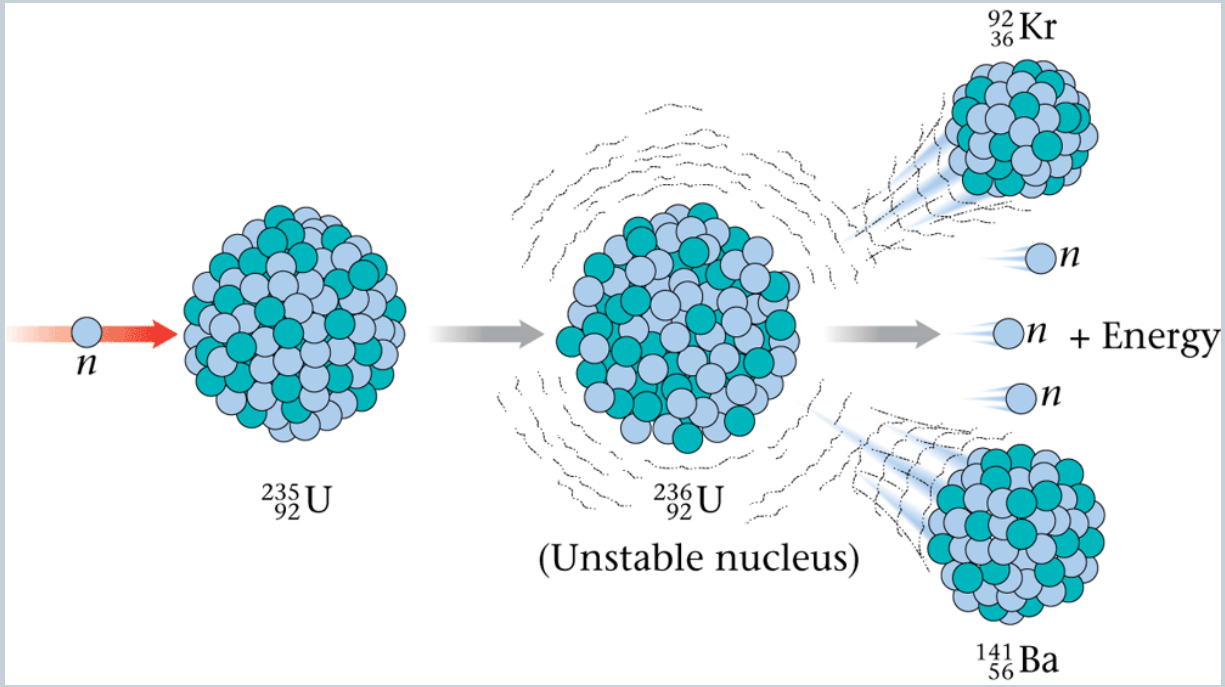
Using Nuclear Energy

A. Nuclear Energy

- Two types of nuclear processes can produce energy
  - **Combining 2 light nuclei to form a heavier nucleus** - fusion
  - Splitting a heavy nucleus into 2 nuclei with smaller mass numbers - fission

Using Nuclear Energy

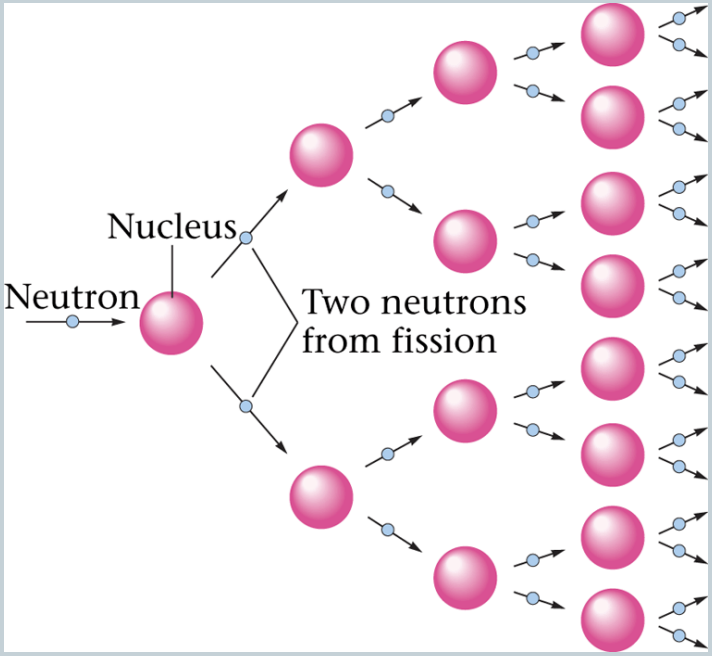
B. Nuclear Fission



- Releases a huge amount of energy (2.1×10^{13} J/mol uranium-235)
- Each fission produces 3 neutrons

Using Nuclear Energy

B. Nuclear Fission



- Chain reaction – self sustaining fission process caused by the production of neutrons that proceed to split other nuclei
- Critical mass – mass of fissionable material required to produce a chain reaction

Using Nuclear Energy

B. Nuclear Fission

Top Ten Countries Producing Electricity by Nuclear Power (in order of total nuclear output)	
Country	Percentage of Country's Total Power Production
United States	21.9
France	77.4
Japan	34.0
Germany	30.3
Russia	13.1
Canada	16.0
Ukraine	43.8
United Kingdom	26.0
Sweden	52.4
South Korea	35.8

Using Nuclear Energy

C. Nuclear Reactors

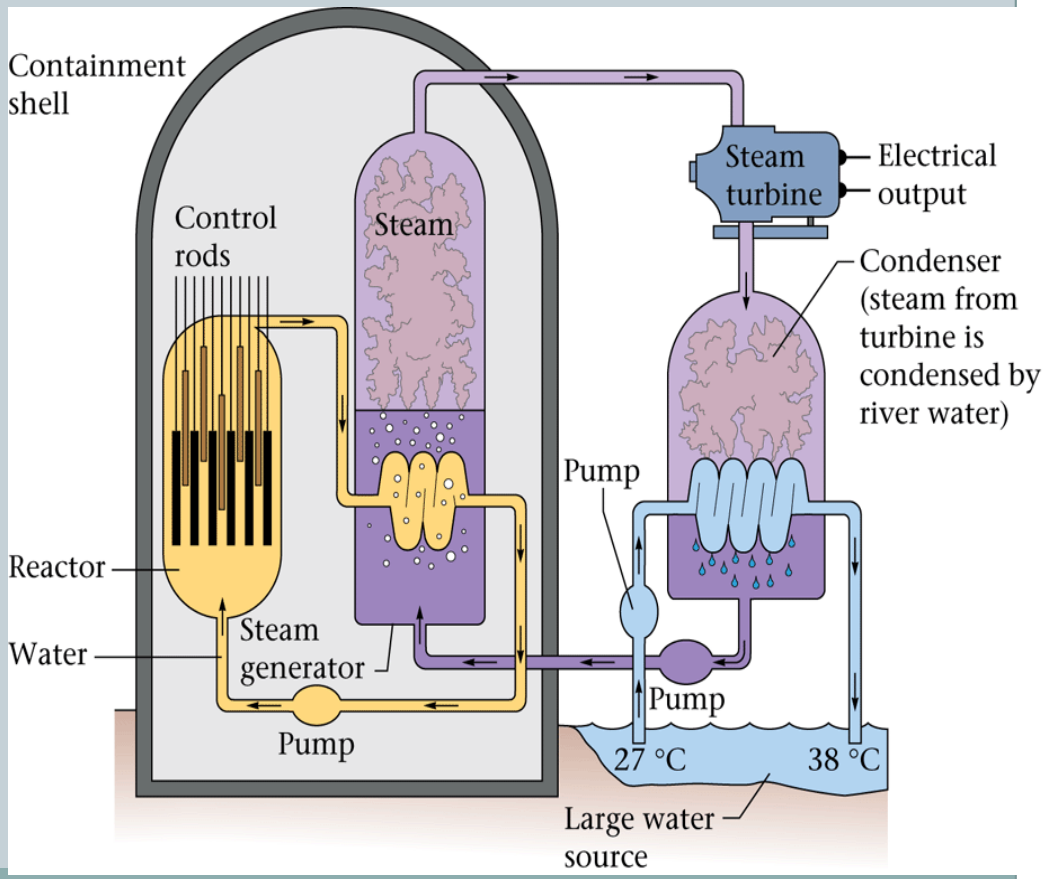
Positives:

1. Developed to produce electricity.
2. Energy can heat water to produce steam for turbine engines.

Negatives:

1.Potential meltdown releasing huge amounts of radiation

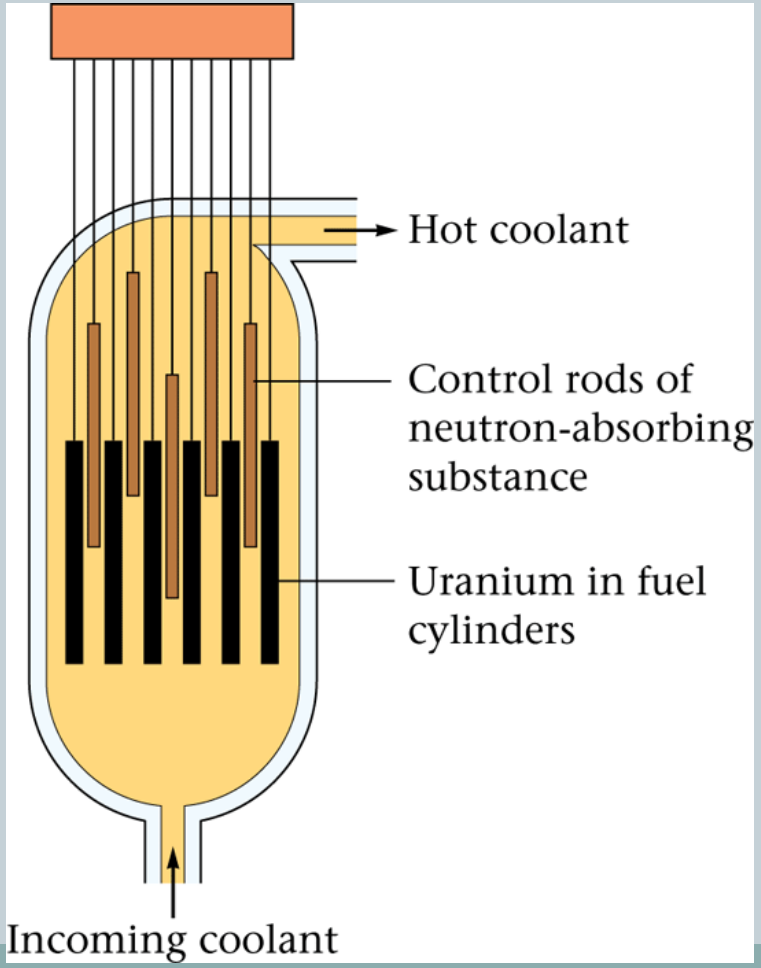
2. Hard to find safe nuclear waste disposal of radioactive materials that are radioactive for thousands of years



Using Nuclear Energy

C. Nuclear Reactors

Nuclear Power Plants use the principle of controlled nuclear **fission**



Reactor core

Using Nuclear Energy

D. Nuclear Fusion

- Process of combining 2 light nuclei
- Produces more energy per mole than fission
- Powers the stars and sun

$$ {}_{1}^{1}\mathrm{H} + {}_{1}^{1}\mathrm{H} \rightarrow {}_{1}^{2}\mathrm{H} + {}_{1}^{0}\mathrm{e} + \text{energy} $$

$$ {}_{1}^{1}\mathrm{H} + {}_{1}^{2}\mathrm{H} \rightarrow {}_{2}^{3}\mathrm{He} + \text{energy} $$

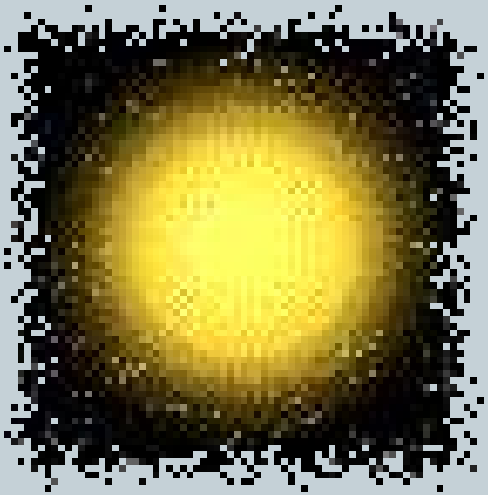
$$ {}_{2}^{3}\mathrm{He} + {}_{2}^{3}\mathrm{He} \rightarrow {}_{2}^{4}\mathrm{He} + 2\ {}_{1}^{1}\mathrm{H} + \text{energy} $$

$$ {}_{2}^{3}\mathrm{He} + {}_{1}^{1}\mathrm{H} \rightarrow {}_{2}^{4}\mathrm{He} + {}_{1}^{0}\mathrm{e} + \text{energy} $$

Using Nuclear Energy

D. Nuclear Fusion

- Requires extremely high temperatures
- Currently not technically possible for us to use as an energy source



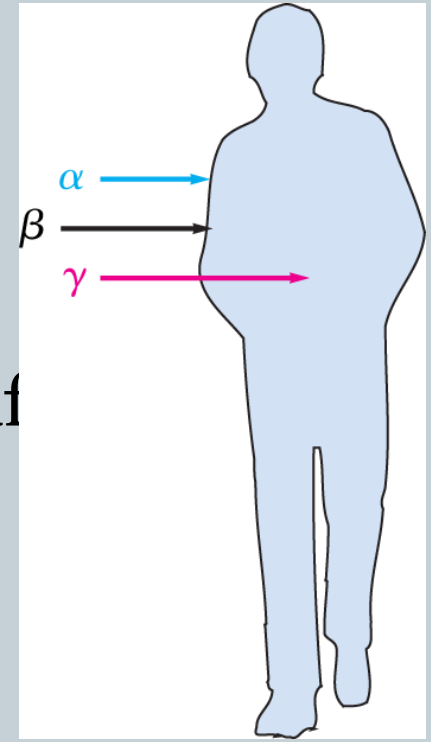
19.3 Using Nuclear Energy

E. Effects of Radiation

Biological Effects of Radiation

- Penetrating ability of the radiation into the tissues
- Ionizing ability of the radiation to af

Cell functions.



Using Nuclear Energy

E. Effects of Radiation

Table 19.5

Effects of Short-Term Exposures to Radiation

Dose (rem)	Clinical Effect
0–25	nondetectable
25–50	temporary decrease in white blood cell counts
100–200	strong decrease in white blood cell counts
500	death of half the exposed population within 30 days after exposure

- The End