Radiation: What it is and what it does

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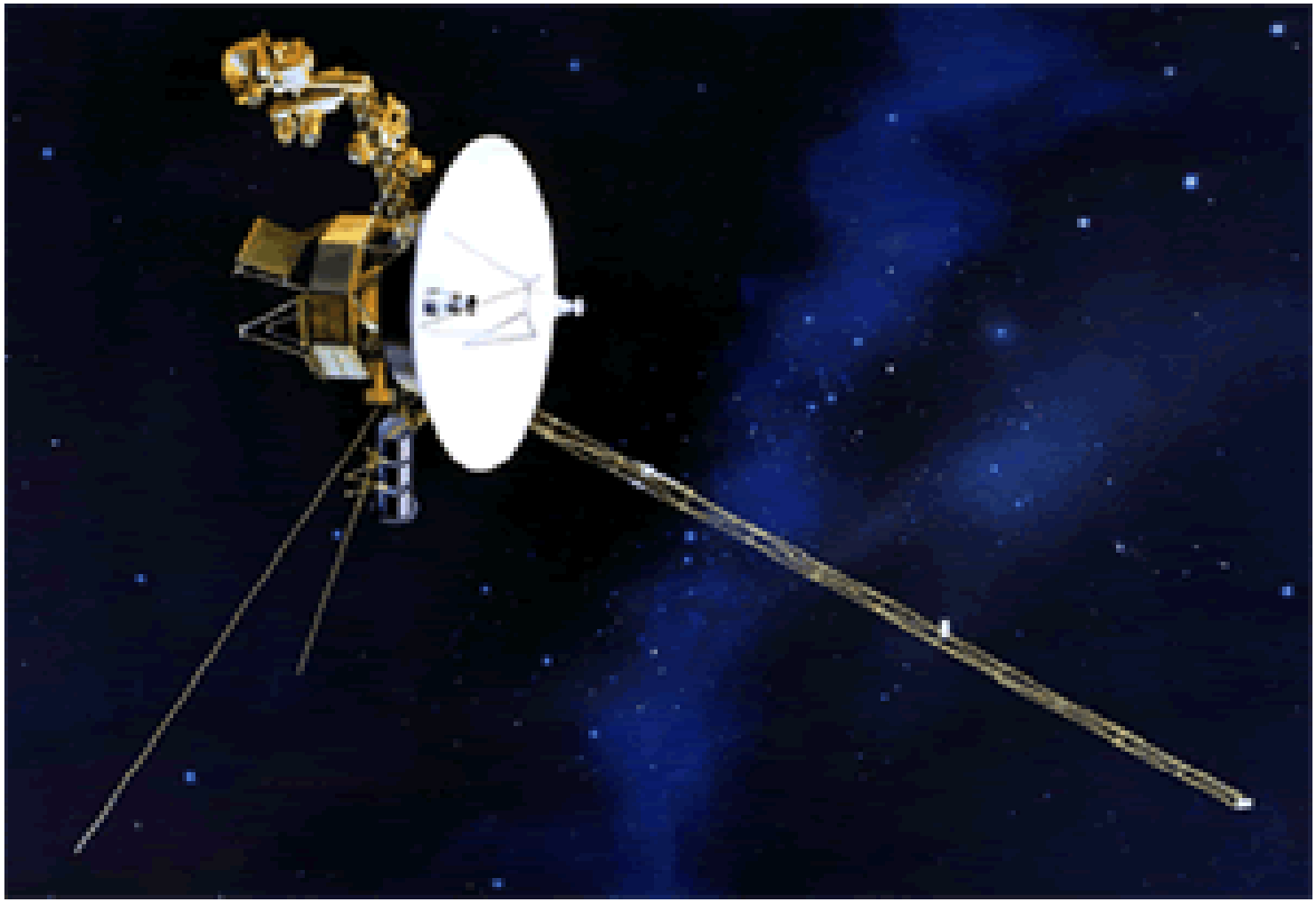
What do the following things have in common?

Voyager



Soda Can

Bugs

Each represents an application of nuclear science and technology.

Questions we'll answer. . .

- What is *radiation*?
- Where does it come from?
- What is *radioactivity*?
- What's the difference between *contamination* and *irradiation*?
- What are some applications?
- Is it *safe*?

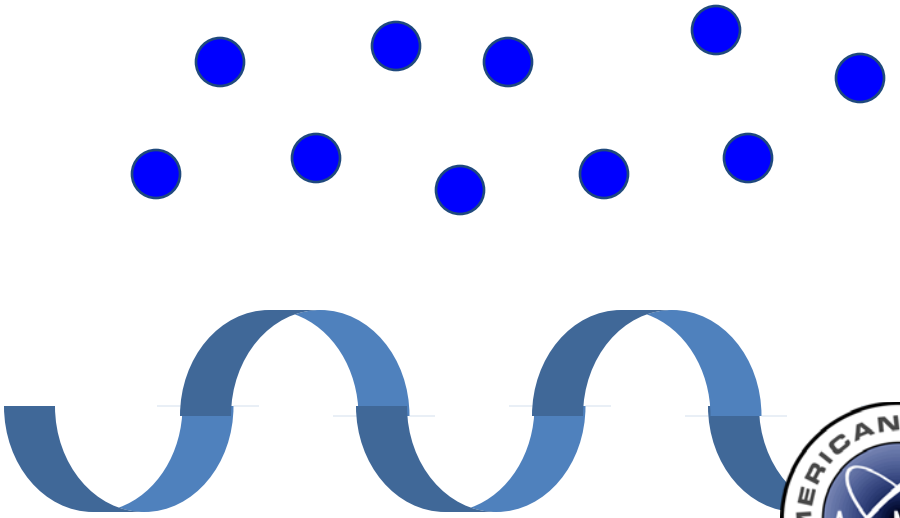
What is Radiation?

Transmission of energy via . . .

Particles

or

Waves

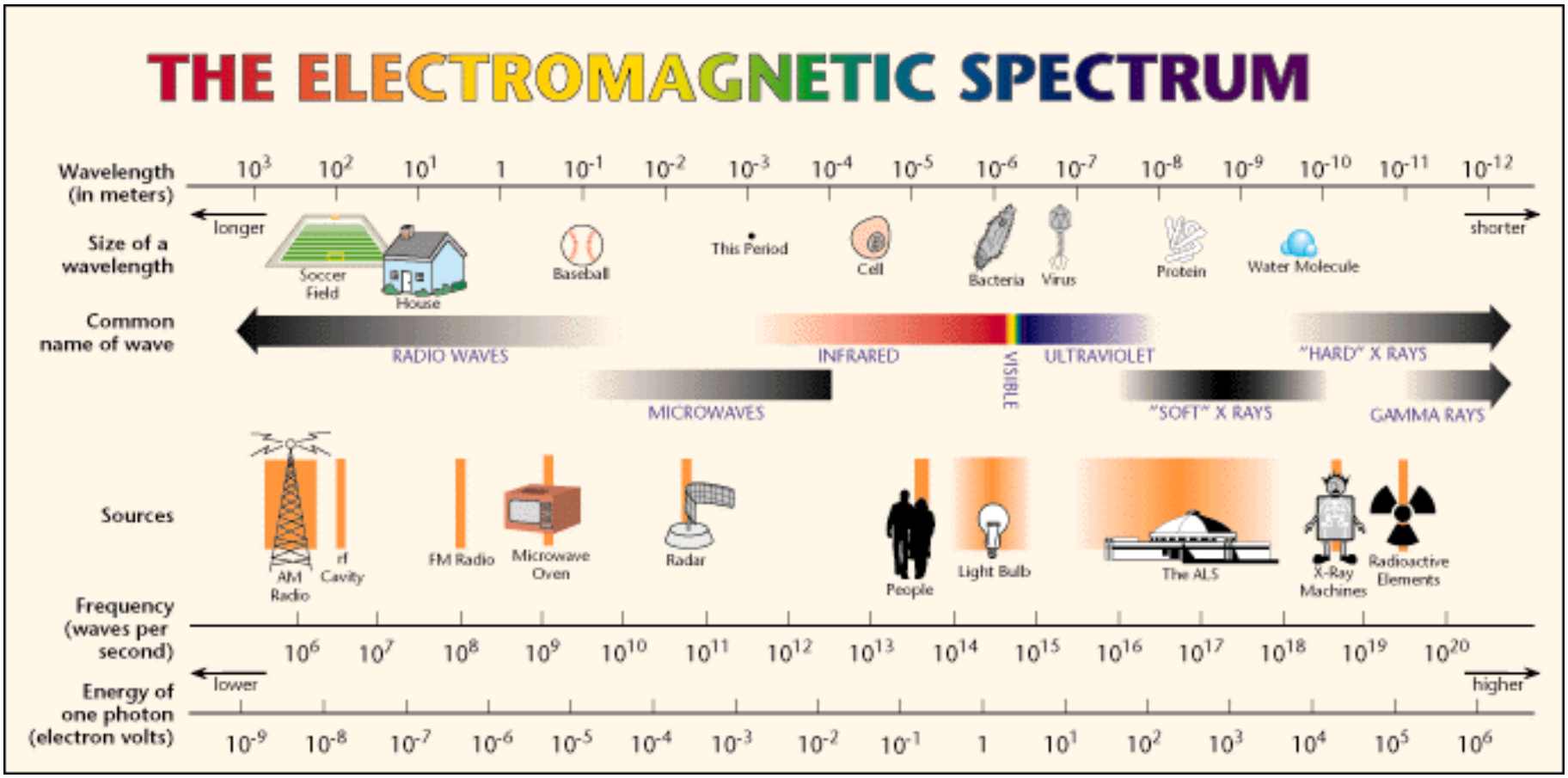


Types of radiation

Non-Ionizing	Ionizing
Radiowaves	
Microwaves	
Infrared	
Ultraviolet	
Visible Light	

Electromagnetic Spectrum

http://www.lbl.gov/MicroWorlds/ALSTool/EMSpec/EMSpec2.html



Types of radiation

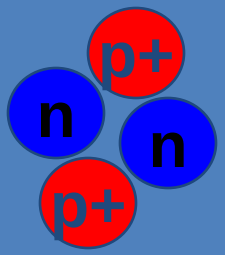
Non-Ionizing	Ionizing
Radiowaves	*Alpha*
Microwaves	*Beta*
Infrared	*Gamma (rays)*
Ultraviolet	*X-Rays*
Visible Light	*Neutrons*

Nature of Radiation

Alpha (α)

2 protons, 2 neutrons

positively charged particle



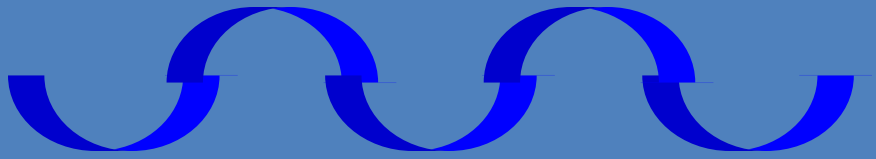
Beta (β)

like an electron

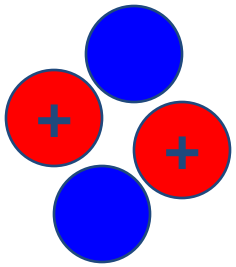
negatively charged particle

Gamma (γ)

Wave energy (*not* a particle)



PENETRATING ABILITY

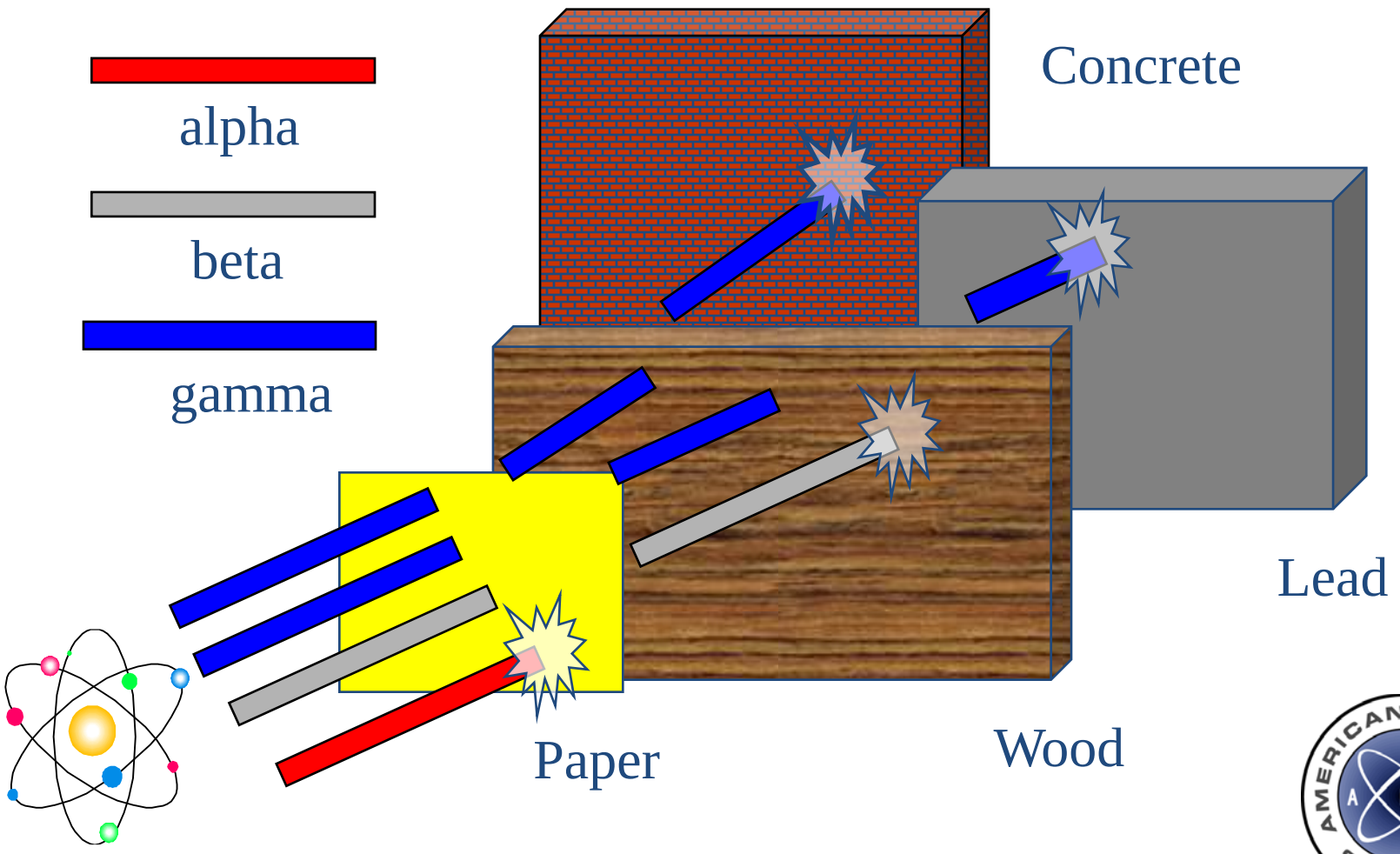


α

β

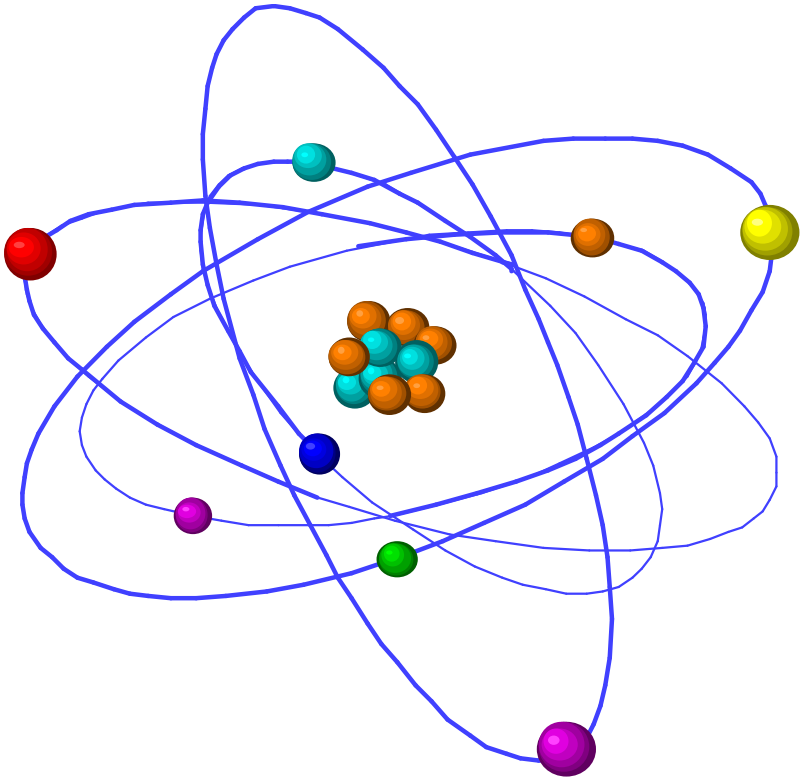
γ

SHIELDING



Which type of radiation is emanating from these every day objects?

Where does radiation come from?



Atoms . . .
from
radioactive
or unstable
atoms

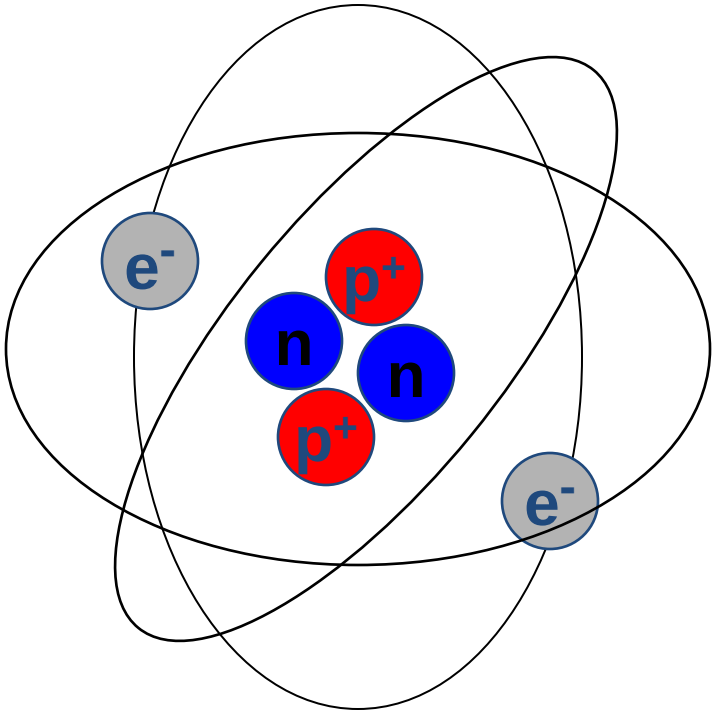
What part of atoms?

The Nucleus!

Hence, we have terms such as *nuclear* science/medicine/reactors.

Remember atomic structure?

THE HELIUM ATOM



HELIUM'S subATOMIC COMPOSITION

2 Protons

2 Neutrons

2 Electrons

More on this helium *isotope* . . .

MASS NUMBER

is total number of protons and neutrons

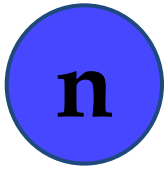
$^{4}_{2}He$

ELEMENT SYMBOL

ATOMIC NUMBER

is number of protons & identifies the element

Protons have a large mass and a positive charge.

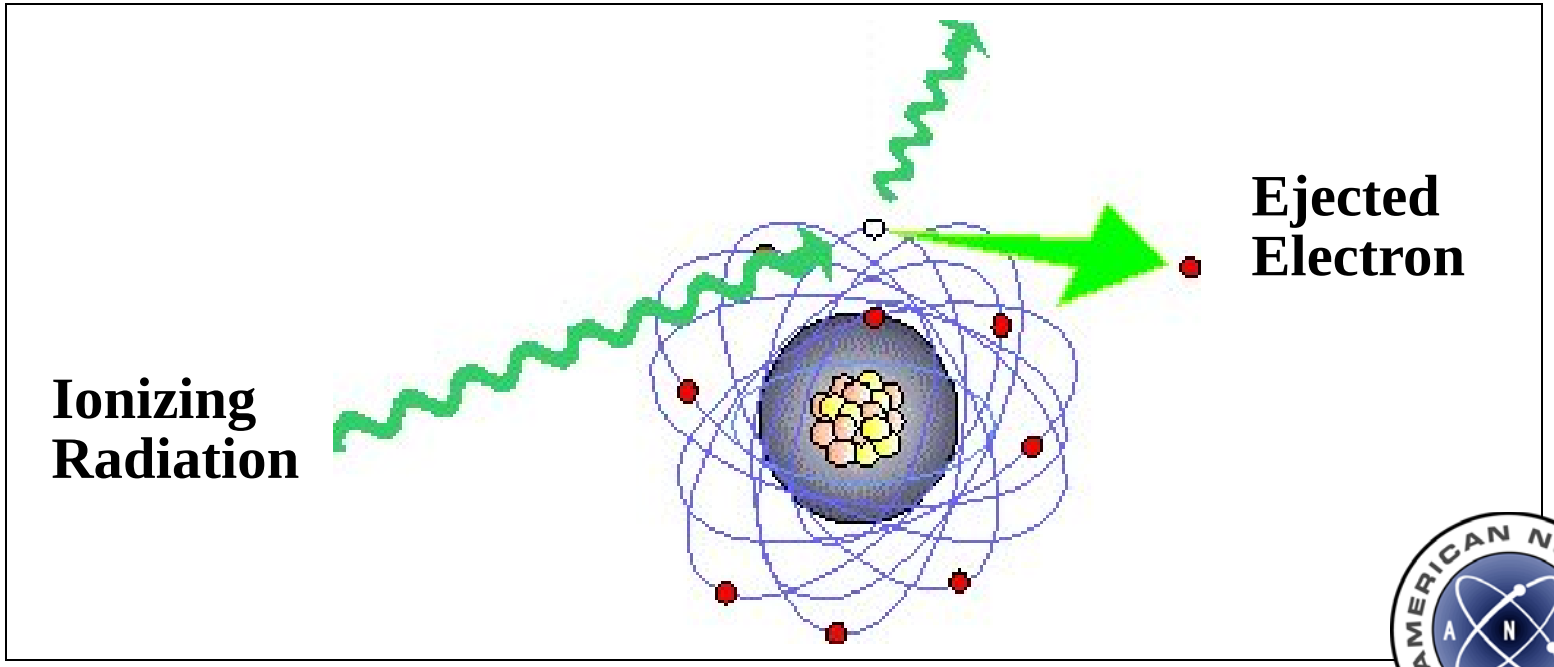


Neutrons have large mass, approximately equal to proton mass, but no charge.

Electrons have a very small mass and a negative charge. Electrons travel outside the nucleus.

Why is it called *ion*izing?

Because it creates *ions* . . .
atoms with a charge.

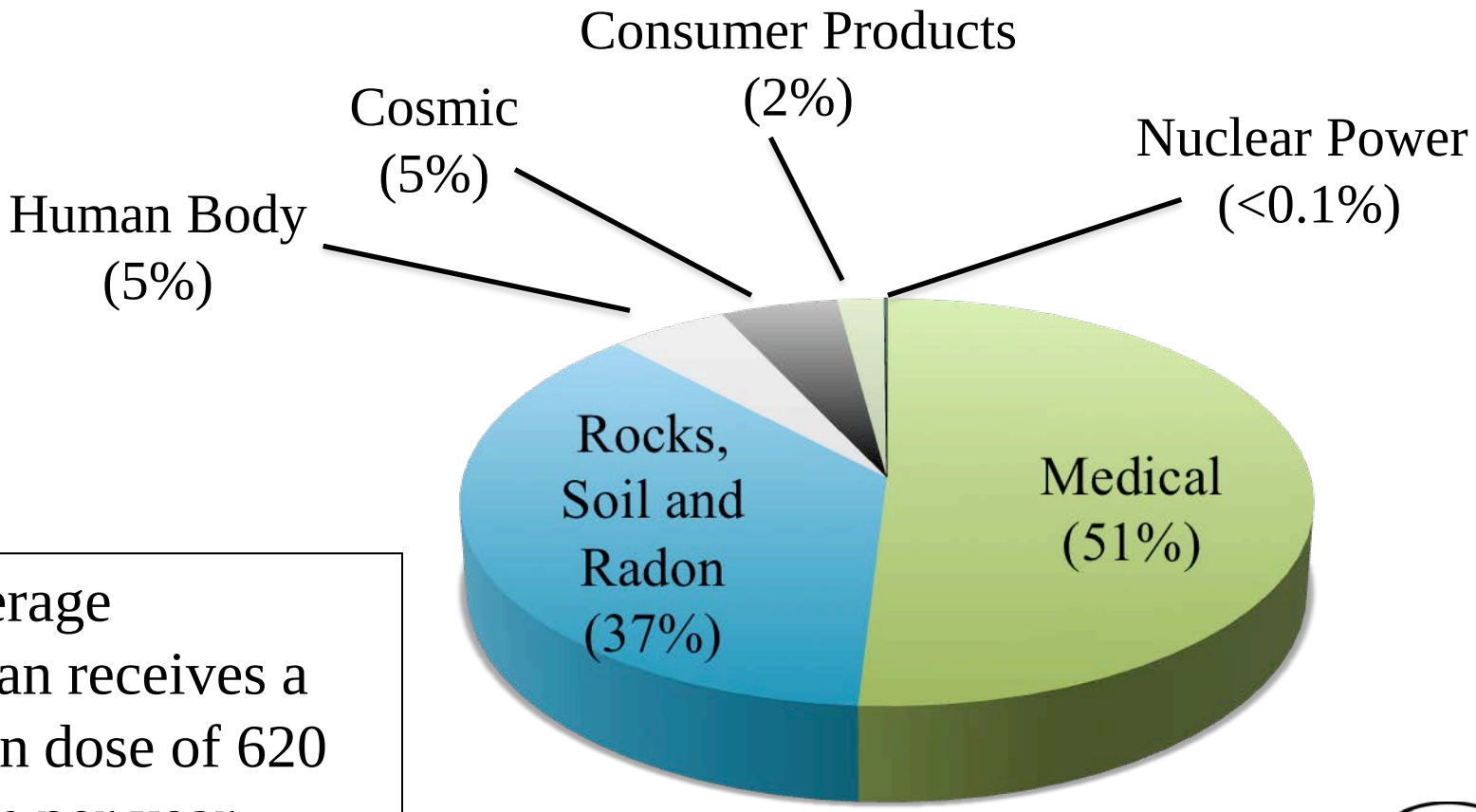


If radiation comes from atoms and everything is made of atoms, is there radiation around us right now?

But, of course!
It's called background radiation.

“Listen” to the background radiation with a Geiger counter.

Sources of average radiation dose in the US



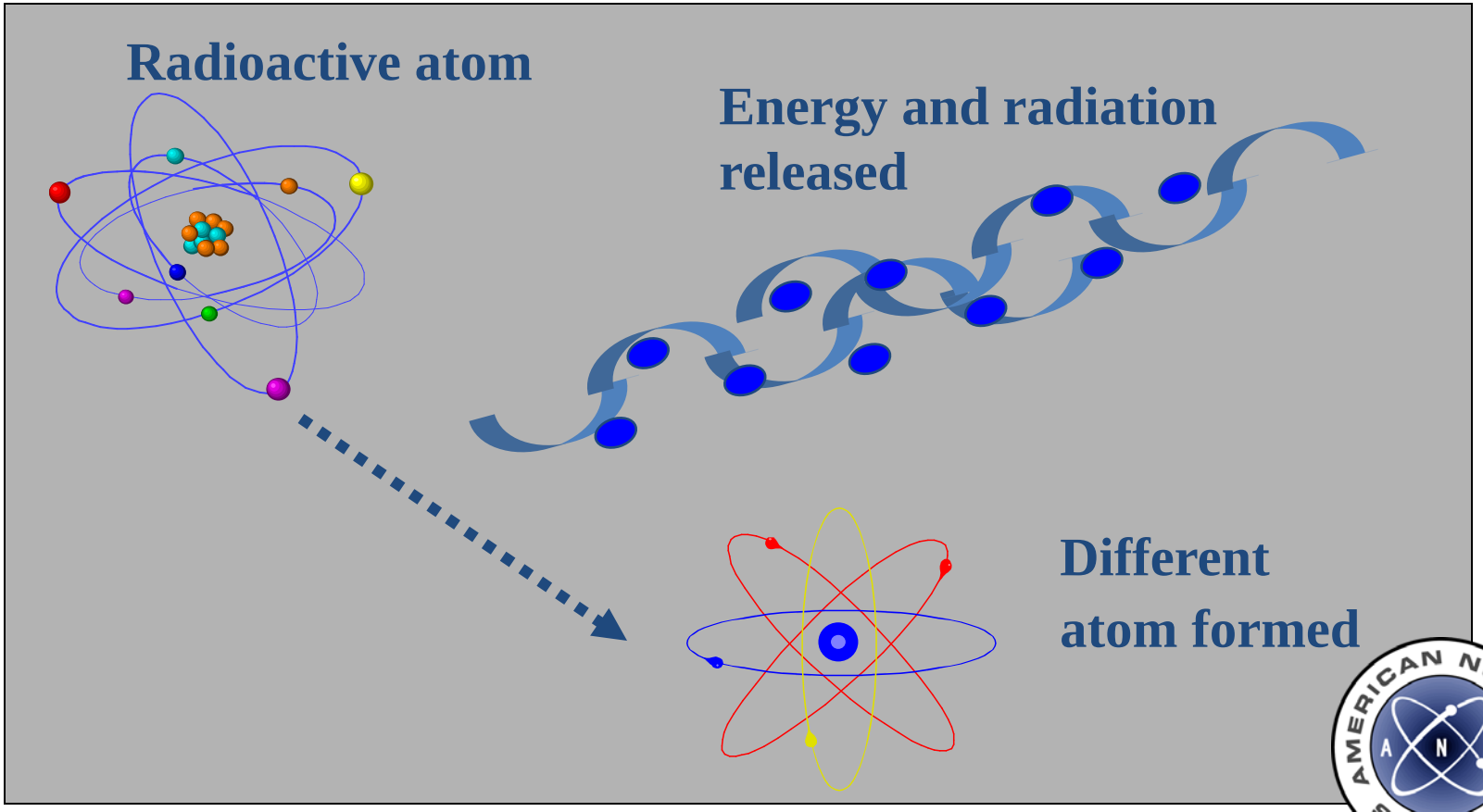
The average American receives a radiation dose of 620 millirem per year.

Source: National Council on Radiation Protection and Measurement Report 160 (2006)

What's radioactivity?

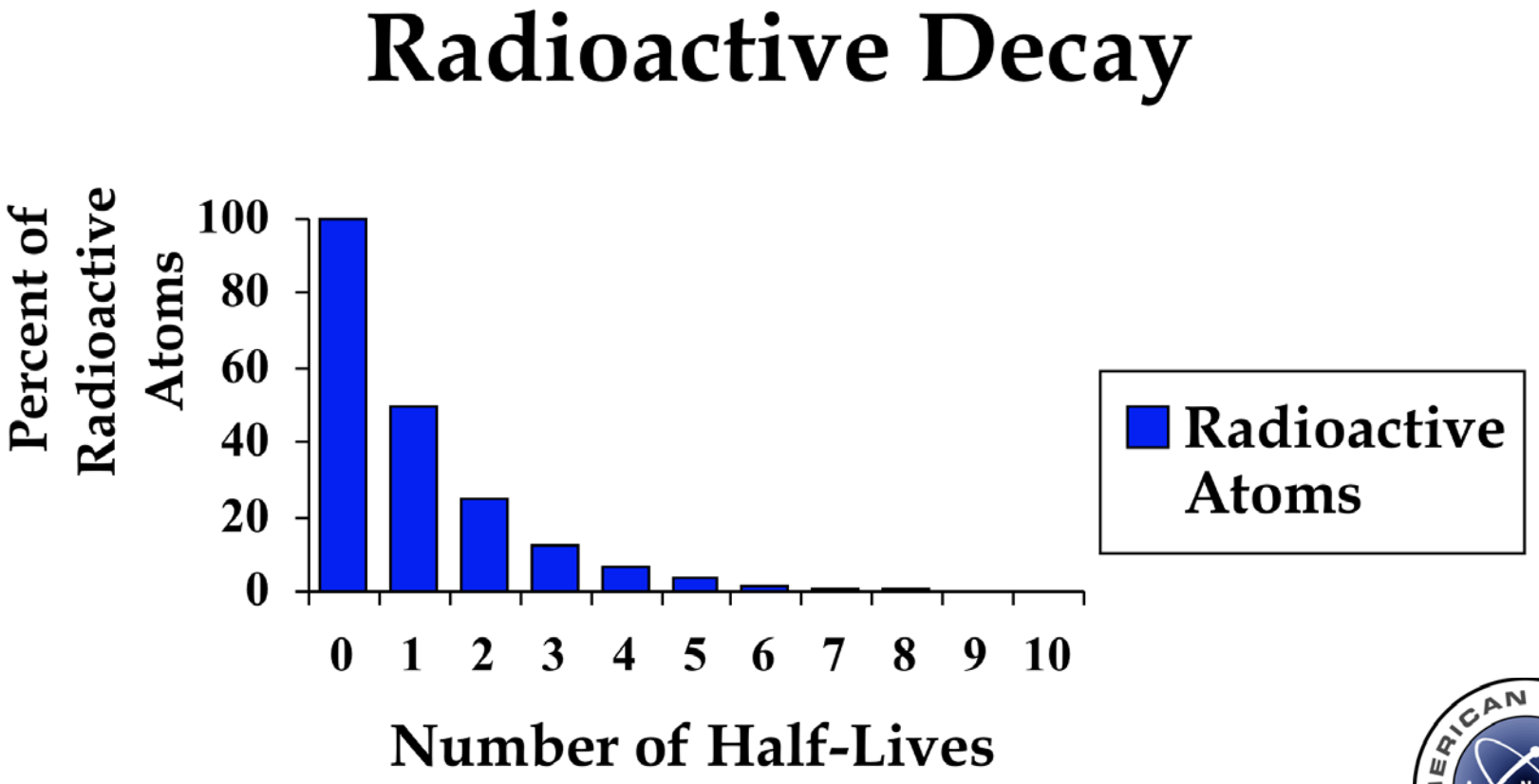
What is radioactivity?

The spontaneous emission of “fragments” or “bundles” of energy from energetic nuclei creating more stable nuclei.

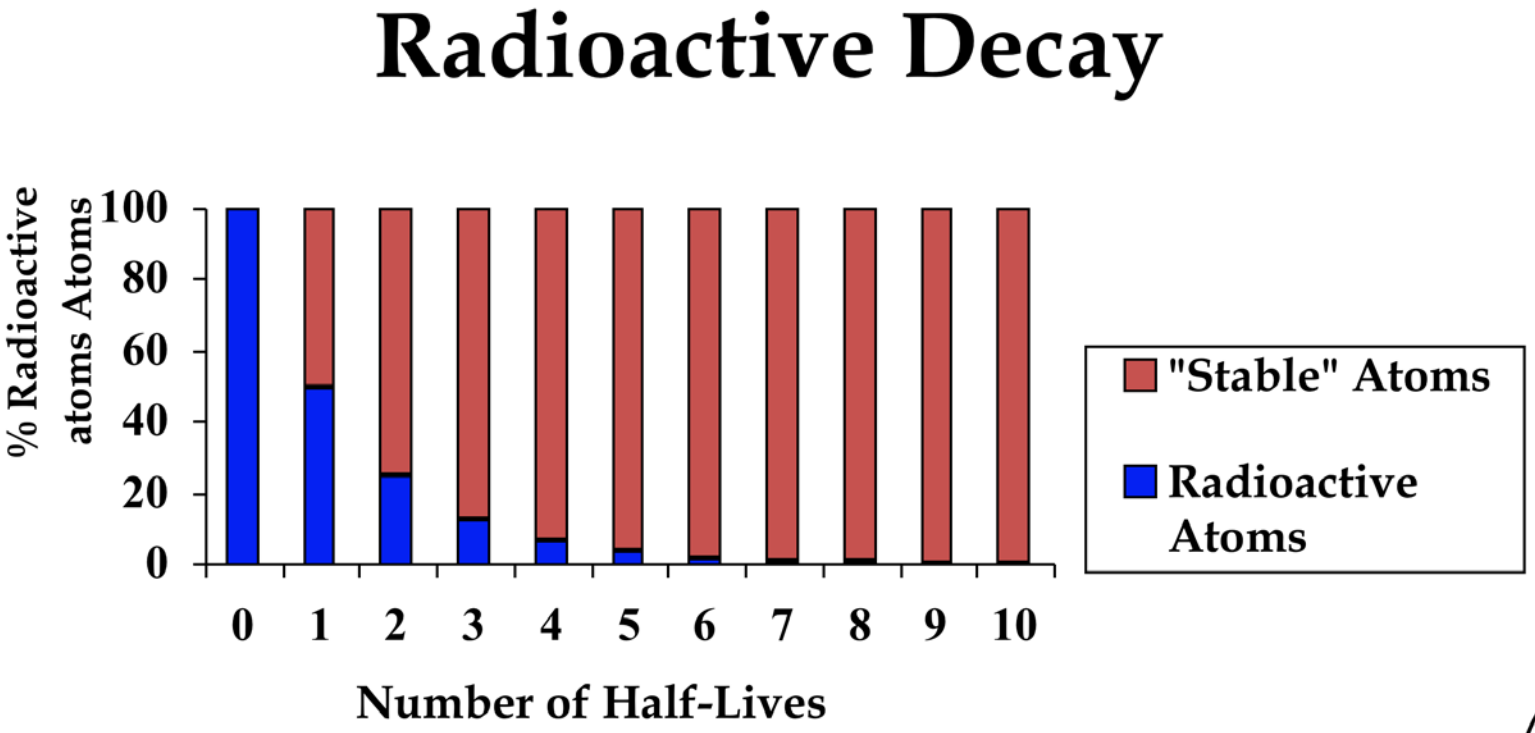


Radioactive atoms
emit *radiation*.

Half Life


Radioactive Decay
Percent of Radioactive Atoms
100
80
60
40
20
0
0 1 2 3 4 5 6 7 8 9 10
Number of Half-Lives
Radioactive Atoms

Half Life


Radioactive Decay
% Radioactive atoms Atoms
100
80
60
40
20
0
0 1 2 3 4 5 6 7 8 9 10
Number of Half-Lives
"Stable" Atoms
Radioactive Atoms

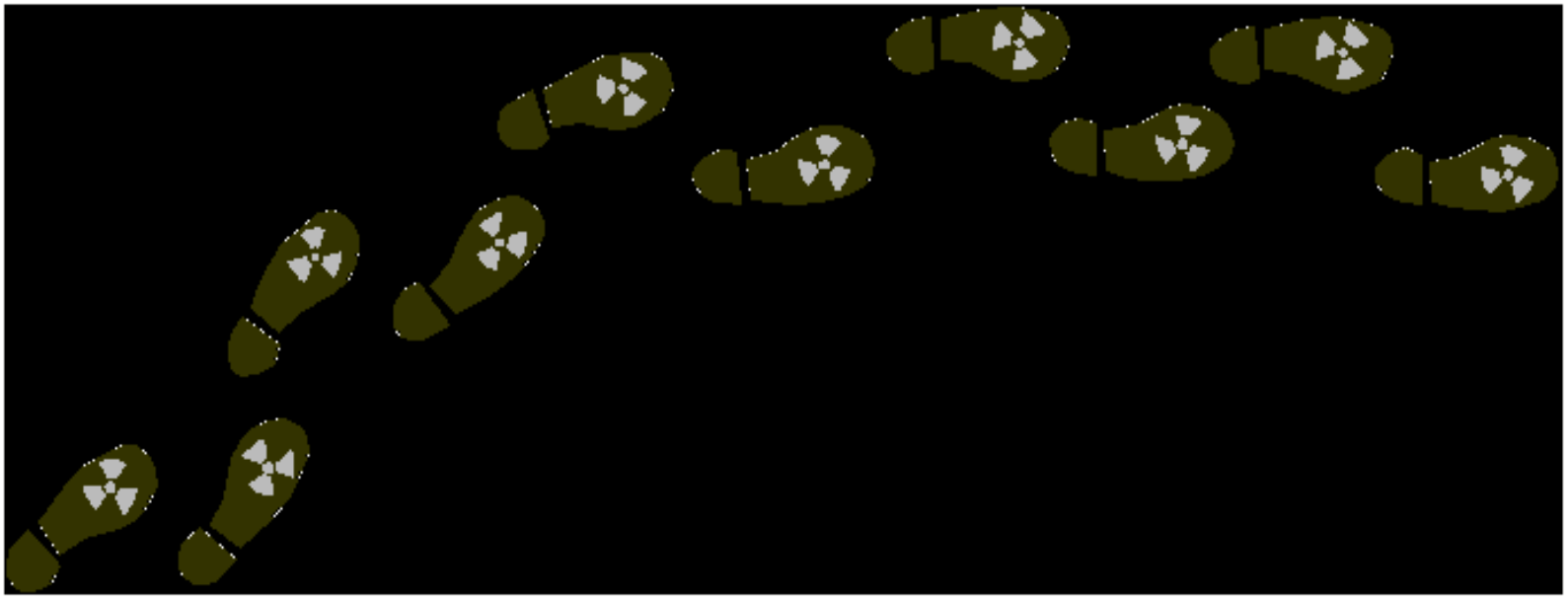
If I’m exposed to radiation, do I become (more) radioactive?

No!

You've been *irradiated*, exposed to radiation.

Which is not to be confused with . . .

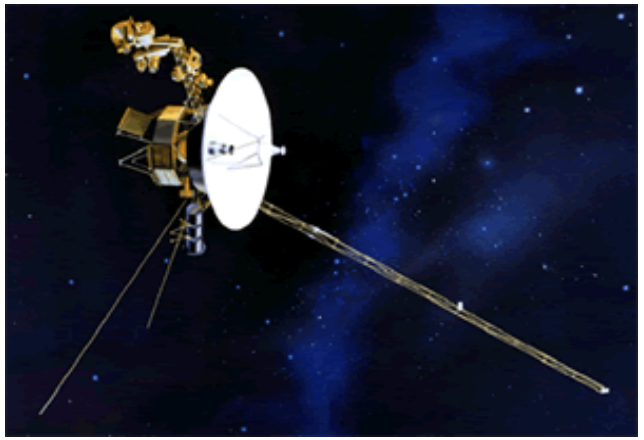
Radioactive Contamination



Radioactive Contamination is radioactive material in an unwanted place.

What are some applications of irradiation?

- Alpha radiation is used to
  - Power space probes



- Beta radiation is used for gauging
  - Thickness of aluminum during production

- Gamma radiation is used for
  - Preserving food, protecting from insects

Question...

How do we make a stable atom radioactive?

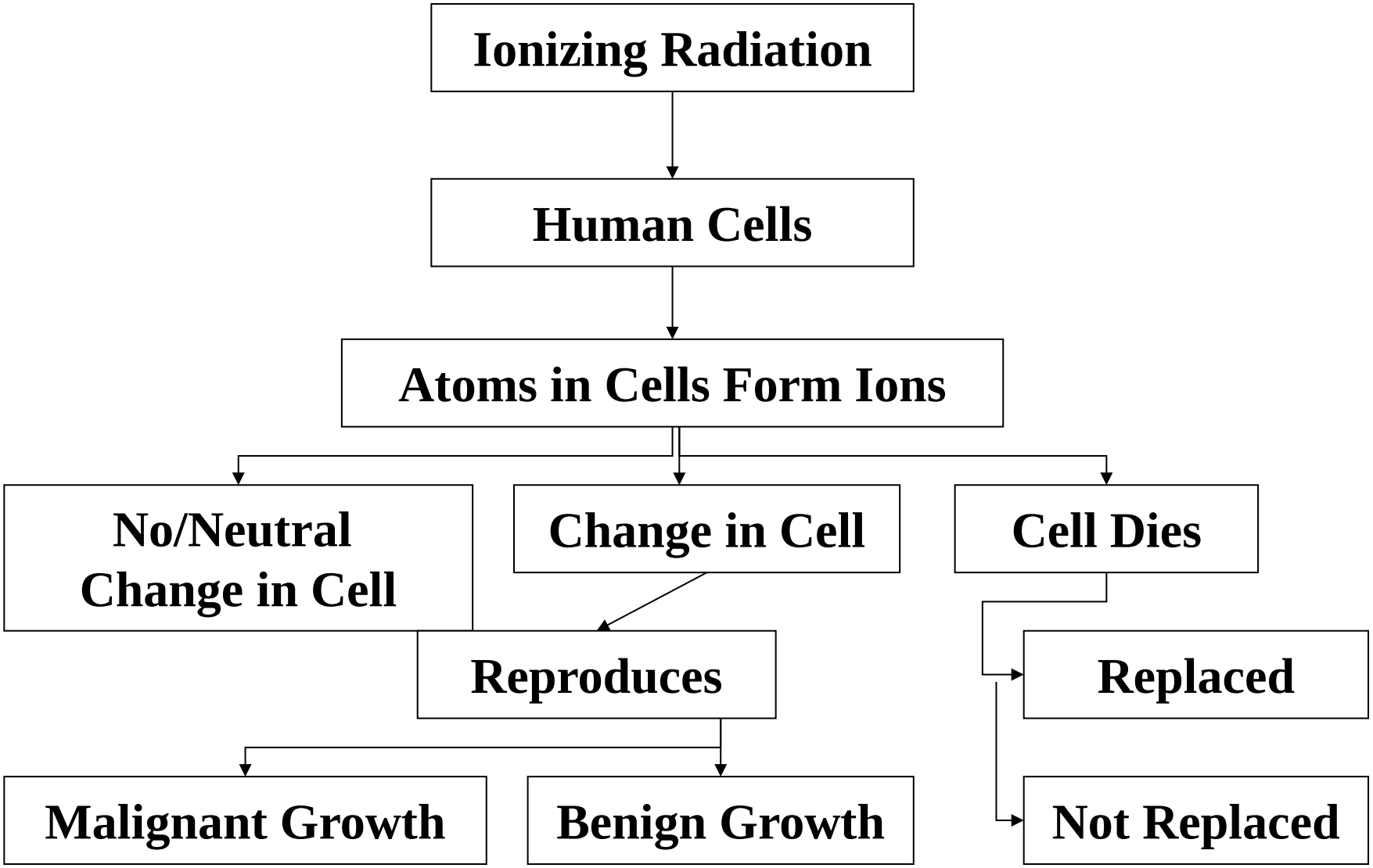
Answer...

- How do we make a stable atom radioactive?
  - By adding energy to the nucleus
  - This is done by adding a particle such as a neutron from a reactor or a high energy charged particle from an accelerator such as an electron or proton

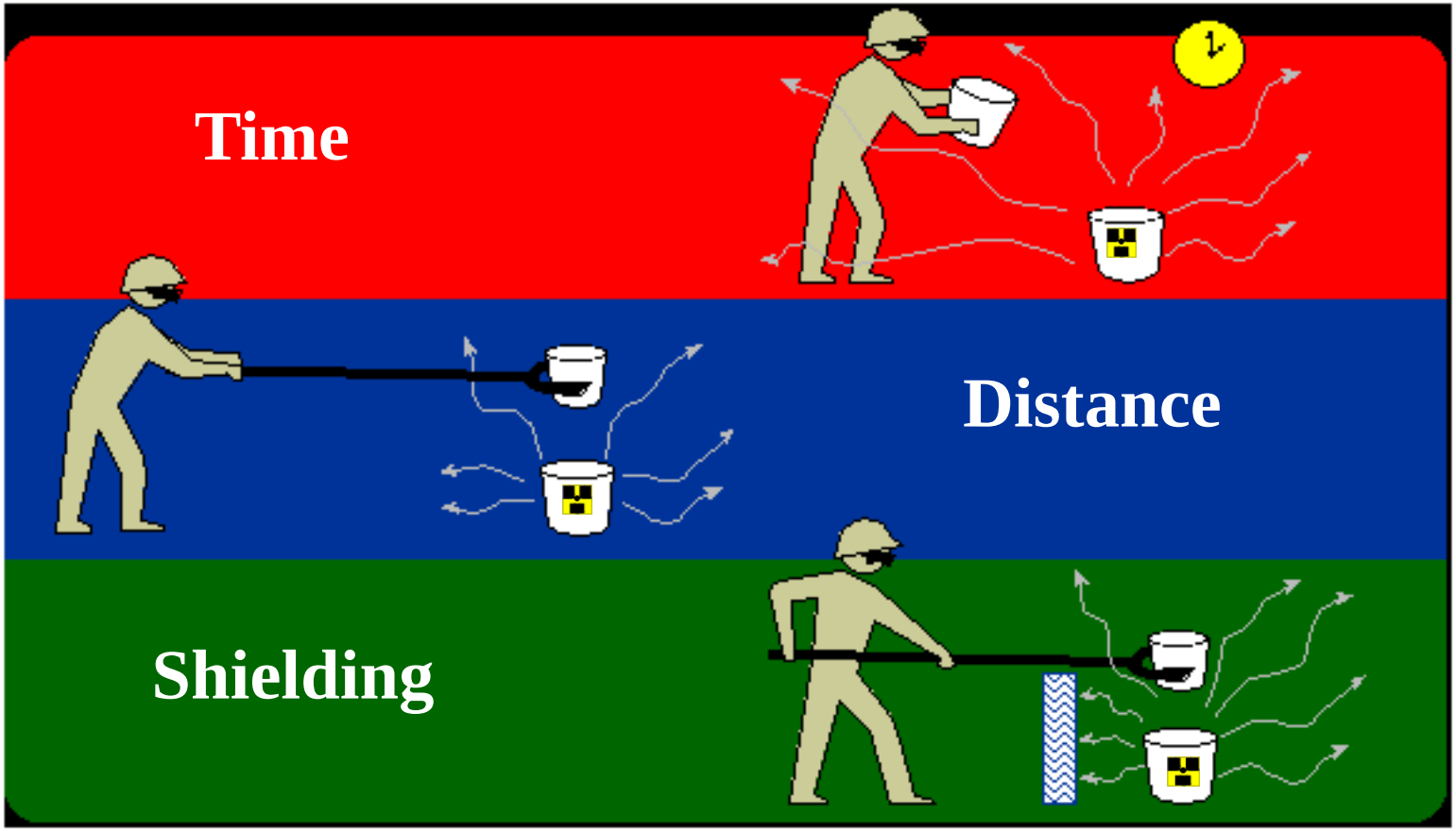
Question...

OK, so I don’t become radioactive from being irradiated, but are there other effects of radiation exposure?

What happens when you're exposed to radiation?



How do we protect ourselves?



How much is too much dose?

Perspective

Dose (mrem)	**Source**
1	Dental X-ray
25	Round trip flight to South Africa
40	Your body
110	Head and body CAT scan
620	Average dose in U.S.
5500	Average dose in Guarapari, Brazil
10,200	Average dose in Ramsar, Iran
0 – 25,000	No observable effect

Effects of Acute Whole-Body Radiation Doses

Dose (mrem)	Effect
0-25,000	No observable effect
25,000-100,000	Slight blood changes
100,000-200,000	Vomiting (5-50%) Moderate blood changes Full recovery within a few weeks
200,000-600,000	Vomiting (50-100%) Severe blood changes Hemorrhage, infections, hairloss Death (0-80%) within 2 mos. Survivors recover in 1 mo. to 1 yr.
600,000-1,000,000	Same as above Death (80-100%) within 2 mos.

Dose Limits in US Regulations

5000

(radiation workers)

&

100

(members of the public)

per year in milli-rem

(or *50* and *1* in milli-Sievert)

Some things to remember

- We live in a radioactive world
- Radiation (or things that generate radiation) are used to our benefit
- Nuclear power and other nuclear technologies are tightly regulated – very conservative limits are applied to limit doses

The End . . .