Introduction to Nuclear Science

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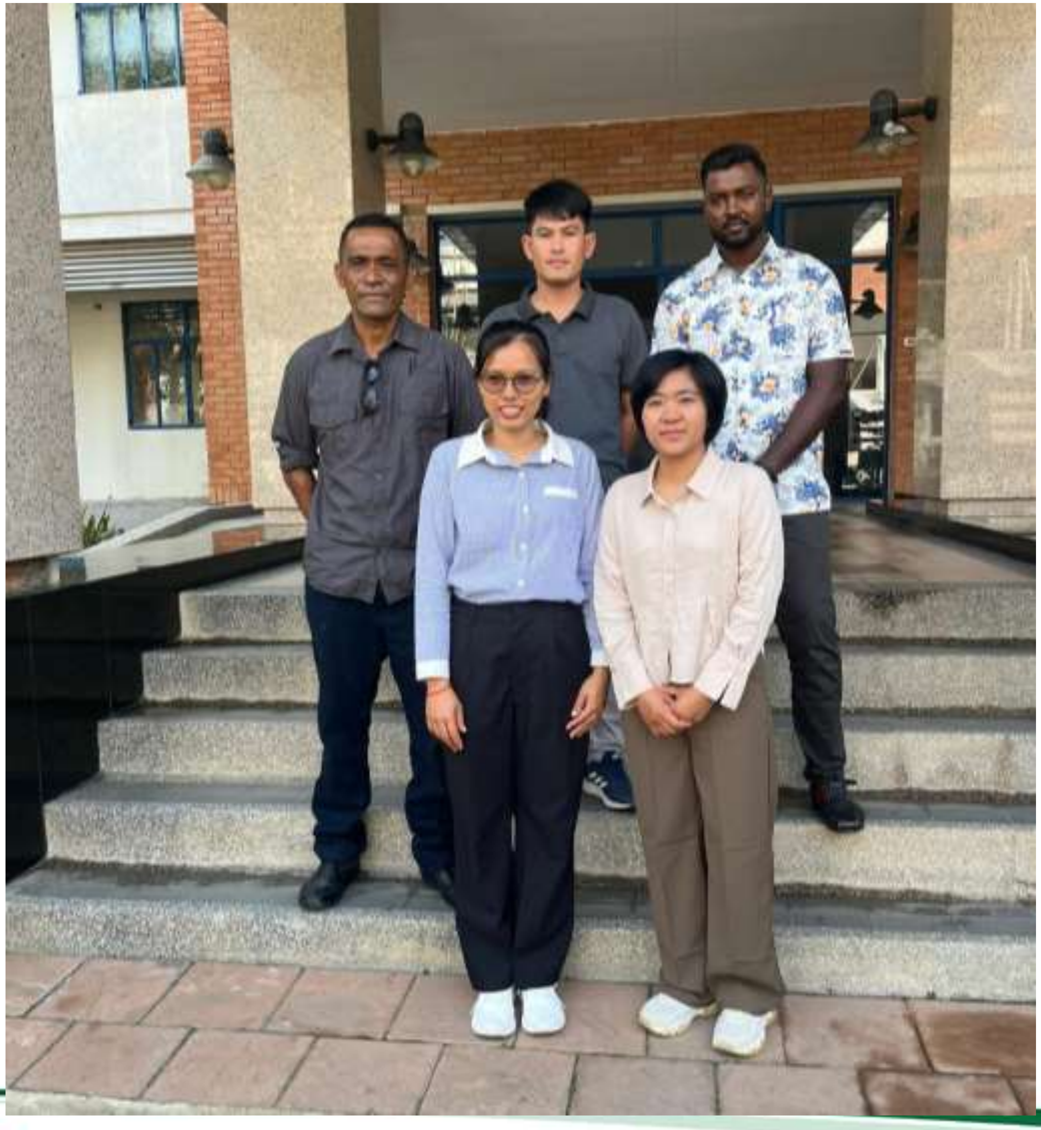
Nuclear Technology Research and Development Center
TINT

IAEA Fellowship Training on Plant Mutation Breeding
5 Feb 2025

Welcome to TINT



Fiji: Josese Tagivetaua
Fiji: Krushneel Chand
Cambodia: Heng Soknang
Myanmar: Zun Phoo Wai
Laos: Phousavanh Inthapanya

Instructor intro

- Roppon Picha
- Position: Head of Agriculture and Food Technology (หัวหน้าฝ่ายเทคโนโลยีเกษตรและอาหาร)
- Nuclear Technology Research and Development Center (ศูนย์วิจัยและพัฒนาเทคโนโลยีนิวเคลียร์)
- Thailand Institute of Nuclear Technology (สถาบันเทคโนโลยีนิวเคลียร์แห่งชาติ)
- Background: M.S. and Ph.D. in Physics at UC Davis, US
- Current work: management of agriculture and food research, including food irradiation, food provenance study, plant mutation breeding, and sterile insect technique.

R&D

Agriculture and Food Research at TINT

แมลง

(SIT)

ปรับปรุงพันธุ์พืช

(Plant Mutation)

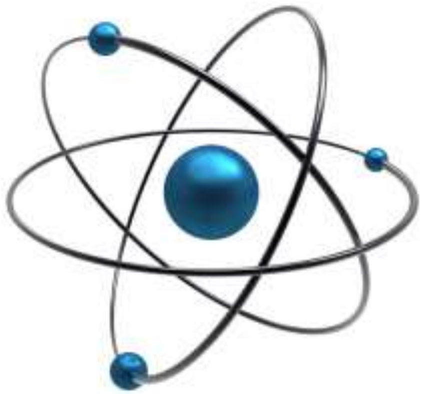
อาหารฉายรังสี

(Food Irradiation)

ตรวจพิสูจน์อาหาร

(Food Authentication)

Outline



Basics

Measurement

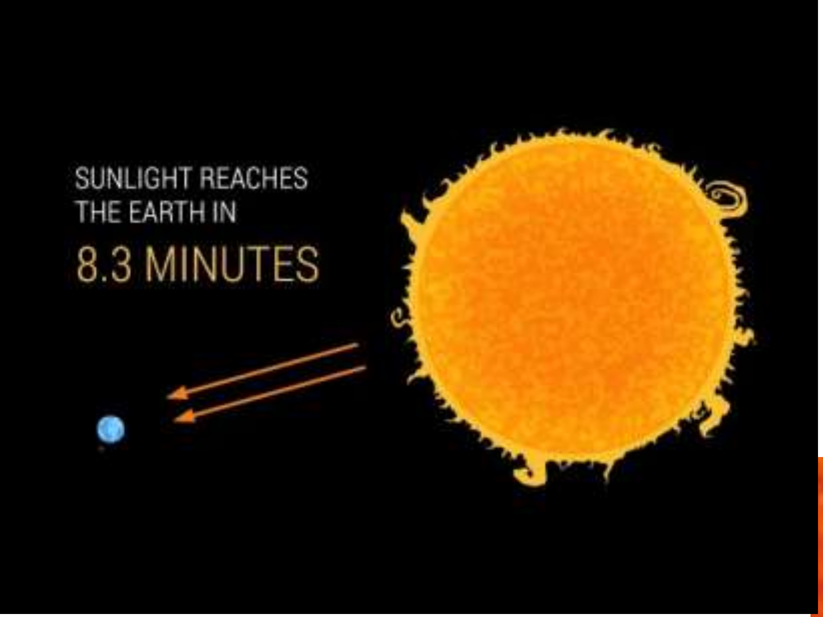
Applications

Basic Nuclear Physics

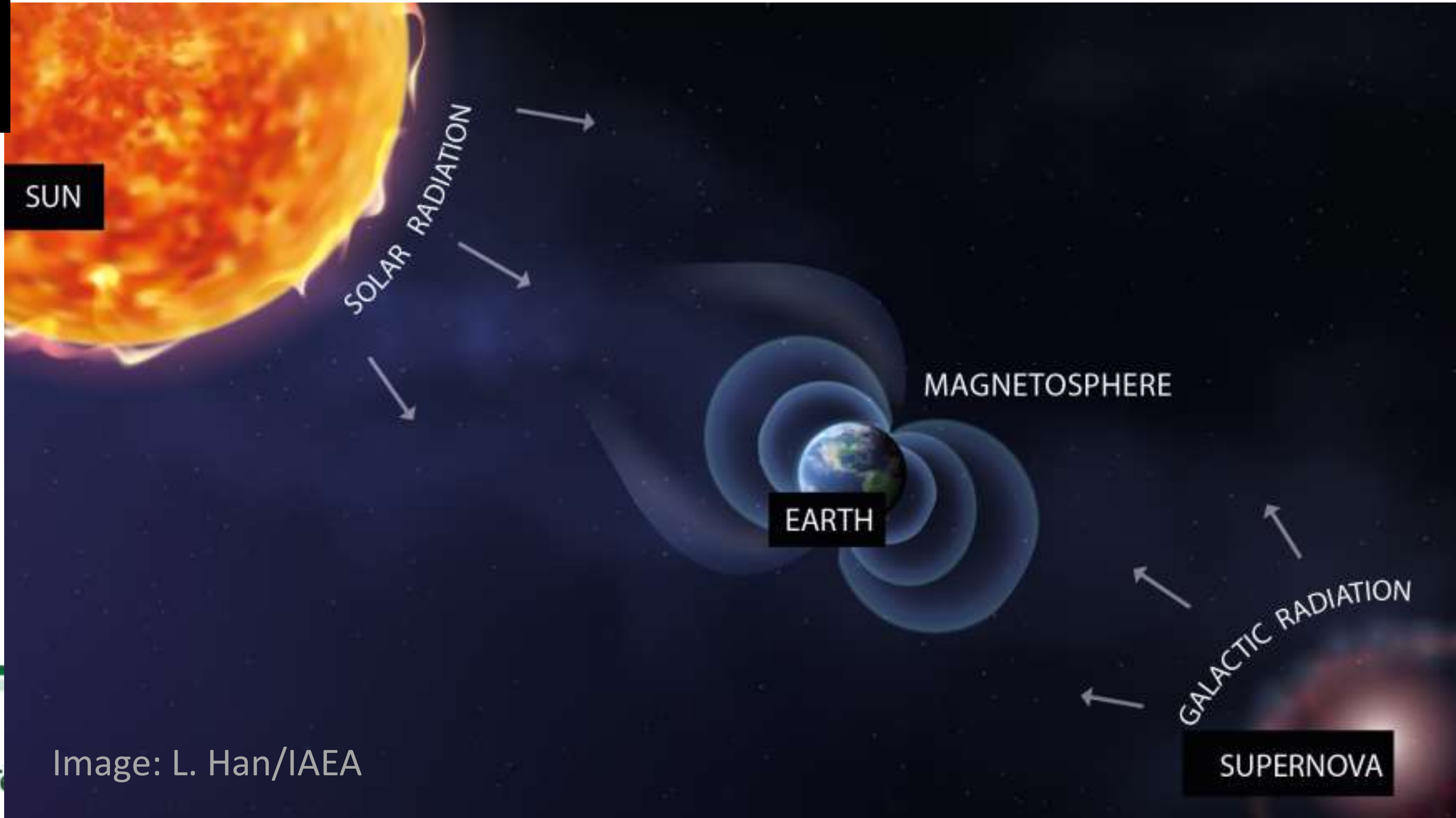
What is “nuclear”?

Radiation

is part of our lives. It is natural and exists long before we were born.

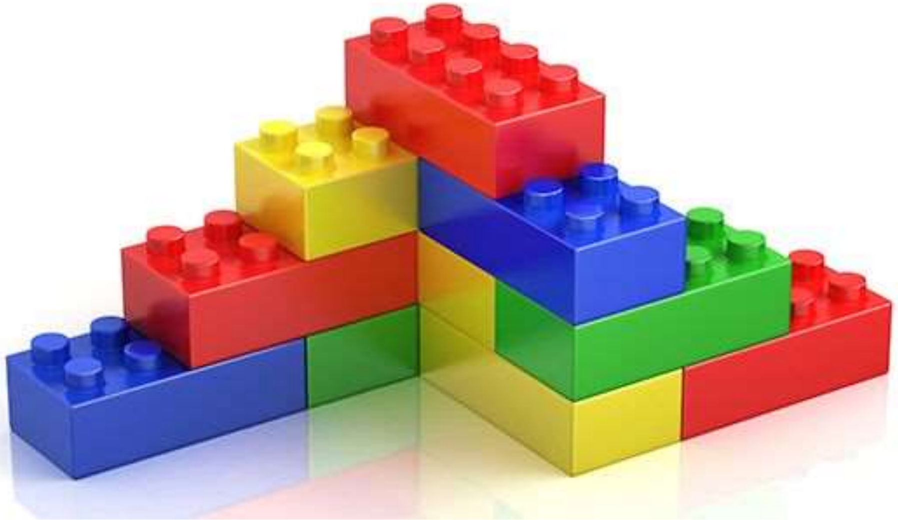


Cosmic radiation, mostly consisting of protons, can come from the sun or from other galaxies.

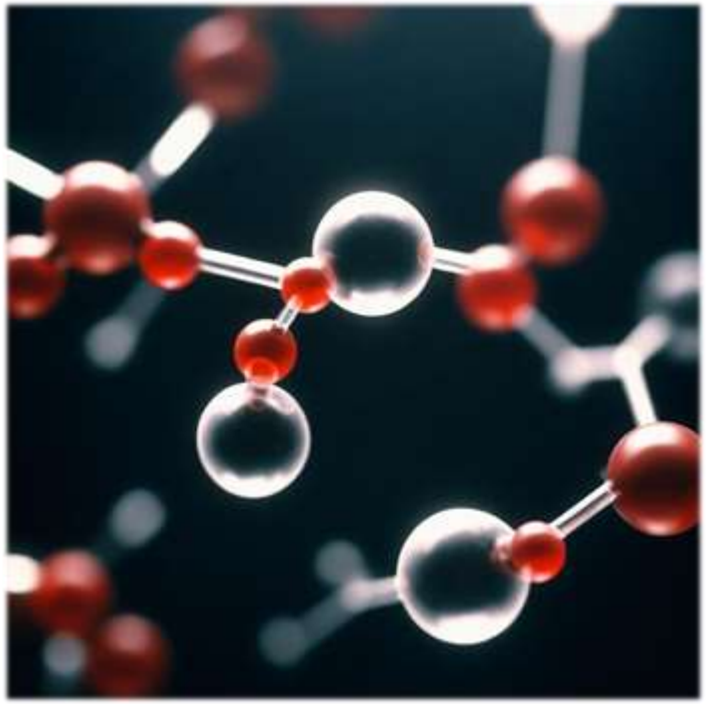


Physics of Nucleus

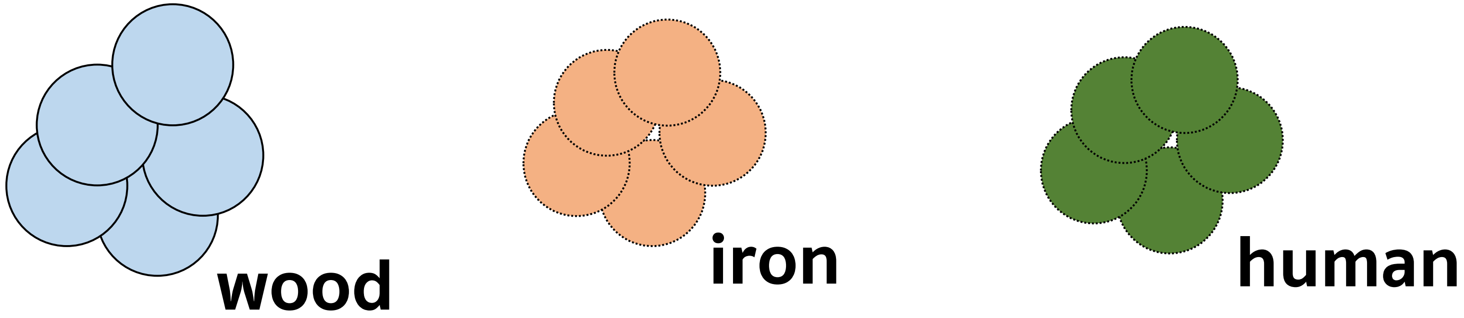
- What are the building blocks of all things?



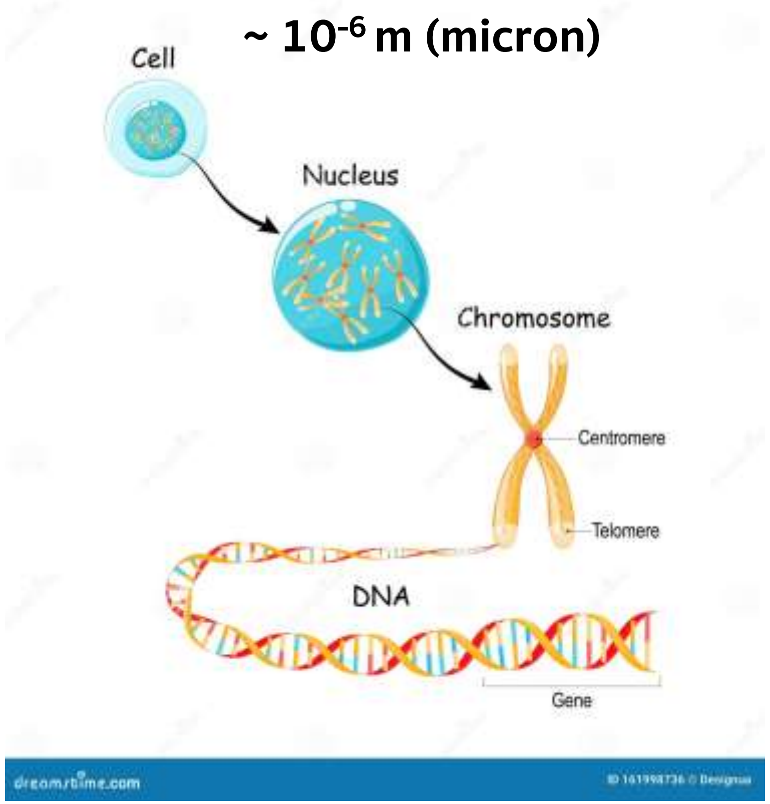
Democritus
5th century BC



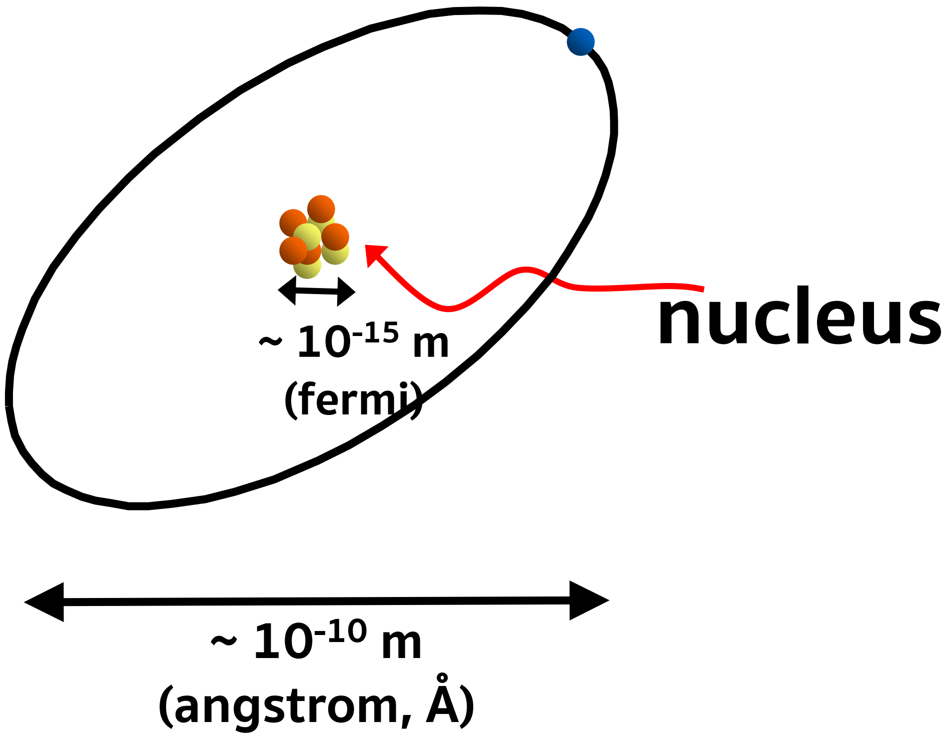
Greeks' *atomos*: uncuttable particles



Nucleus



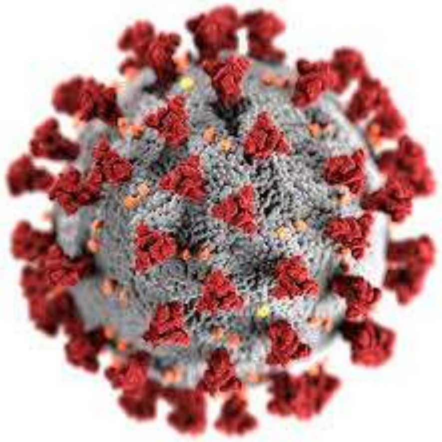
Biology

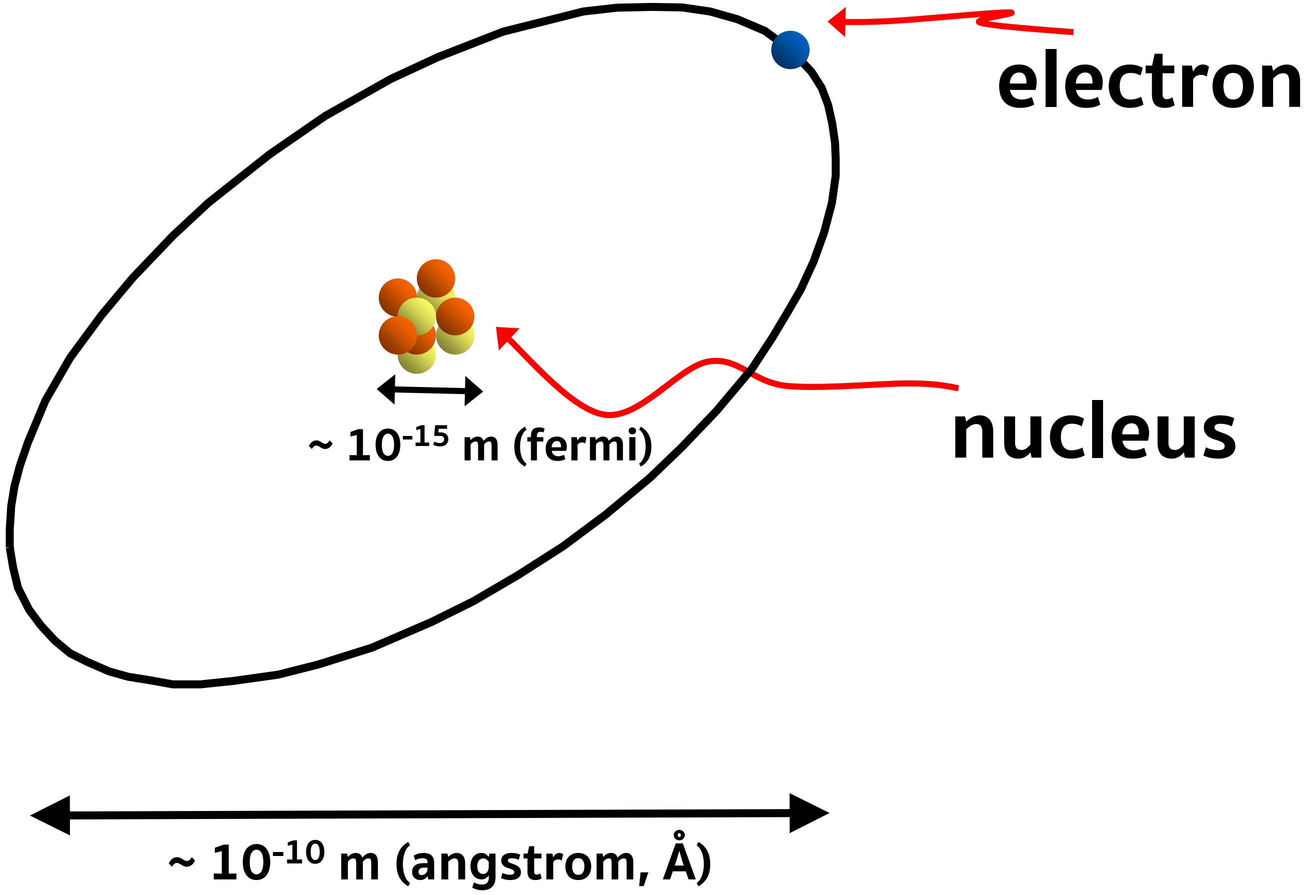


Physics

COVID-19 virus

Diameter: ≈100 nm
Volume: ~10^6 nm^3 = 10^{-3} fL
Mass: ~10^3 MDa ≈ 1 fg



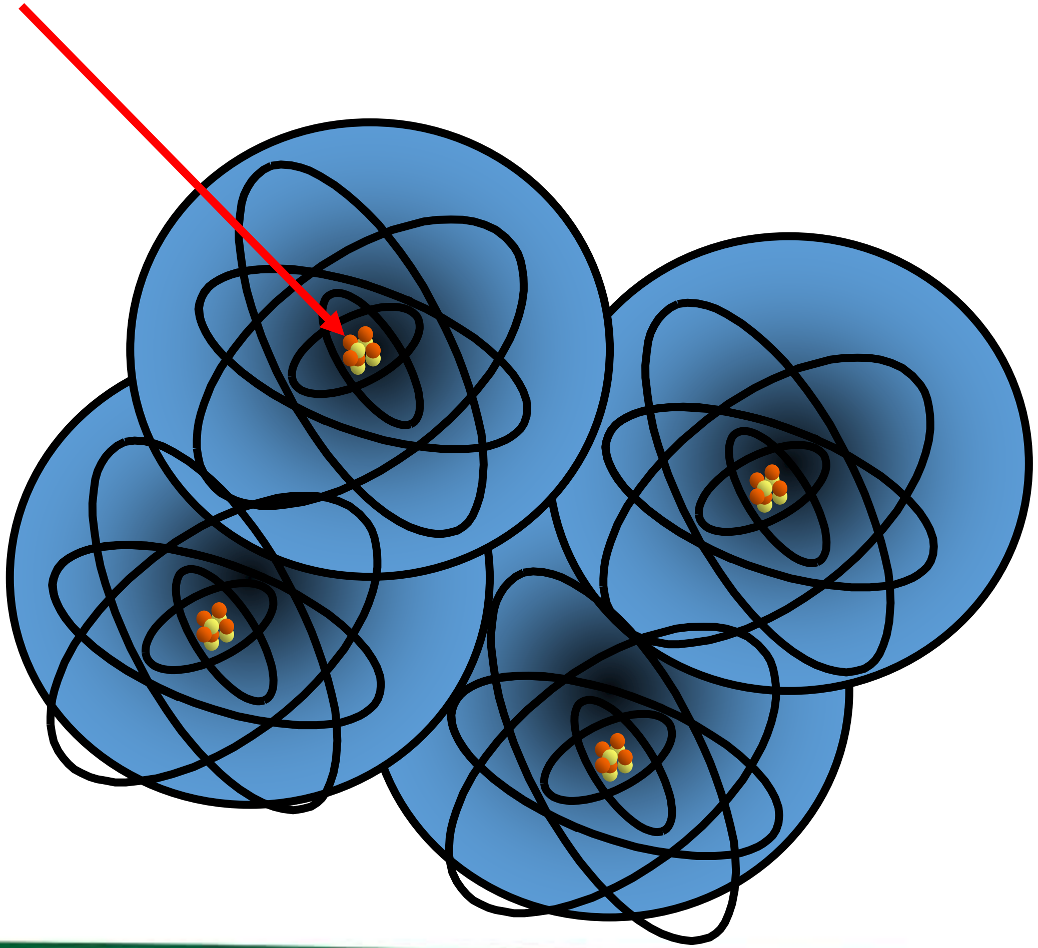


Periodic Table of the Elements

1 H Hydrogen 1.008																	2 He Helium 4.003
3 Li Lithium 6.941	4 Be Beryllium 9.012											5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180
11 Na Sodium 22.990	12 Mg Magnesium 24.305											13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.066	17 Cl Chlorine 35.453	18 Ar Argon 39.948
19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.867	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.845	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.723	32 Ge Germanium 72.631	33 As Arsenic 74.922	34 Se Selenium 78.972	35 Br Bromine 79.904	36 Kr Krypton 84.798
37 Rb Rubidium 85.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.95	43 Tc Technetium 98.907	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.906	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.711	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.904	54 Xe Xenon 131.294
55 Cs Cesium 132.905	56 Ba Barium 137.328	57-71	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.84	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.217	78 Pt Platinum 195.085	79 Au Gold 196.967	80 Hg Mercury 200.592	81 Tl Thallium 204.383	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium [208.982]	85 At Astatine 209.987	86 Rn Radon 222.018
87 Fr Francium 223.020	88 Ra Radium 226.025	89-103	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [269]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [269]	111 Rg Roentgenium [272]	112 Cn Copernicium [277]	113 Nh Nihonium unknown	114 Fl Flerovium [289]	115 Mc Moscovium unknown	116 Lv Livermorium [298]	117 Ts Tennessine unknown	118 Og Oganesson unknown
		57 La Lanthanum 138.905	58 Ce Cerium 140.116	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.242	61 Pm Promethium 144.913	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.500	67 Ho Holmium 164.930	68 Er Erbium 167.259	69 Tm Thulium 168.934	70 Yb Ytterbium 173.055	71 Lu Lutetium 174.967	
		89 Ac Actinium 227.028	90 Th Thorium 232.038	91 Pa Protactinium 231.036	92 U Uranium 238.029	93 Np Neptunium 237.048	94 Pu Plutonium 244.064	95 Am Americium 243.061	96 Cm Curium 247.070	97 Bk Berkelium 247.070	98 Cf Californium 251.080	99 Es Einsteinium [254]	100 Fm Fermium 257.095	101 Md Mendelevium 258.1	102 No Nobelium 259.101	103 Lr Lawrencium [262]	

Alkali Metal | Alkaline Earth | Transition Metal | Basic Metal | Semimetal | Nonmetal | Halogen | Noble Gas | Lanthanide | Actinide

over 99% mass of the atom



- **Nuclear physics** = the science involving the heart of the atom
- **Nucleus** = the tiny, super-dense core that holds a mind-boggling amount of energy.

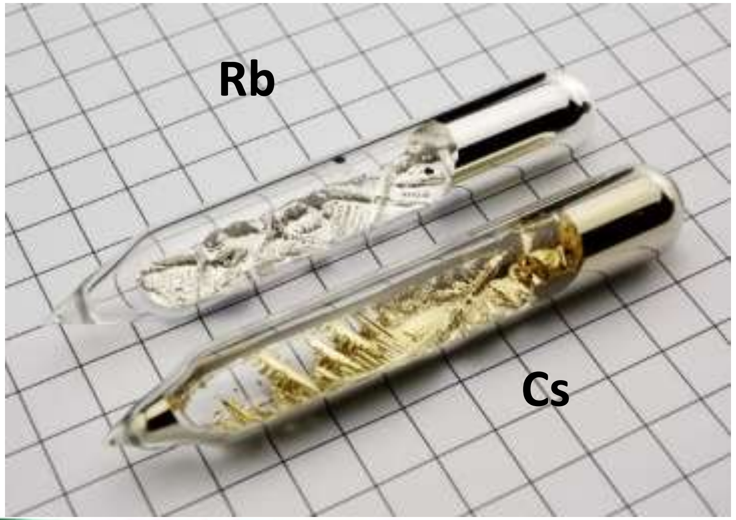
Nuclide symbol

Mass number = p + n → A

$^{A}_{Z}X$ ← Name

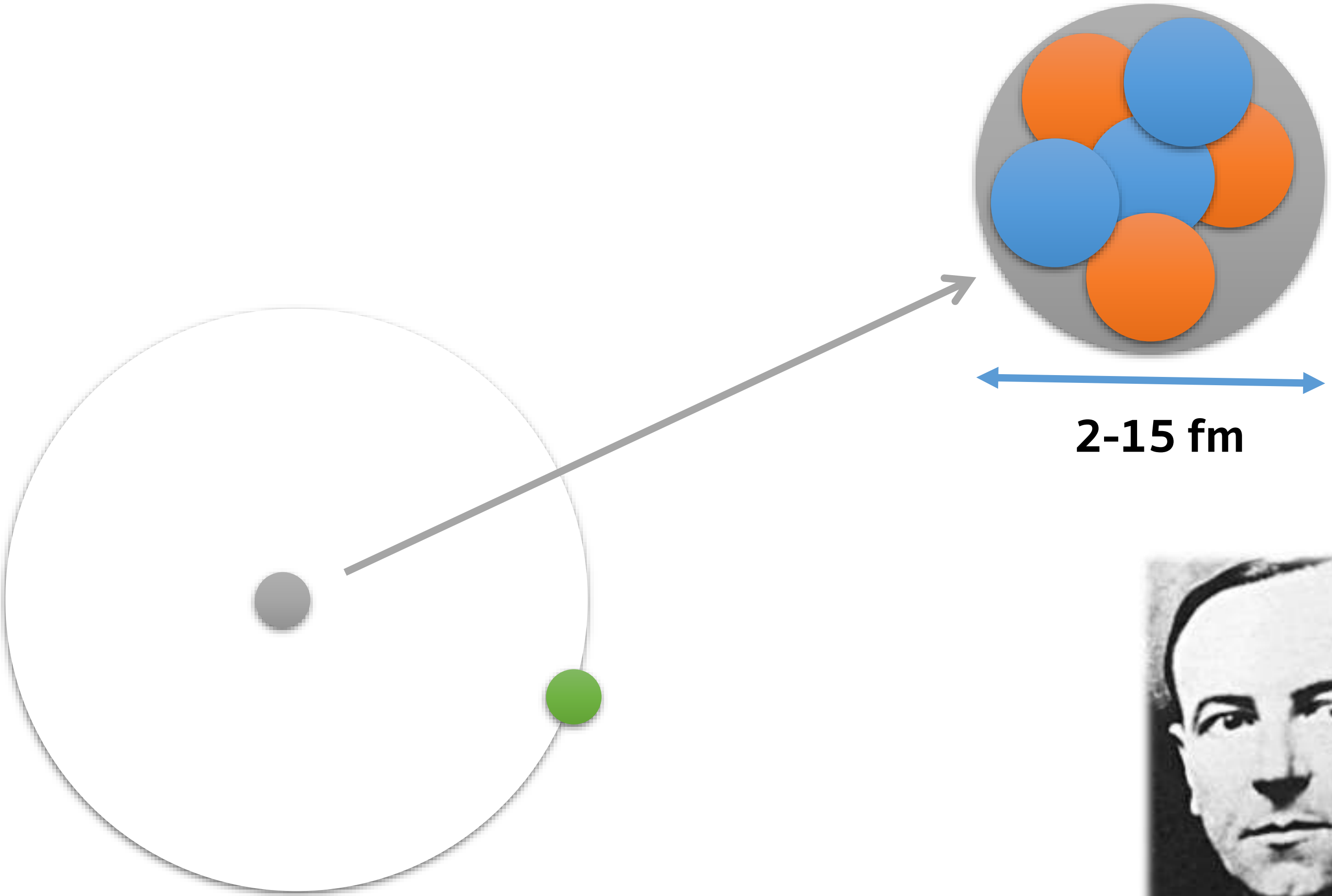
Atomic number = p → Z

$^{87}_{37}\mathrm{Rb}$



Nuclear Science

stable / radioactive



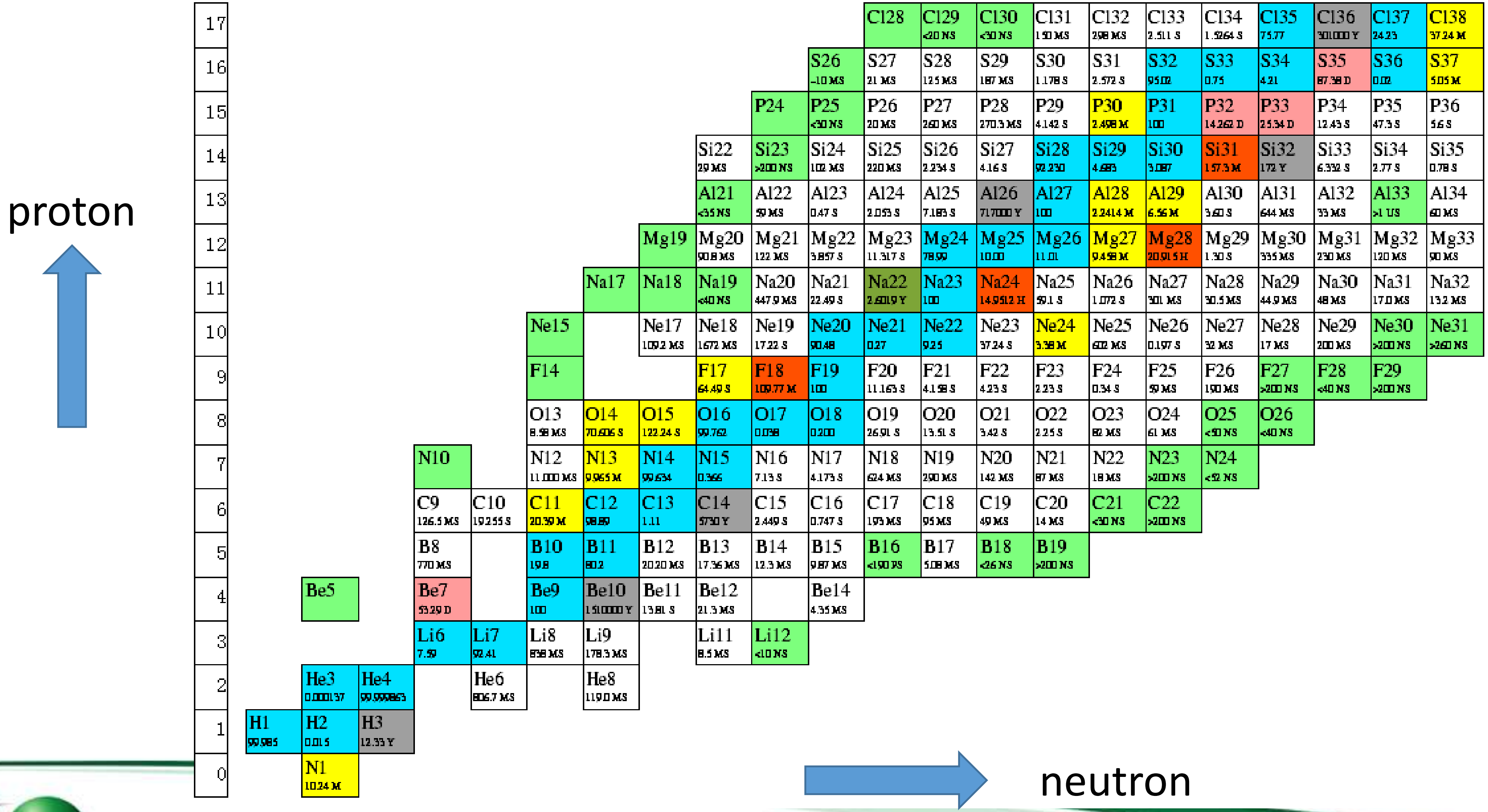
E. Rutherford

$^{4}He + {}^{14}N \rightarrow {}^{17}O + {}^{1}p$

J. Chadwick

$^{4}He + {}^{9}Be \rightarrow {}^{12}C + {}^{1}n$

Chart of nuclides



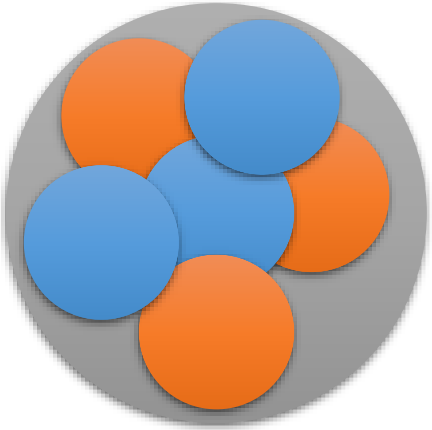
Fission and Fusion

Nuclear fission is like breaking apart those tiny Lego bricks and releasing a tsunami of energy in the process.

Nuclear fusion is where atoms join forces to create even more energy, which is the process that powers the sun.

Nuclear Energy

Nucleus is a very dense source of energy.

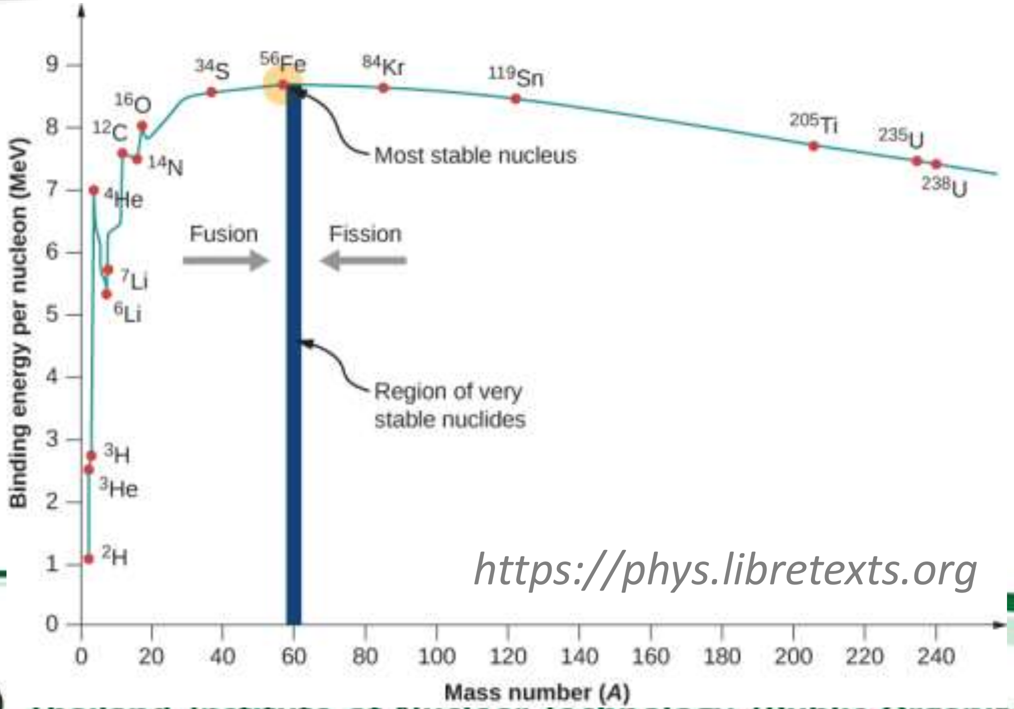


Nuclear bond ~ few MeV/bond

- fission ~ 180 MeV/reaction
- fusion ~ 18 MeV/reaction
- decay (radiate)

Chemical bond ~ few eV/bond

- Gas burning ~ 9 eV/reaction



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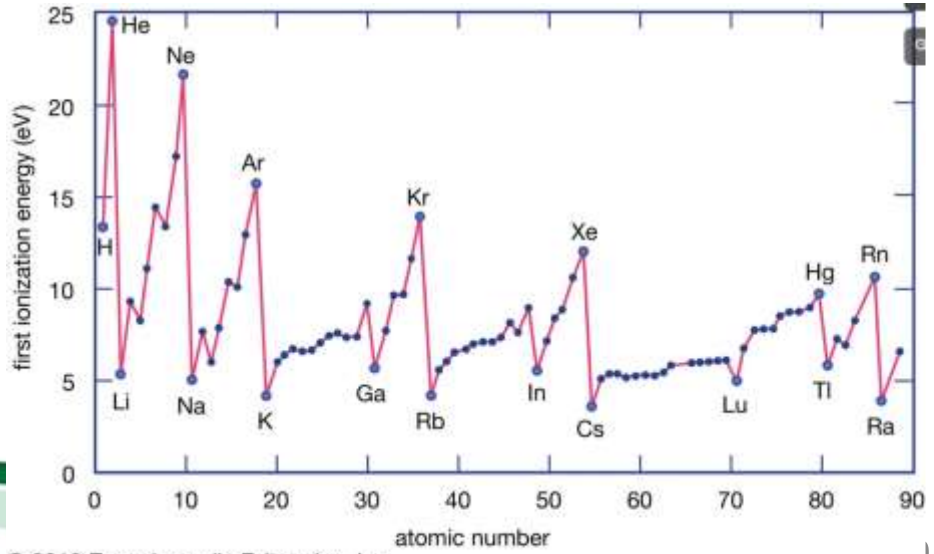
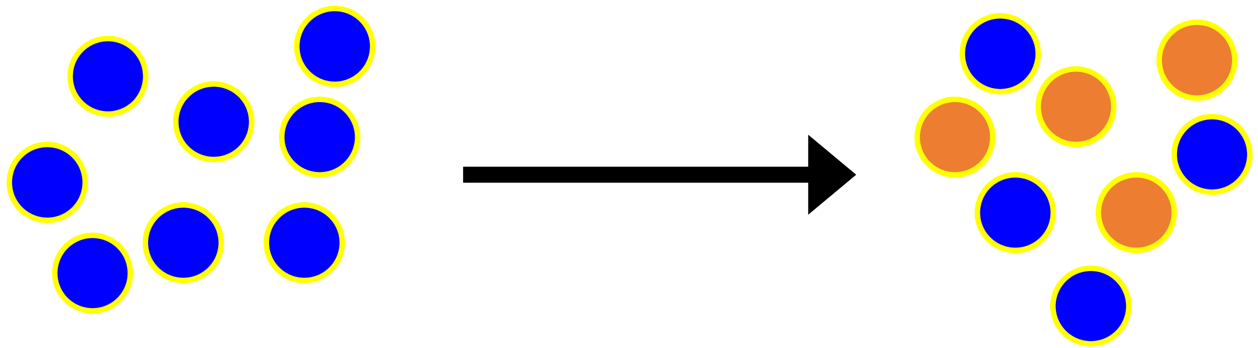


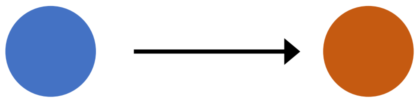
Decay law

Decay rate (dN/dt) is directly proportional to the number of radionuclides (N)

Each radionuclide has a characteristic half-life ($t_{1/2}$)



Decay Law



$$dN/dt = -\lambda N$$

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

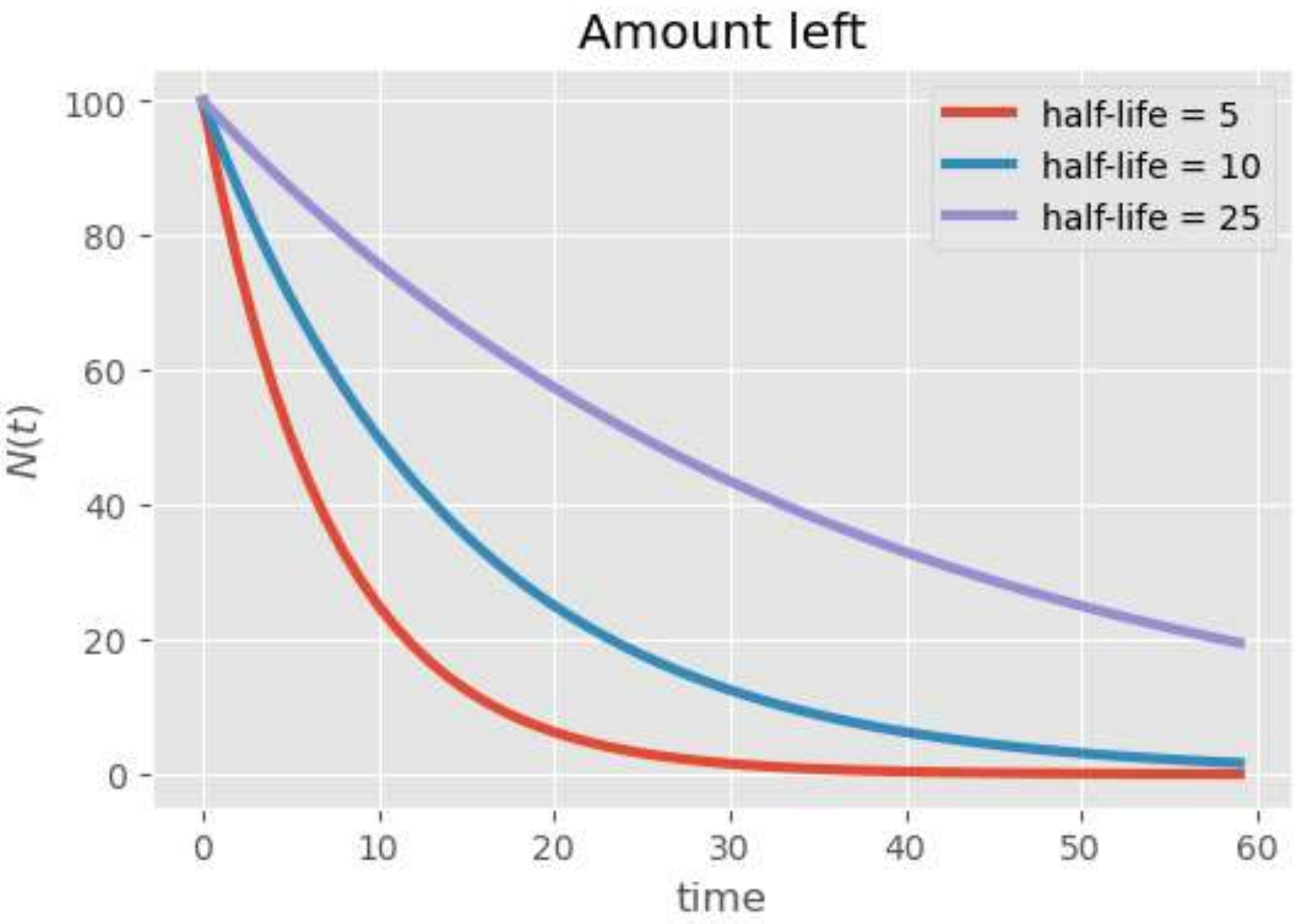
N = number of nuclides at time t

N_0 = initial number of nuclides ($t = 0$)

λ = decay constant

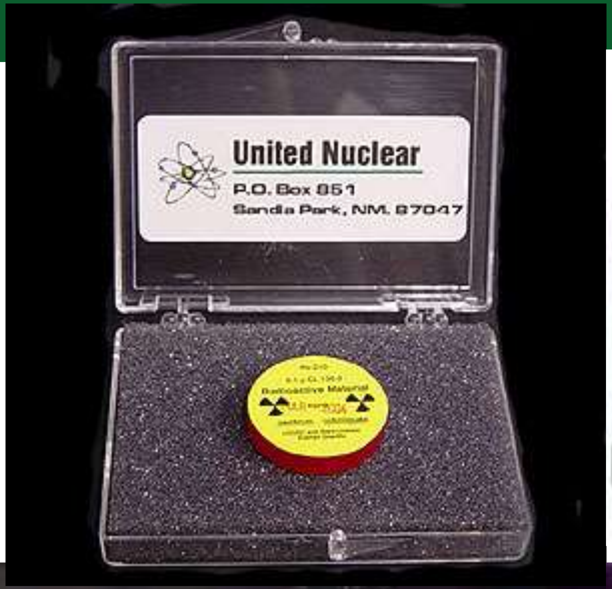
$$\lambda = \ln 2/t_{1/2} = 0.693/t_{1/2}$$

$t_{1/2}$ = half-life


Amount left
100
80
60
40
20
0
N(t)
0
10
20
30
40
50
60
time
half-life = 5
half-life = 10
half-life = 25

Radiation source types

Sealed:
Radioisotope is prevented from dispersing.

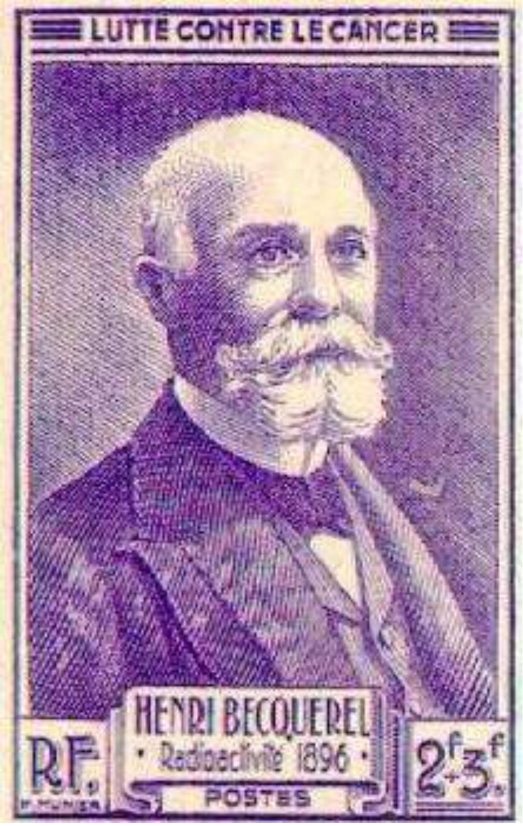


Unsealed:
Radioisotope can disperse. Examples are tracers in industrial and medical settings.

Measurement and Protection

How to measure radiation

1 becquerel (Bq) = 1 decay/sec



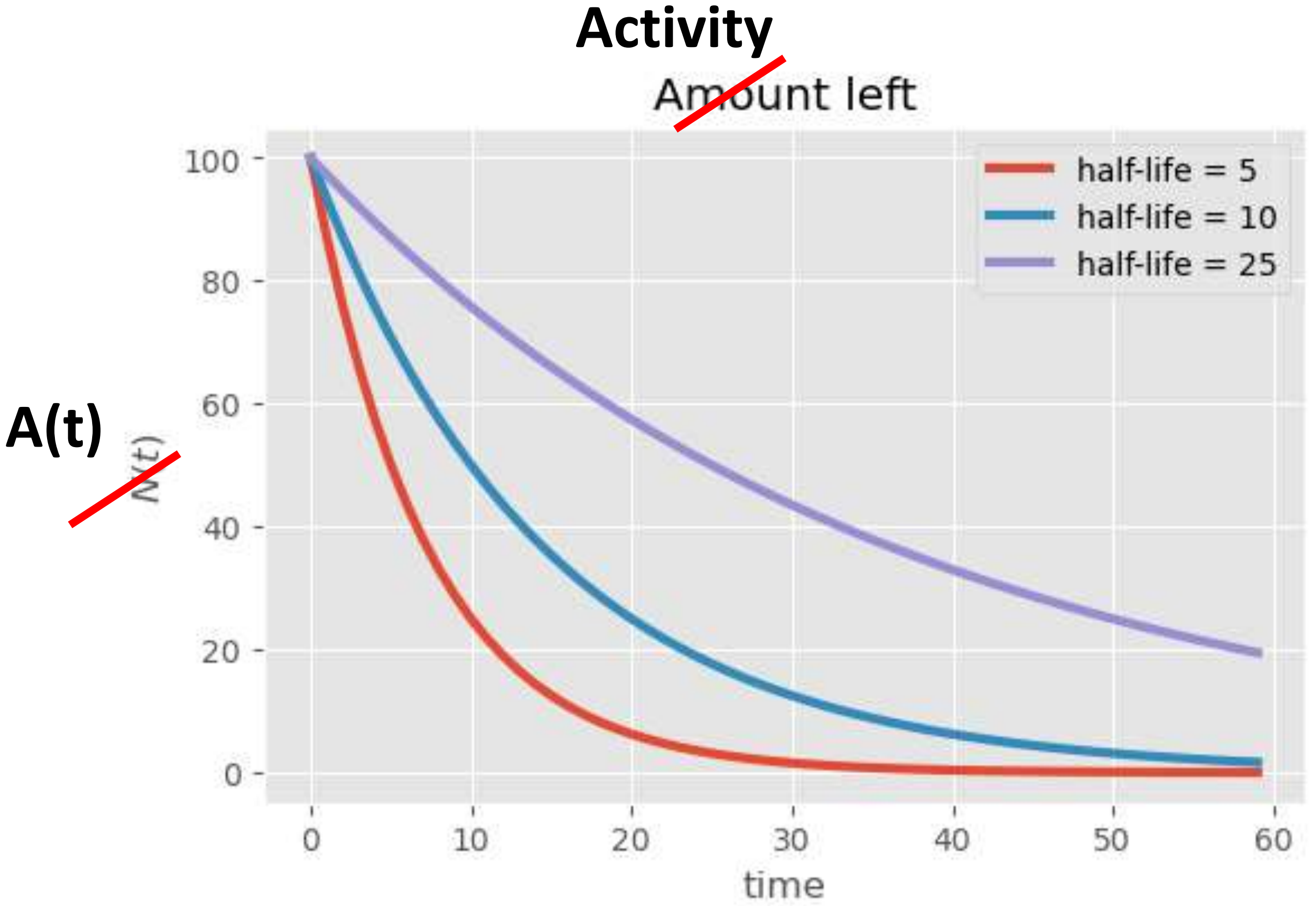
Henri Becquerel

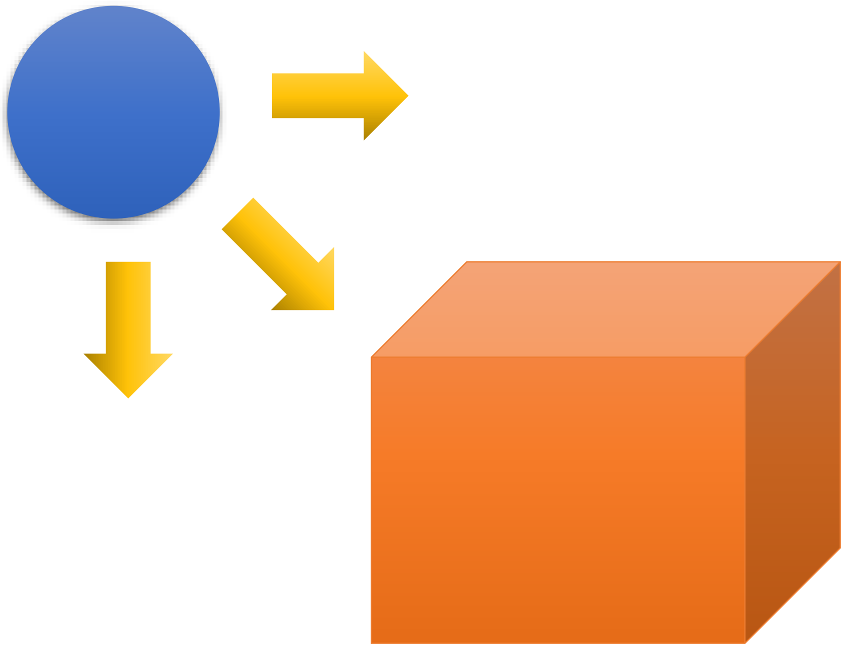
Pierre and Marie Curie

$1\ Ci = 3.7x\ 10^{10}\ Bq$

Activity = decay intensity

$$A(t) = \lambda N(t) = A_0 e^{-\lambda t}$$





Absorbed dose = Energy deposited

J/kg or Gray (Gy)

1 Gy = 100 rad

Table 1. Dose requirement in various applications of food irradiation

Purpose	Dose (kGy)[a]	Products
Low dose (up to 1 kGy)		
(*a*) Inhibition of sprouting	0.05-0.15	Potatoes, onions, garlic, ginger-root, etc.
(*b*) Insect disinfestation and parasite disinfection	0.15-0.50	Cereals and pulses, fresh and dried fruits, dried fish and meat, fresh pork, etc.
(*c*) Delay of physiological process (e.g. ripening)	0.50-1.0	Fresh fruits and vegetables
Medium dose (1-10 kGy)		
(*a*) Extension of shelf-life	1.0-3.0	Fresh fish, strawberries, etc.
(*b*) Elimination of spoilage and pathogenic micro-organisms	1.0-7.0	Fresh and frozen seafood, raw or frozen poultry and meat, etc.
(*c*) Improving technological properties of food	2.0-7.0	Grapes (increasing juice yield), dehydrated vegetables (reduced cooking time), etc.
High dose (10-50 kGy)[b]		
(*a*) Industrial sterilization (in combination with mild heat)	30-50	Meat, poultry, seafood, prepared foods, sterilized hospital diets
(*b*) Decontamination of certain food additives and ingredients	10-50	Spices, enzyme preparations, natural gum, etc.

[a] Gy: gray - unit used to measure absorbed dose. For definition, see page 20

[b] Only used for special purposes. The Joint FAO/WHO Codex Alimentarius Commission has not yet endorsed high-dose applications (see Annex 2).

Source: WHO: Food Irradiation , 1988

Non-Small Cell Lung Cancer

Recommended Radiation Doses:

Treatment type	Total dose	Fraction size
Preoperative*[1]	45-50 Gy	1.8-2 Gy
Postoperative[2,3] • Negative margins • Extracapsular nodal extension or microscopic positive margins • Gross residual tumor	 50 Gy 54-60 Gy up to 70 Gy	 1.8-2 Gy 1.8-2 Gy 1.8-2 Gy
Definitive • Without concurrent chemotherapy[4] • With concurrent chemotherapy[5] (mainly carboplatin + paclitaxel)[5]	 up to 77.4 Gy (keep V20 ≤ 35% up to 74 Gy	 2-2.15 Gy 2 Gy

*Doses greater than 50 Gy in the preoperative setting have been reported to be safe at selective institutions

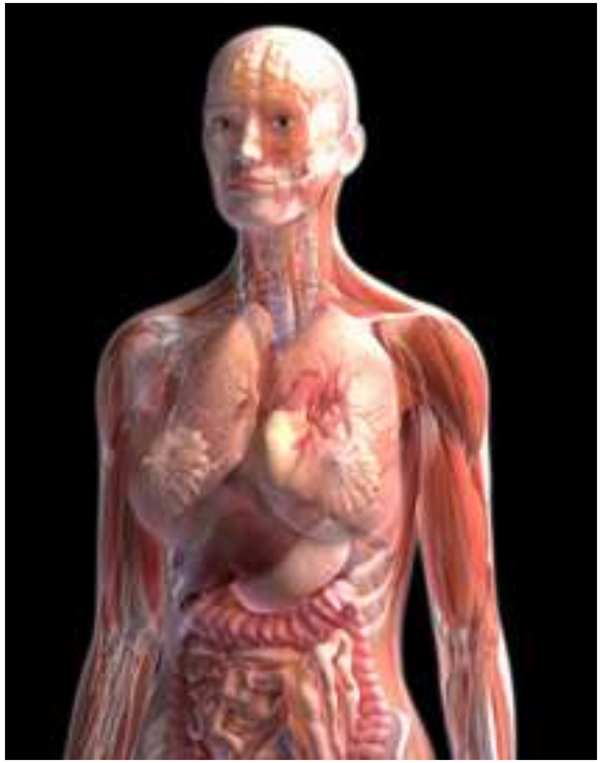
NCCN® Practice Guidelines in Oncology – v.2.2009

Source: NCCN, 2009

Energy deposited = dose x Quality Factor

radiation dependent

RBE: relative biological effectiveness

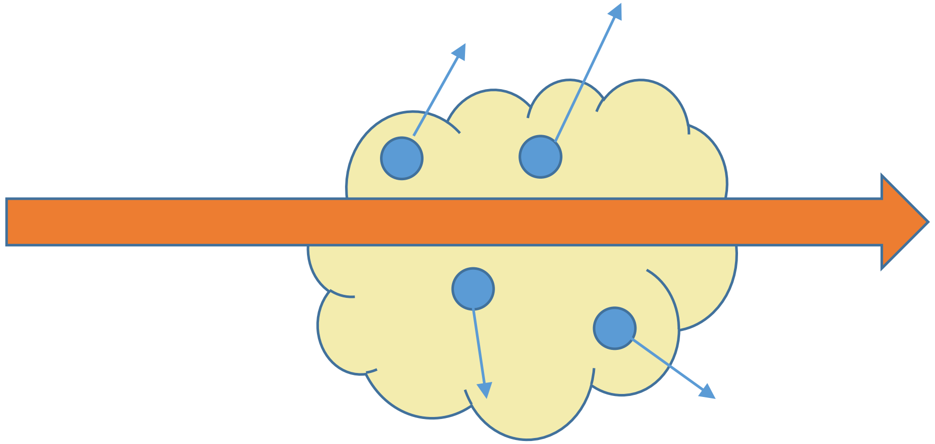


Dose equivalent

1 sievert (Sv) = 100 rem

Name	Symbol(s)	Representation
Alpha particle	$^{4}_{2}\mathrm{He}$ or $^{4}_{2}\alpha$	
Beta particle	$^{0}_{-1}\mathrm{e}$ or $^{0}_{-1}\beta$	
Positron	$^{0}_{+1}\mathrm{e}$ or $^{0}_{+1}\beta$	
Proton	$^{1}_{1}\mathrm{H}$ or $^{1}_{1}\mathrm{p}$	
Neutron	$^{1}_{0}\mathrm{n}$	
Gamma ray	γ	γ

Linear energy transfer (LET)



Which ones are high LET?

Table 3.1. Approximate LETs and RBEs of Several Types of Radiation

Radiation Type	LET (keV/μm)	RBE
Linac X-rays (6–15 MeV)	0.3	~0.8
Beta particle (1 MeV)	0.3	0.9
Cobalt-60 γ-rays	0.2	0.8–0.9
250 kVp X-rays (standard)	2	1.0
150 MeV protons (therapy energies)	0.5	~1.1
Neutrons	0.5–100	1–2
Alpha particles	50–200	5–10
Carbon ions (in spread out Bragg peak)	40–90	2–5

LET, linear energy transfer; *RBE*, relative biological effectiveness.

Modified from Coia LR, Moylan DE. Introduction to clinical radiation oncology. 3rd ed. Madison, WI: Medical Physics Publishing; 1996.p. 24, Table 2.1, © 1996 with permission.

Activity (A)

Decay rate

unit: Ci (curie) and Bq (becquerel)
1 Bq = 1 dps
1 Ci = 3.7×10^{10} dps (A of 1-g radium)

Exposure Dose (X)

Ionization of air (1 cc) at STP (T=273.15 K and P=1 atm)

unit: R (roentgen) or C/kg
(1 R = 2.58×10^{-4} C/kg)

Absorbed Dose (D)

Energy absorption

unit: Gy (gray) and rad
(1 Gy = 1 J/kg = 100 rad)

Dose Equivalent (DE)

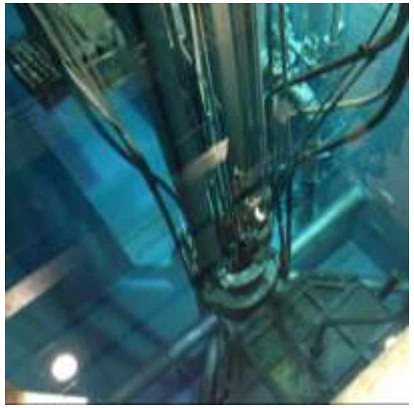
Dose with impact on living cells
DE = D*QF

unit: Sv (sievert) and rem
(1 Sv = 100 rem)
QF is radiation dependent

Radiation sources @ TINT

Gamma
Co-60 (1.17, 1.33 MeV)
A various

E-beam
20 MeV (Ongkharak)
3-10 MeV (Klong 5)

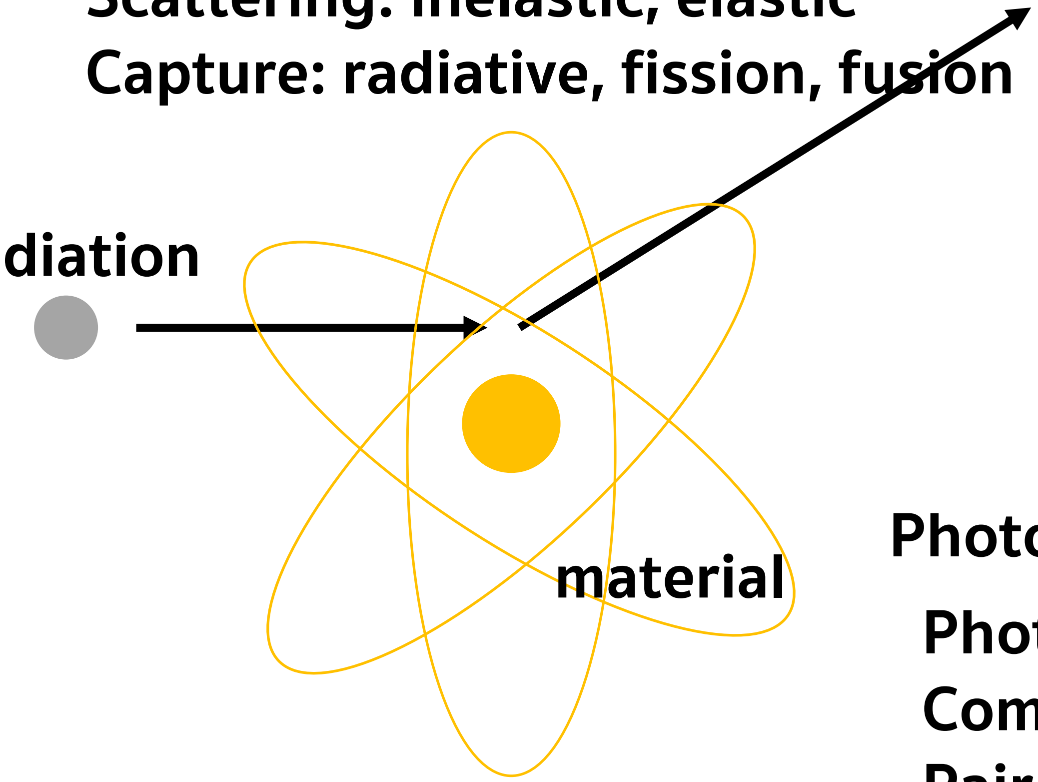


Neutron
Research Reactor

X-ray
5 MV

Nuclear interactions

Scattering: inelastic, elastic
Capture: radiative, fission, fusion



Photons:

- **Photoelectric effect**
- **Compton scattering**
- **Pair production**
- **Auger effect (electron emission)**

Name	Symbol(s)	Representation
Alpha particle	${}^{4}_{2}\mathrm{He}$ or ${}^{4}_{2}\alpha$	
Beta particle	${}^{0}_{-1}\mathrm{e}$ or ${}^{0}_{-1}\beta$	
Positron	${}^{0}_{+1}\mathrm{e}$ or ${}^{0}_{+1}\beta$	
Proton	${}^{1}_{1}\mathrm{H}$ or ${}^{1}_{1}\mathrm{p}$	
Neutron	${}^{1}_{0}\mathrm{n}$	
Gamma ray	γ	 γ

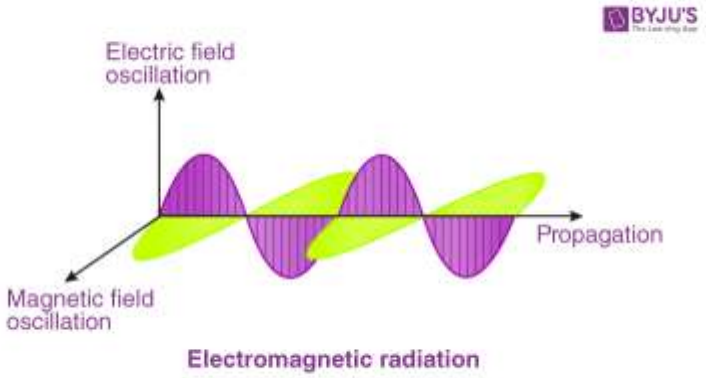
- cobalt (Co)-60: 1.17, 1.33 MeV gamma
- cesium (Cs)-137: 661 keV gamma
- technetium (Tc)-99m: 140 keV gamma
- radon (Rn)-222: 5.6 MeV alpha
- uranium (U)-238: 4.3 MeV alpha
- americium (Am)-241: 5.5 MeV alpha
- iodine (I)-131: beta-
- fluorine (F)-18: beta+ (positron)

What about X-ray?

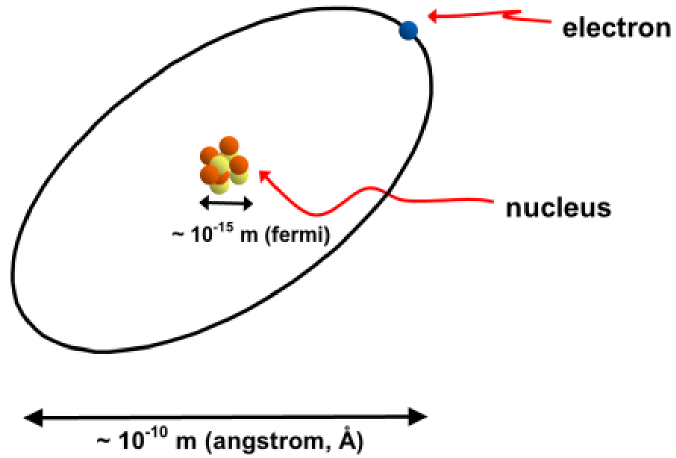
Is it “nuclear”?

High energy photons

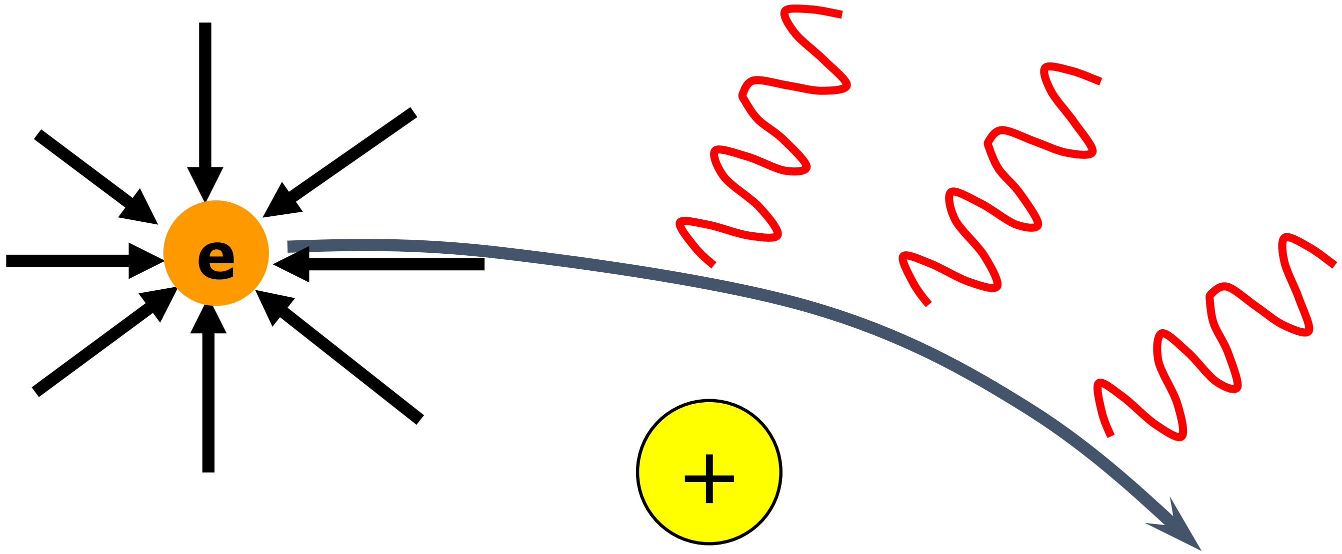
- X-ray is a high-energy electromagnetic (EM) radiation. Like all other EM waves, X-ray travels at speed of light c
- Its energy is directly proportional to the frequency (Planck-Einstein relation): E = hf (h = Planck's constant)
- While visible light has energy of 2-3 eV, energy of X-ray is in the range 100 eV-100 keV.
- Similar to X-ray, gamma is a high-energy EM wave. They come from different sources.

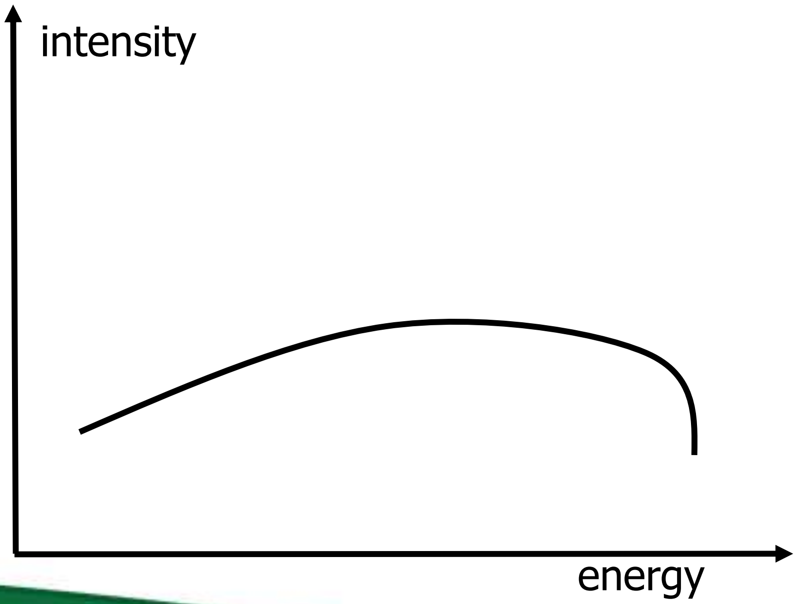


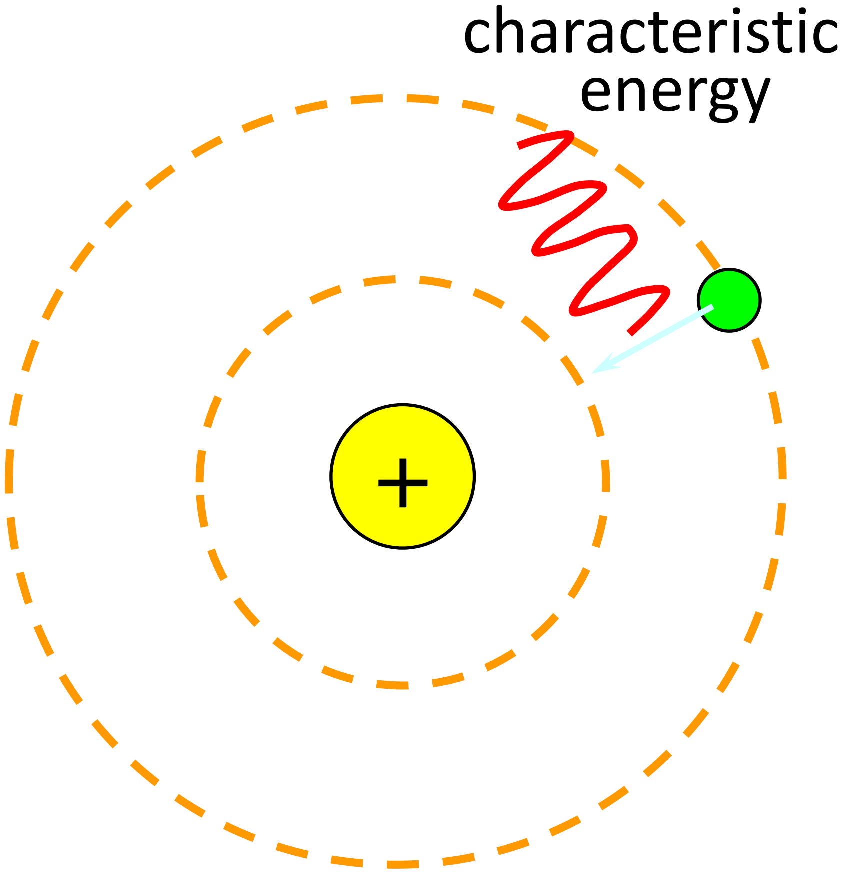
X-ray



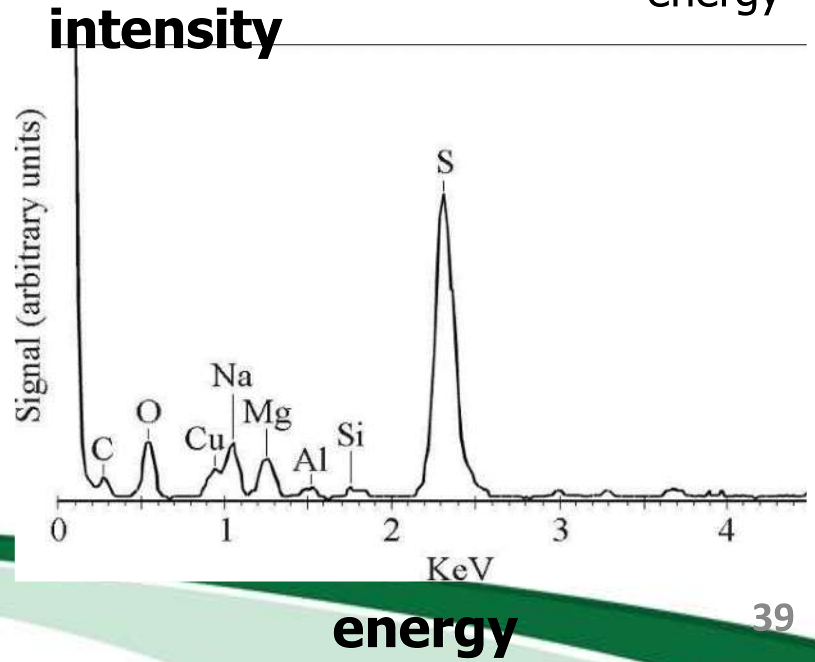
bremsstrahlung (braking radiation):
Continuous energy

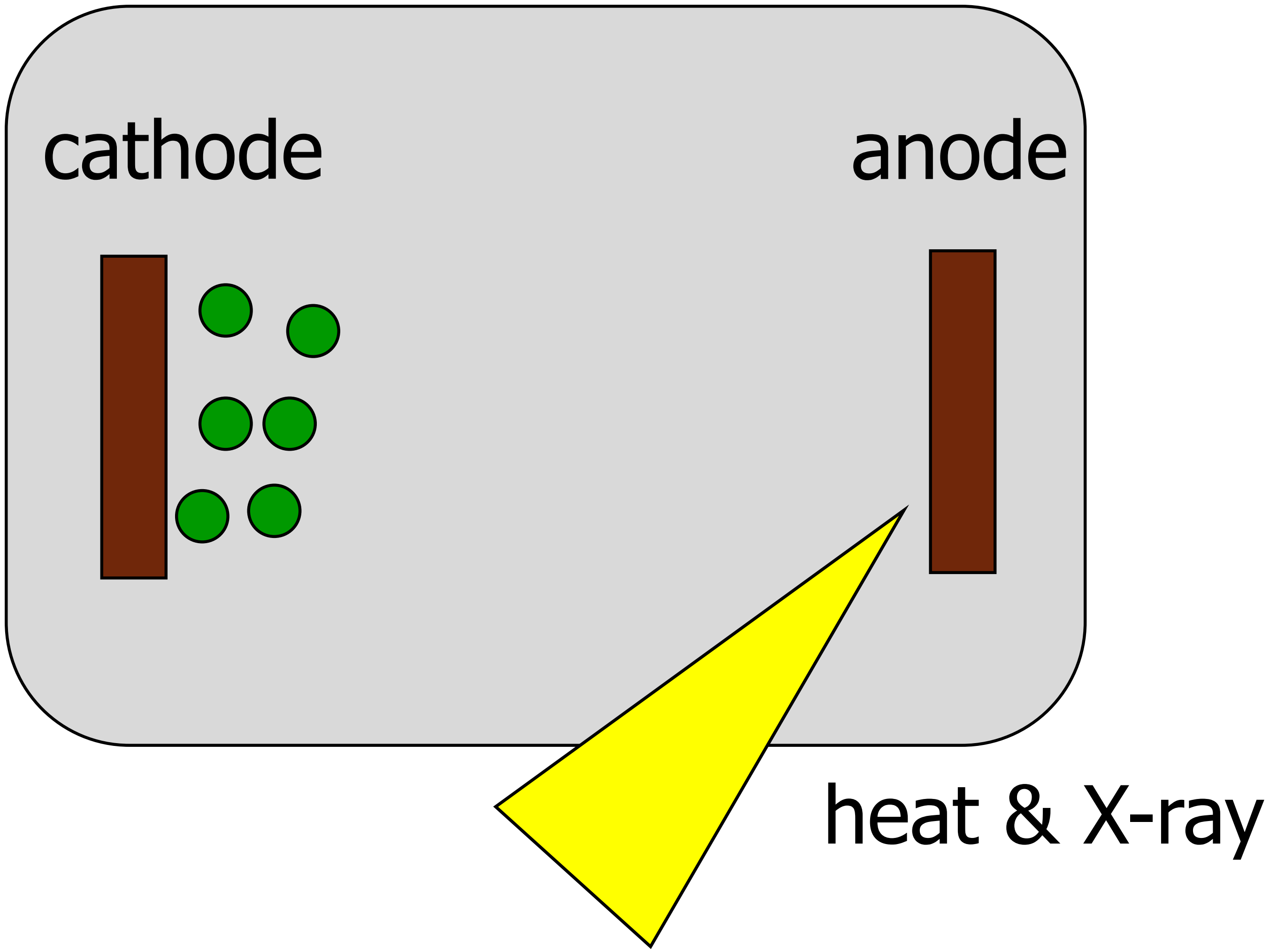





characteristic
energy
+


intensity
energy

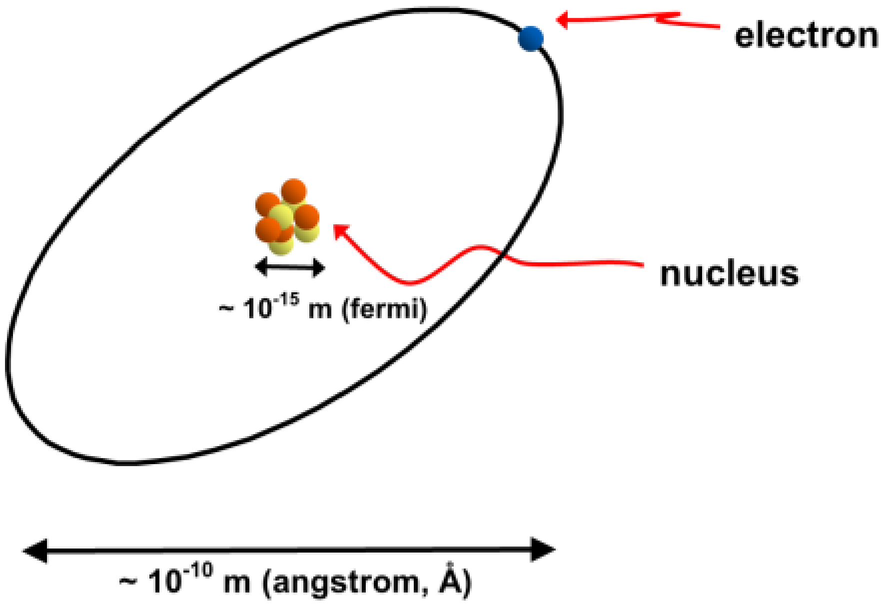

intensity
Signal (arbitrary units)
C
O
Cu
Na
Mg
Al
Si
S
0
1
2
3
4
KeV
energy



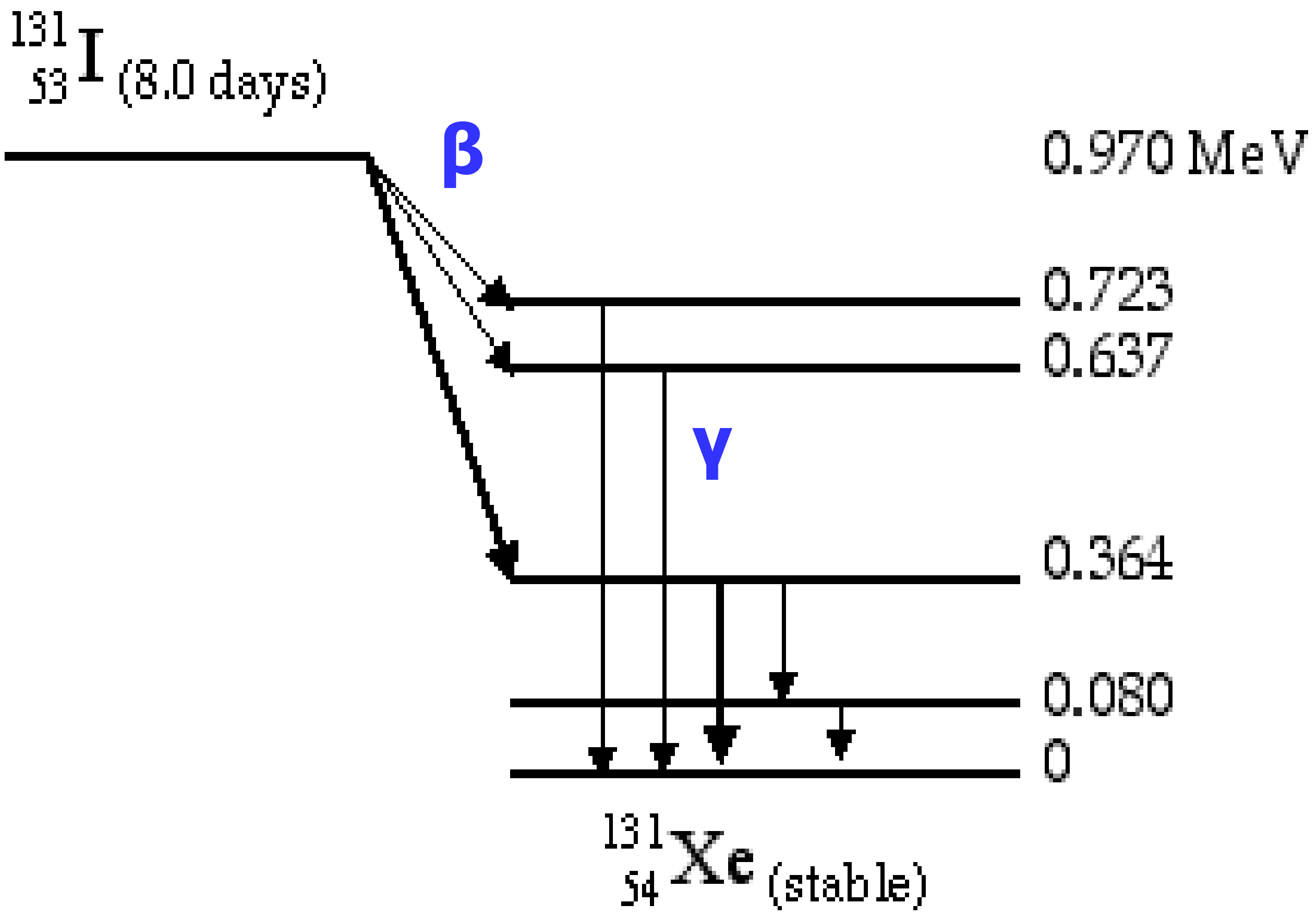
Wilhem Conrad Roentgen

One of the first X-ray images, taken in 1895. Hand of Anna Bertha Ludwig (Roentgen's wife).

Gamma ray

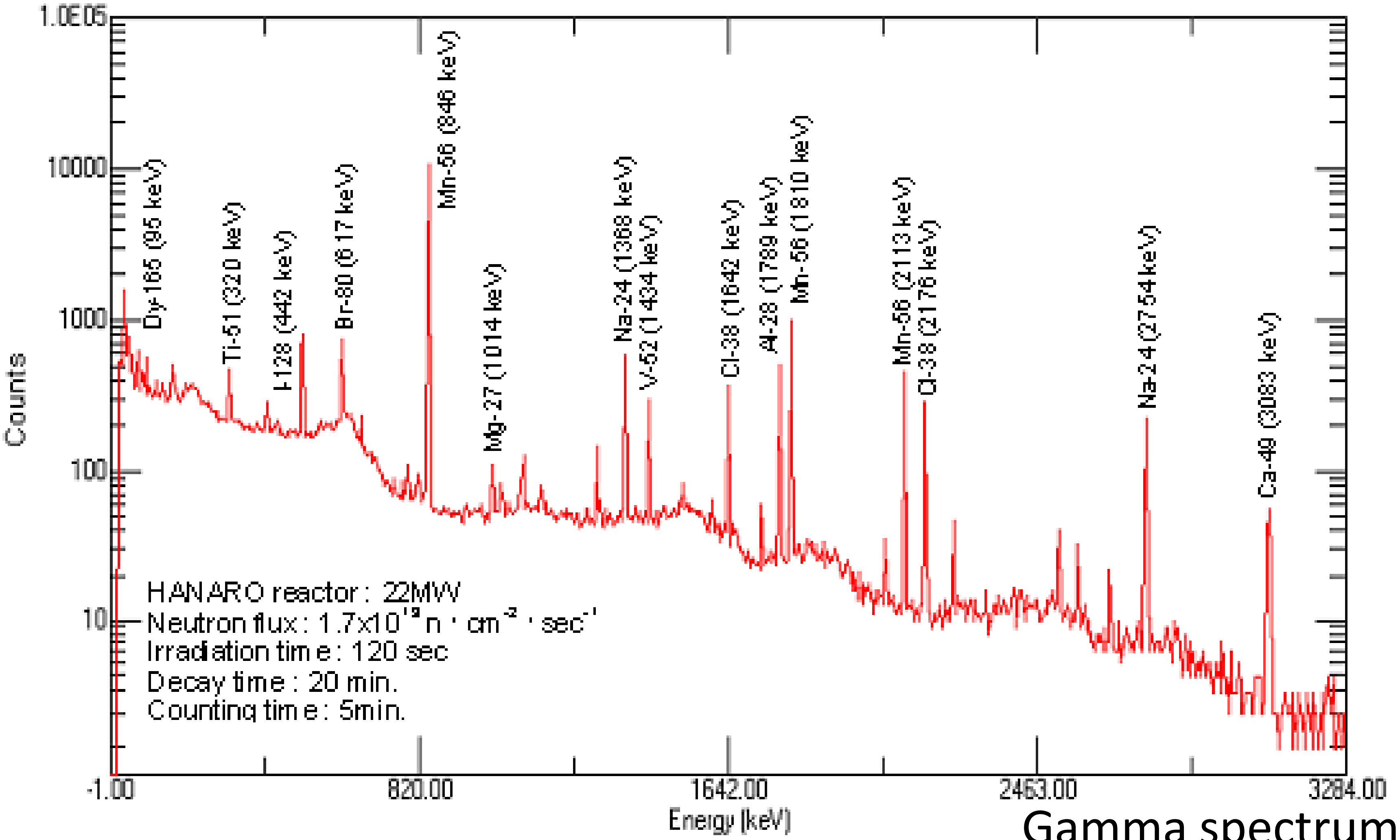


electron
nucleus
~ 10^-15 m (fermi)
~ 10^-10 m (angstrom, Å)



131 53 I (8.0 days)
β
0.970 MeV
0.723
0.637
γ
0.364
0.080
0
131 54 Xe (stable)

Gamma ray

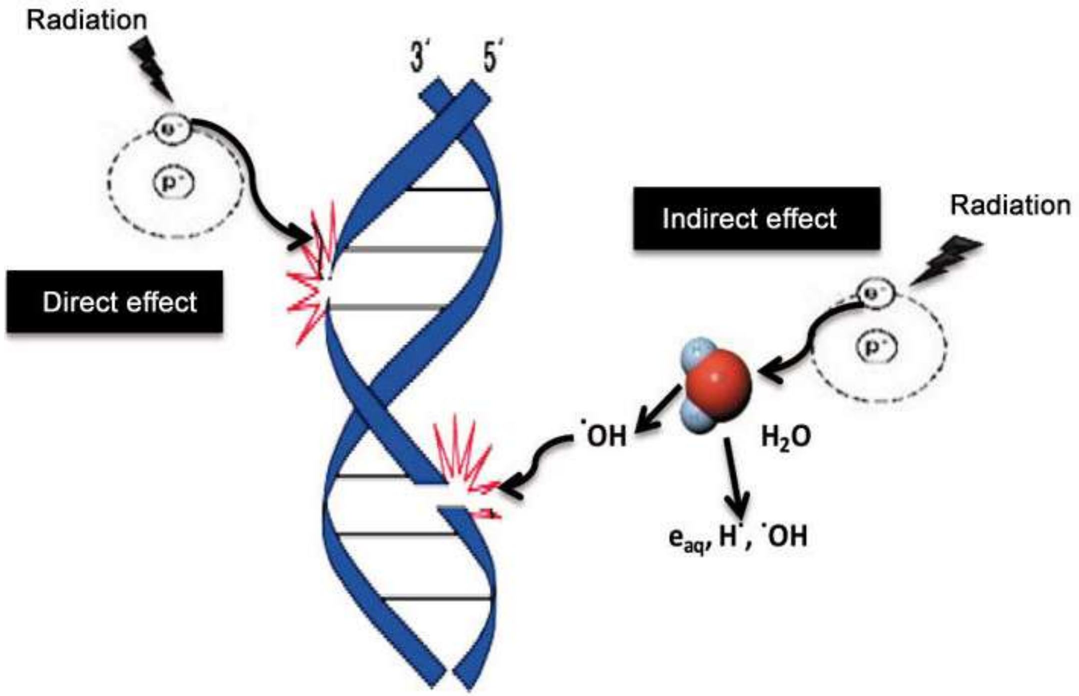


Gamma spectrum from NAA

source: Hanaro (http://hanaro.kaeri.re.kr/english/gam.htm)

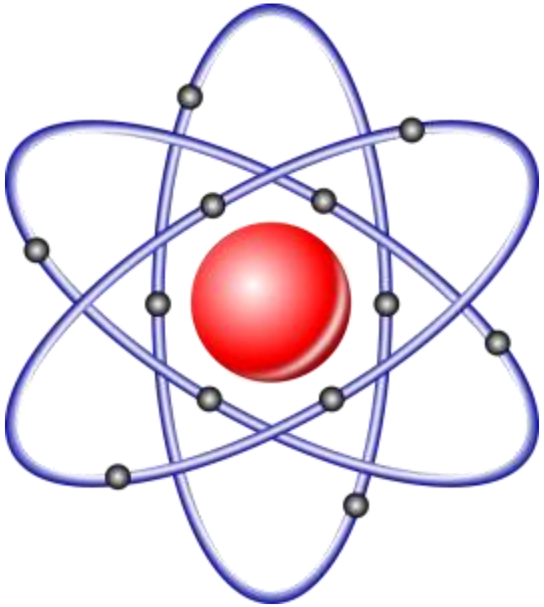
Biological effects: mutation

- Direct: radiation energy is absorbed directly by DNA molecule. This causes breaks in DNA strands (single- or double-strand)
- Indirect: radiation ionizes water molecules, creating reactive oxygen species (ROS) such as hydroxyl radicals (•OH), superoxide ($O_2•^-$), and hydrogen peroxide (H_2O_2). These ROS cause oxidative damage to DNA, proteins, and lipids.



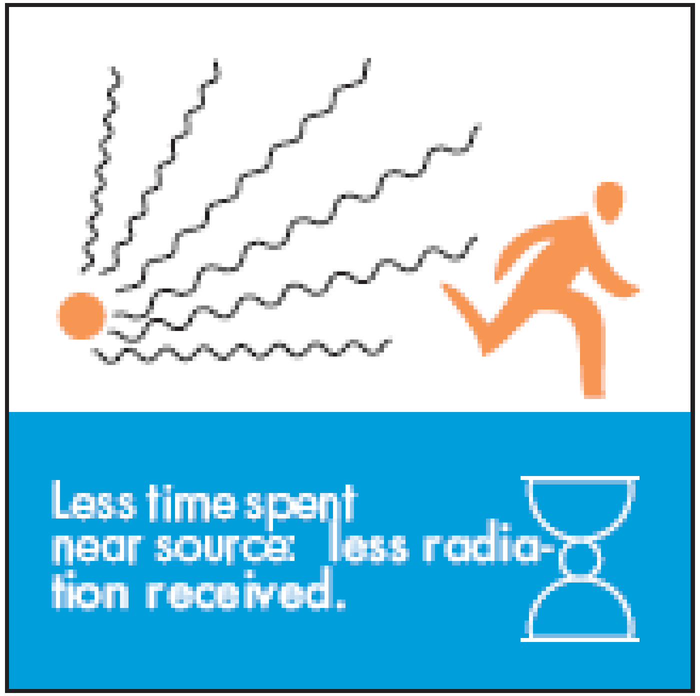
Gamma effects

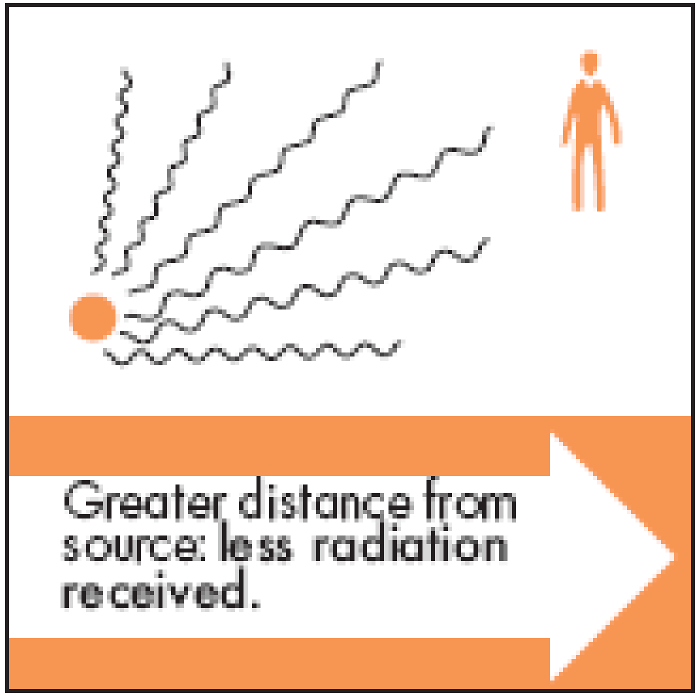
- Physical Level: Energy Transfer Femtoseconds to picoseconds
  - Gamma photons transfer energy to atoms, knocking out electrons from orbit, causing ionization.
  - Ionization creates free radicals, positive ions, and free electrons.
- Chemical Level: DNA and Cellular Damage Nanoseconds to seconds
  - The high-energy gamma rays break chemical bonds in the DNA molecules, causing single-strand breaks (SSBs) and double-strand breaks (DSBs).
- Biological Level: Cellular Repair and Mutagenesis Minutes to weeks
  - After gamma radiation exposure, plant cells activate DNA repair mechanisms.
  - These repair mechanisms are not always perfect. Inaccurate repair or misalignment during homologous recombination can lead to mutations.

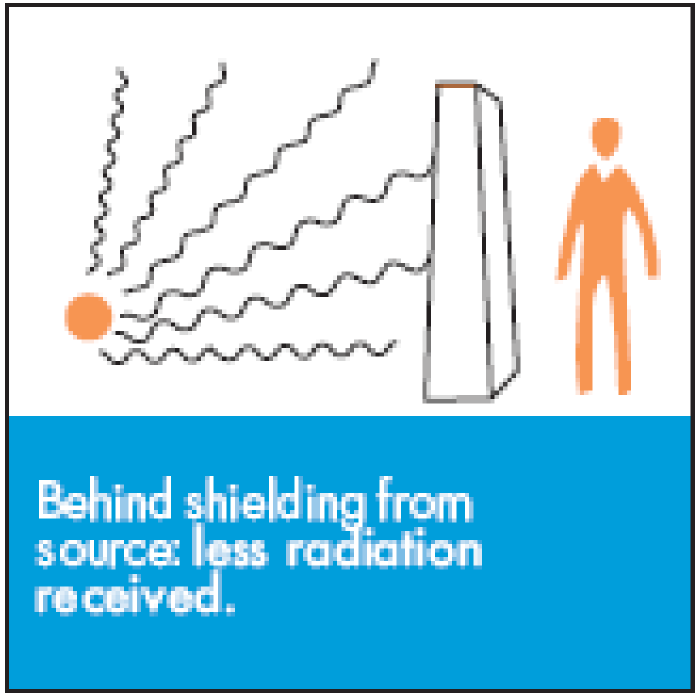


How to keep yourself safe from radiation?

"ALARA = as low as reasonably achievable"



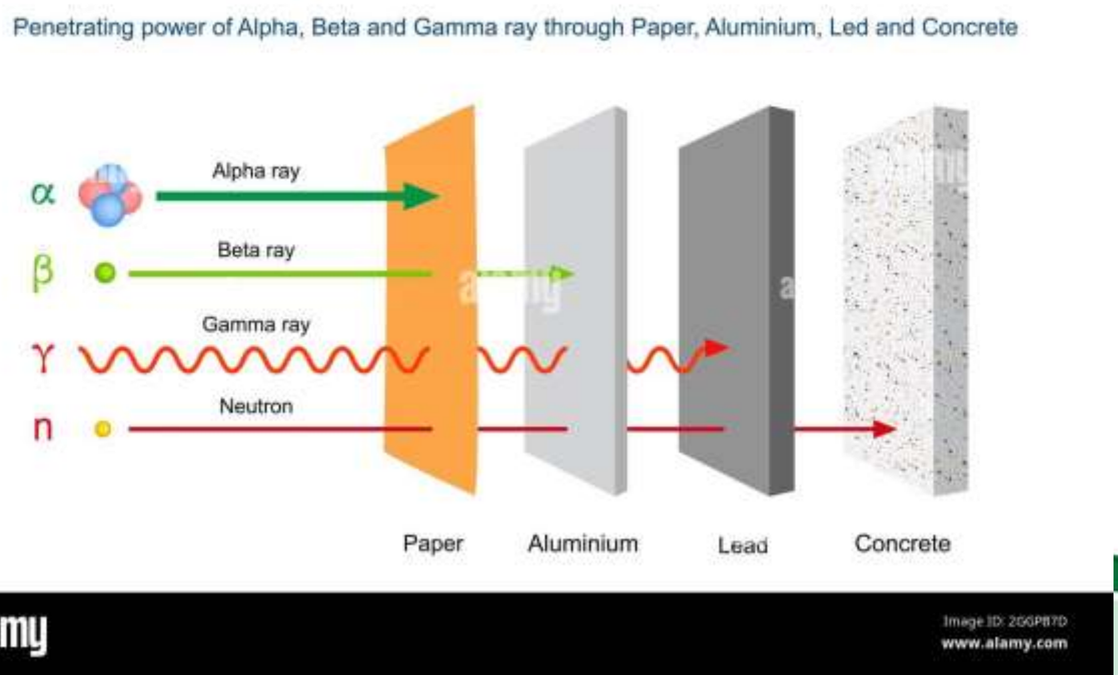




Source: U of Alabama at Birmingham, Environmental Health & Safety Department

Radiation interaction with matter

- Gamma and X-ray: high-energy electromagnetic radiation
  - Very high penetration, typically several cm to meters in biological samples, depending on energy
- Alpha: large mass and double charge
  - very high linear energy transfer (LET)
  - Very short range (few tens of micrometers) in biological samples
- Beta: low mass and single charge
  - limited penetration (few mm to few cm), depending on energy
  - Rapid energy loss, effects are mostly on surface



Name	Symbol(s)	Representation
Alpha particle	${}^{4}_{2}\mathrm{He}$ or ${}^{4}_{2}\alpha$	
Beta particle	${}^{0}_{-1}\mathrm{e}$ or ${}^{0}_{-1}\beta$	
Positron	${}^{0}_{+1}\mathrm{e}$ or ${}^{0}_{+1}\beta$	
Proton	${}^{1}_{1}\mathrm{H}$ or ${}^{1}_{1}\mathrm{p}$	
Neutron	${}^{1}_{0}\mathrm{n}$	
Gamma ray	γ	 γ

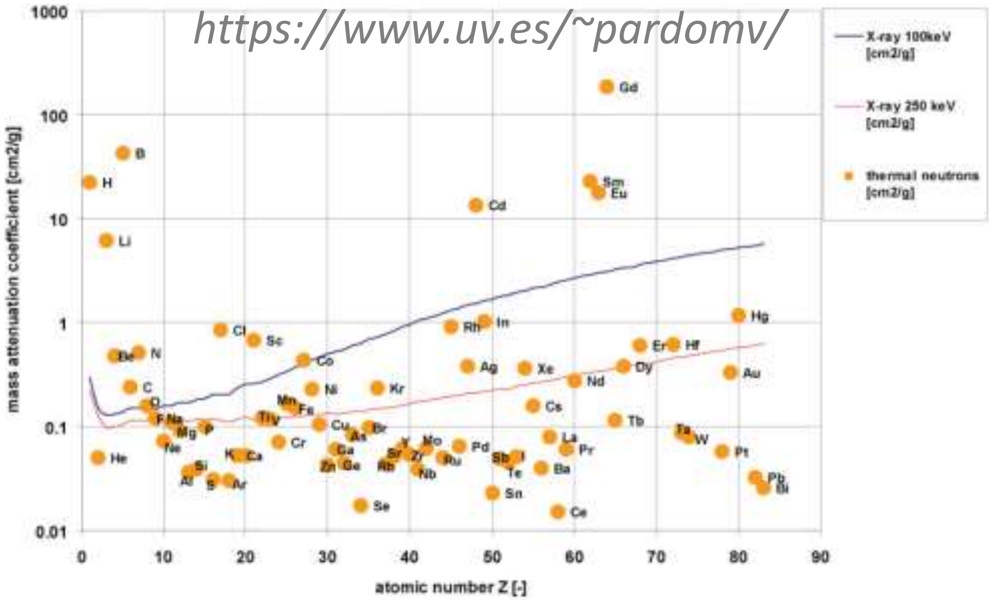
No real need for external source

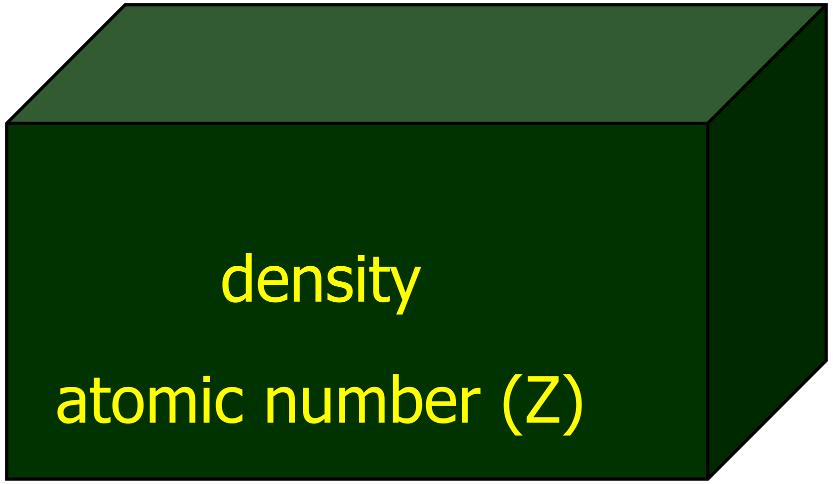
Low-Z: Al, wood, plastic. (maybe)

Consider secondary radiation

H-rich + Cd or Gd

High-Z: Pb





Shielding is not about Termination.
It is Attenuation.

Dose and Effects

Radiation effects on the human body depend on the dose, dose rate, type of radiation, and individual susceptibility.

Dose Range	Effects	Examples
0.001–0.1 Sv	No immediate symptoms; long-term cancer risk.	Background radiation, X-rays.
0.1–1 Sv	Mild symptoms (nausea, fatigue); increased cancer risk.	Radiation therapy, occupational exposure.
1–6 Sv	Acute Radiation Syndrome (ARS) (hematopoietic, gastrointestinal effects).	Severe radiation accidents. (e.g., Chernobyl, Fukushima).
>6 Sv	Neurovascular syndrome; rapid death.	Lethal radiation exposure. (e.g., warfare)

Life expectancy reduction

Activity/Exposure	Risk	Life Expectancy Reduction
Smoking (1 pack/day)	Lung cancer, cardiovascular disease	~10 years
Severe Obesity (BMI >40)	Diabetes, cardiovascular disease, metabolic disorders	~10 years
Heavy alcohol consumption (> 3 drinks/day)	Liver disease, cancer, cardiovascular disease, accidents	~5-10 years
Construction Job	Accidents, exposure to hazardous materials	~1–2 years
Unmarried or divorced	Stress, loneliness, poor health behaviors	~1-2 years compared to married individuals
Elevated background radiation (10 mSv/year) (natural background radiation ~ 2.4 mSv/year)	No significant reduction observed in high background areas (such as Ramsar, Iran) Theoretical risk: ~1-2 days of life lost per year at 10 mSv/y)	~1–2 days/year

Radiation

is part of our lives. It is very useful if handled with care.

Oak Ridge Nat. Lab., 1947

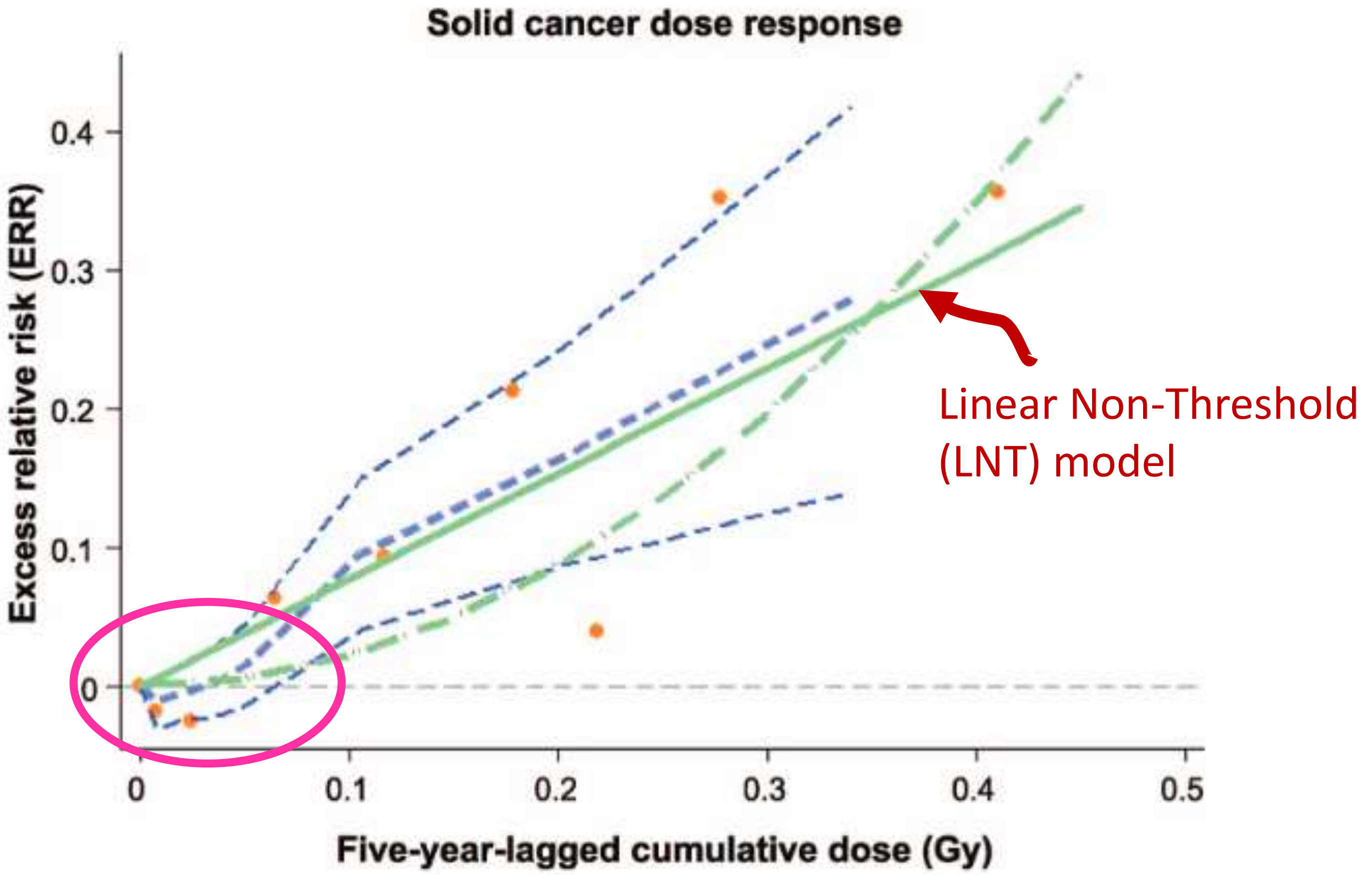


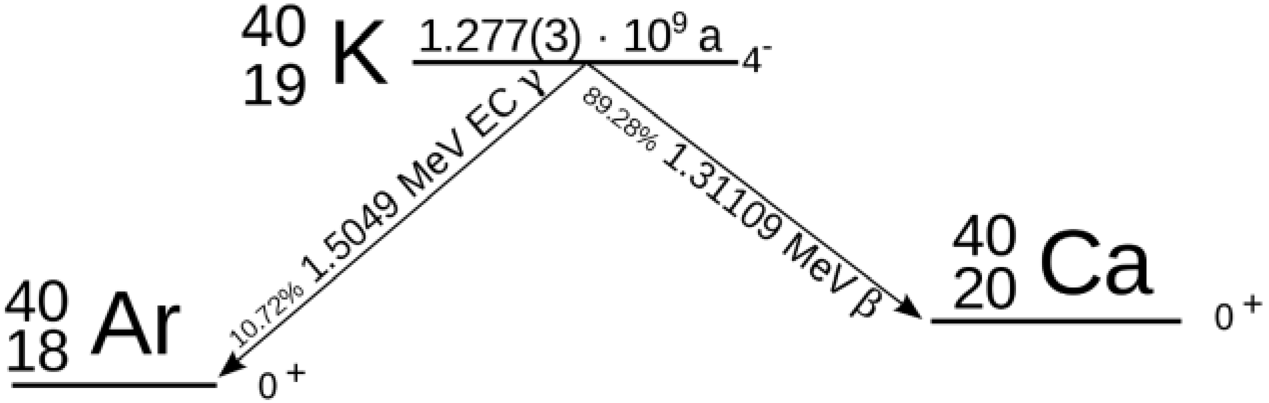
FIG. 1 Solid cancer dose response. All results shown are based on models with adjustment for smoking in the baseline rates. The green lines are the fitted linear (solid) and quadratic (dash-dot-dot) dose-response curves. The orange points are ERR estimates in dose categories while the thick-blue-dashed curve is a nonparametric smooth fit to these points. The outer blue-dashed curves represent approximate (pointwise) ± standard error limits on the nonparametric smooth.

Davis, FG, Yu, KL, Preston, D, Epifanova, S, Degteva, M, Akleyev, AV. Solid cancer incidence in the Techa River Incidence Cohort: 1956–2007. Radiat Res. 2015;184(1):56–65.

K-40

Natural radioisotope

Half-life ~ 1.2 x 10^9 y

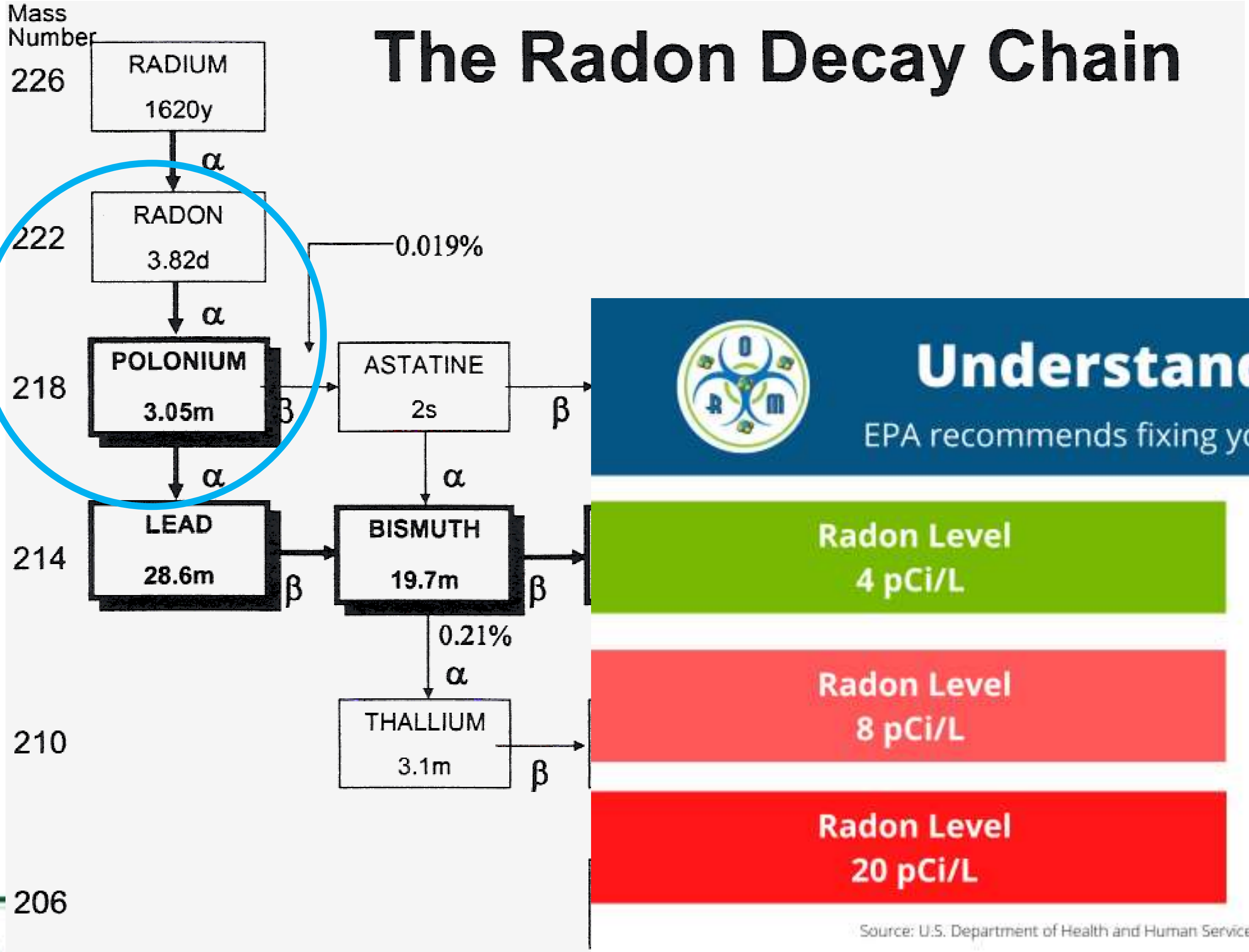


~ 3,500 pCi/kg

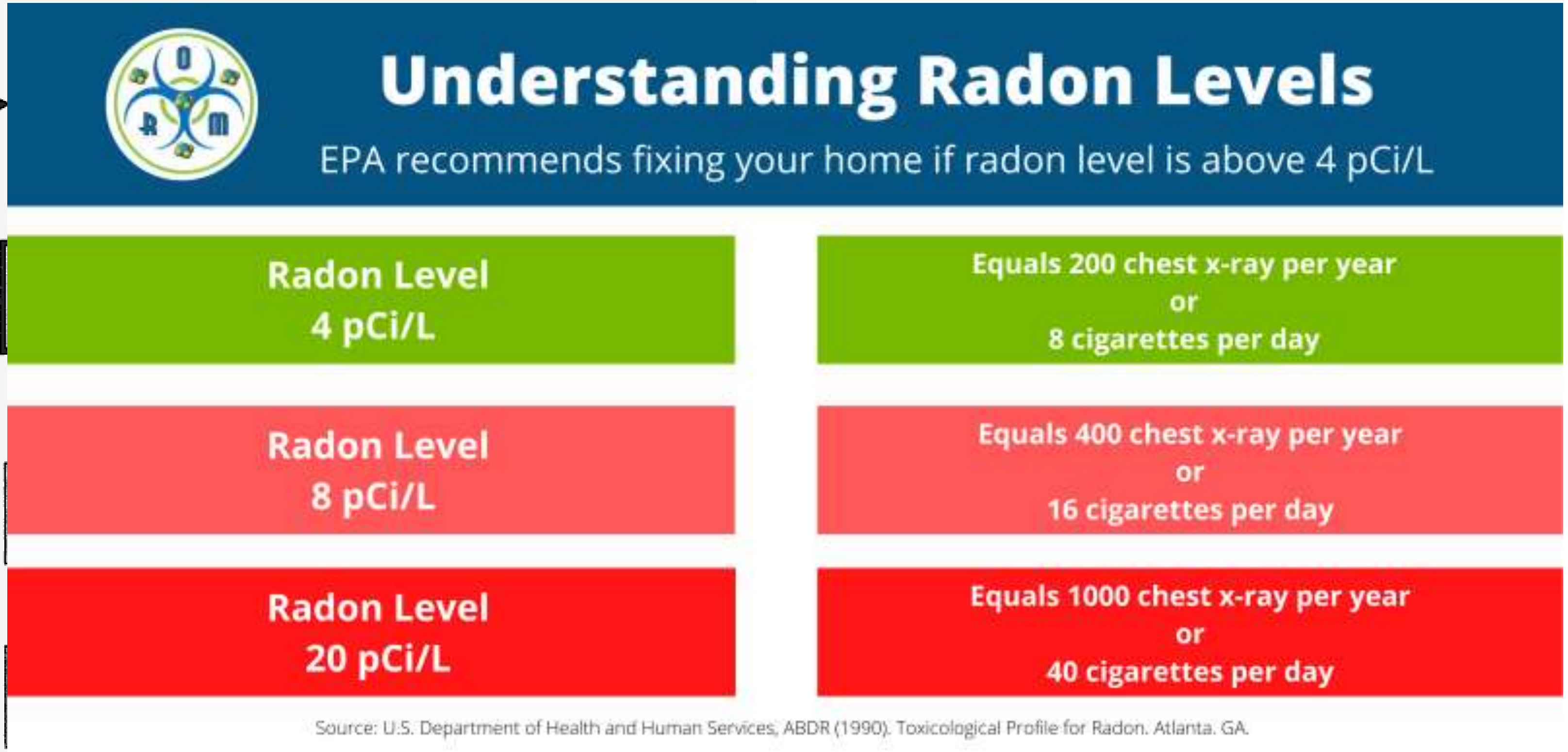
~ 3,400 pCi/kg

~ 3,400 pCi/kg

Rn-222



The Radon Decay Chain
Mass Number
226
222
218
214
210
206
RADIUM 1620y
α
RADON 3.82d
0.019%
α
POLONIUM 3.05m
β
ASTATINE 2s
β
α
α
LEAD 28.6m
β
BISMUTH 19.7m
β
0.21%
α
THALLIUM 3.1m
β



Understanding Radon Levels
EPA recommends fixing your home if radon level is above 4 pCi/L
Radon Level 4 pCi/L
Equals 200 chest x-ray per year or 8 cigarettes per day
Radon Level 8 pCi/L
Equals 400 chest x-ray per year or 16 cigarettes per day
Radon Level 20 pCi/L
Equals 1000 chest x-ray per year or 40 cigarettes per day
Source: U.S. Department of Health and Human Services, ABDR (1990). Toxicological Profile for Radon. Atlanta. GA.

Radium Hot Springs in British Columbia, Canada
Bathing dose rate ~ 2.6 µSv/h (~ 10 times normal background level)

Application examples

What are some research fields?

Environment

Scope of works

- Water Resource
  - + Food adulteration
- Ocean &Soil
- NORM
- EIA for RR
- Archaeology

Infrastructure/ Techniques

- Water Resource:
  - Radiocarbon dating
  - Stable Isotope Analysis
  - Tritium analysis
  - IRMS
  - Chemical analysis
- Ocean &Soil:
  - Carbon cycle
  - Toxin
  - Pb-210 dating
- NORM: Radon &Thoron analysis
- EIA for RR: Simulation software
- Archaeology:
  - PXRF
  - TL/OSL

Archaeology

จัดทำฐานข้อมูลโบราณวัตถุเชิงวิทยาศาสตร์

การอนุรักษ์

Fieldwork	•Survey •On-site analysis
Dating	•C-14 •TL/OSL....
Data analysis	•Typology (CU & FAD) •XRF, XRD, NAA, NI, RT, Raman,...
Interpretation	•Statistical analysis •Combine data

องค์ความรู้

IAEA

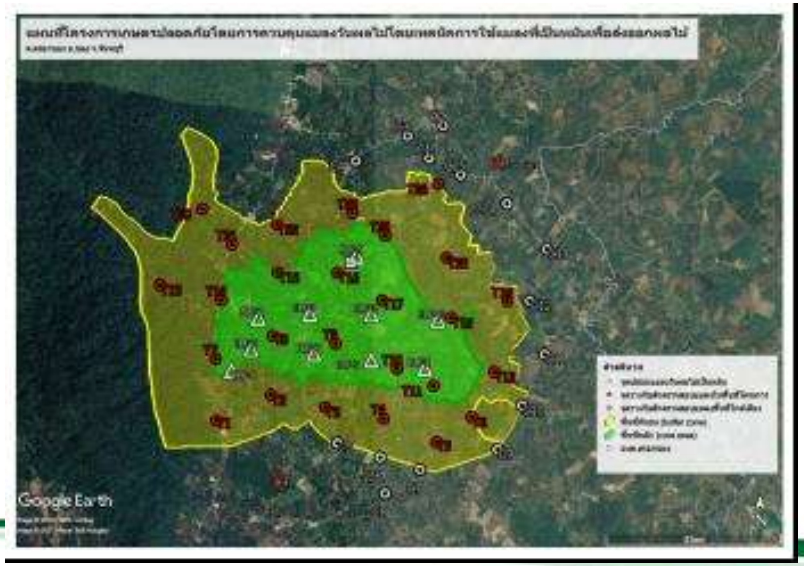
ansto

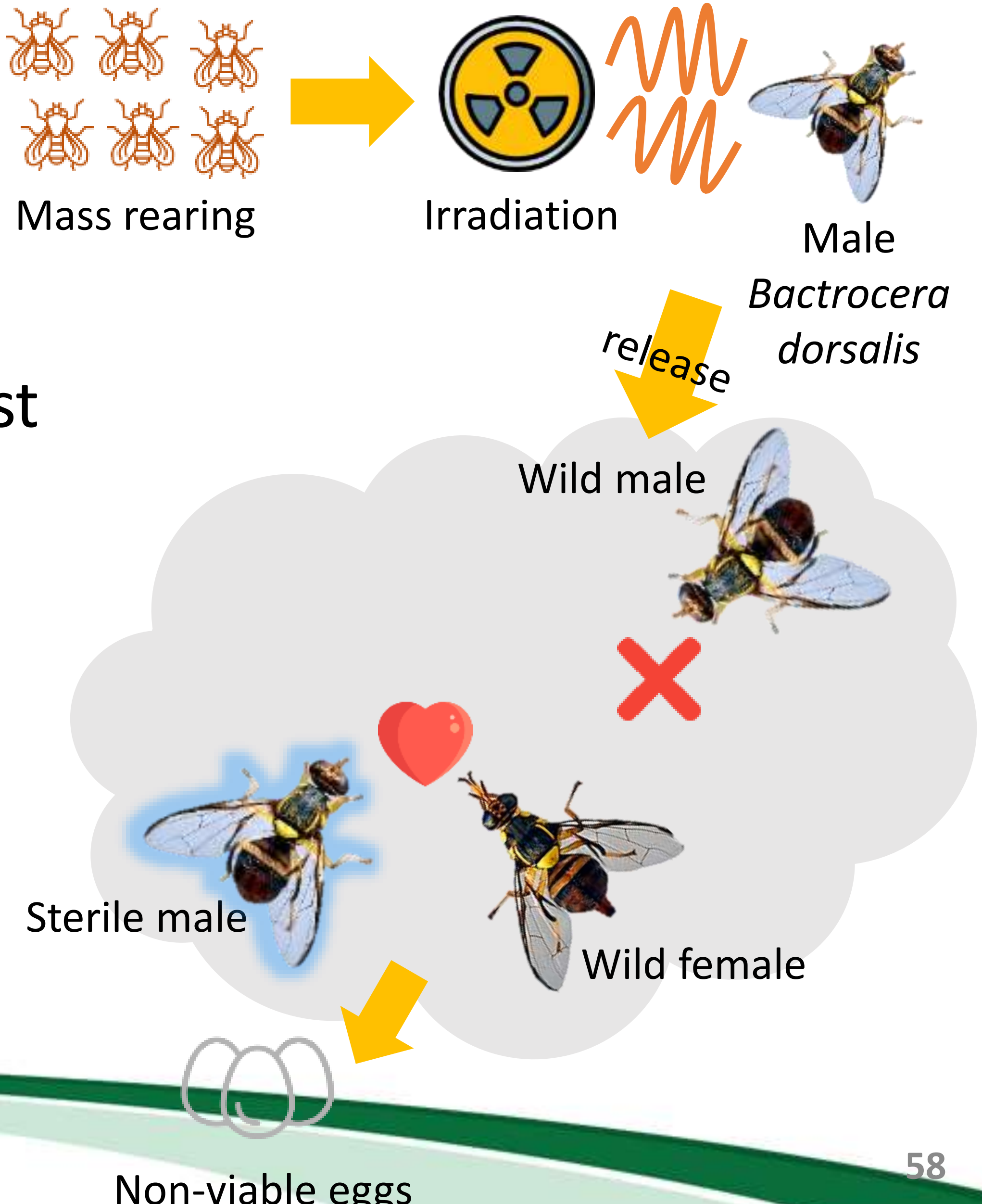
เครื่องทองโบราณ, สำริด, ปราสาทหิน

- ✓ ข้อมูลประวัติศาสตร์ของชาติ
- ☐ ส่งเสริมการท่องเที่ยว
- ☐ ตรวจพิสูจน์

Agriculture – Fruit flies

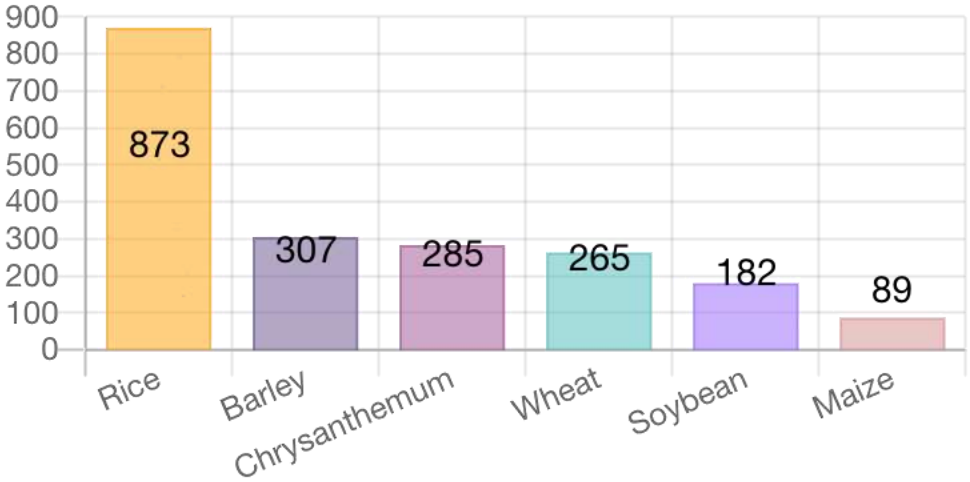
- Sterile Insect Technique (SIT) utilizes gamma and X-ray in decreasing fruit fly population
- Model area: Trok Nong, Chanthaburi, as the first establishment of area of low pest prevalence of fruit fly (ALPP-FF)





Agriculture – Plant Breeding

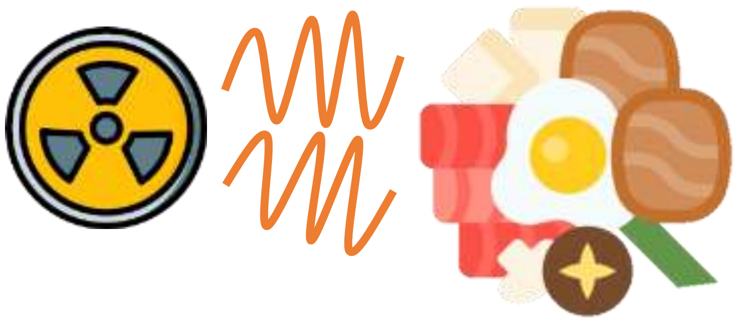
- Plant mutation breeding using radiation to damage DNA.
- It accelerates natural mutation process to obtain faster crop improvement.
- The improvement is crucial for food security. It helps develop plant varieties to withstand stresses (biotic and abiotic), such as hot climate, droughts, soil acidity, and pests and diseases.



https://nucleus.iaea.org/sites/mvd

Food Irradiation

Pathogen and parasite reduction -> shelf-life extension



Dried salted fish: e-beam (10 kGy)

ปลาสลิดแดดเดียวไร้ก้าง : ฉายลำอิเล็กตรอน 10 กิโลเกรย์

วัตถุประสงค์ในการทดสอบ : เพื่อยืดอายุการเก็บ

- ลด จุลินทรีย์ ยีสต์และรา
- หลังจากฉาย รสชาติ เนื้อสัมผัส ไม่เปลี่ยน
- ยืดอายุการเก็บที่อุณหภูมิห้อง 5 วัน

Galangal chili paste: gamma (up to 6 kGy)

น้ำพริกข่า ฉายรังสีแกมมา 2, 4 และ 6 กิโลเกรย์

วัตถุประสงค์ในการทดสอบ : เพื่อกำจัดจุลินทรีย์ปนเปื้อน และยืดอายุการเก็บ

- ลด จุลินทรีย์ ยีสต์และรา
- หลังจากฉาย สี รสชาติ เนื้อสัมผัส ไม่เปลี่ยน
- ยืดอายุการเก็บที่อุณหภูมิห้องได้เพิ่มขึ้น

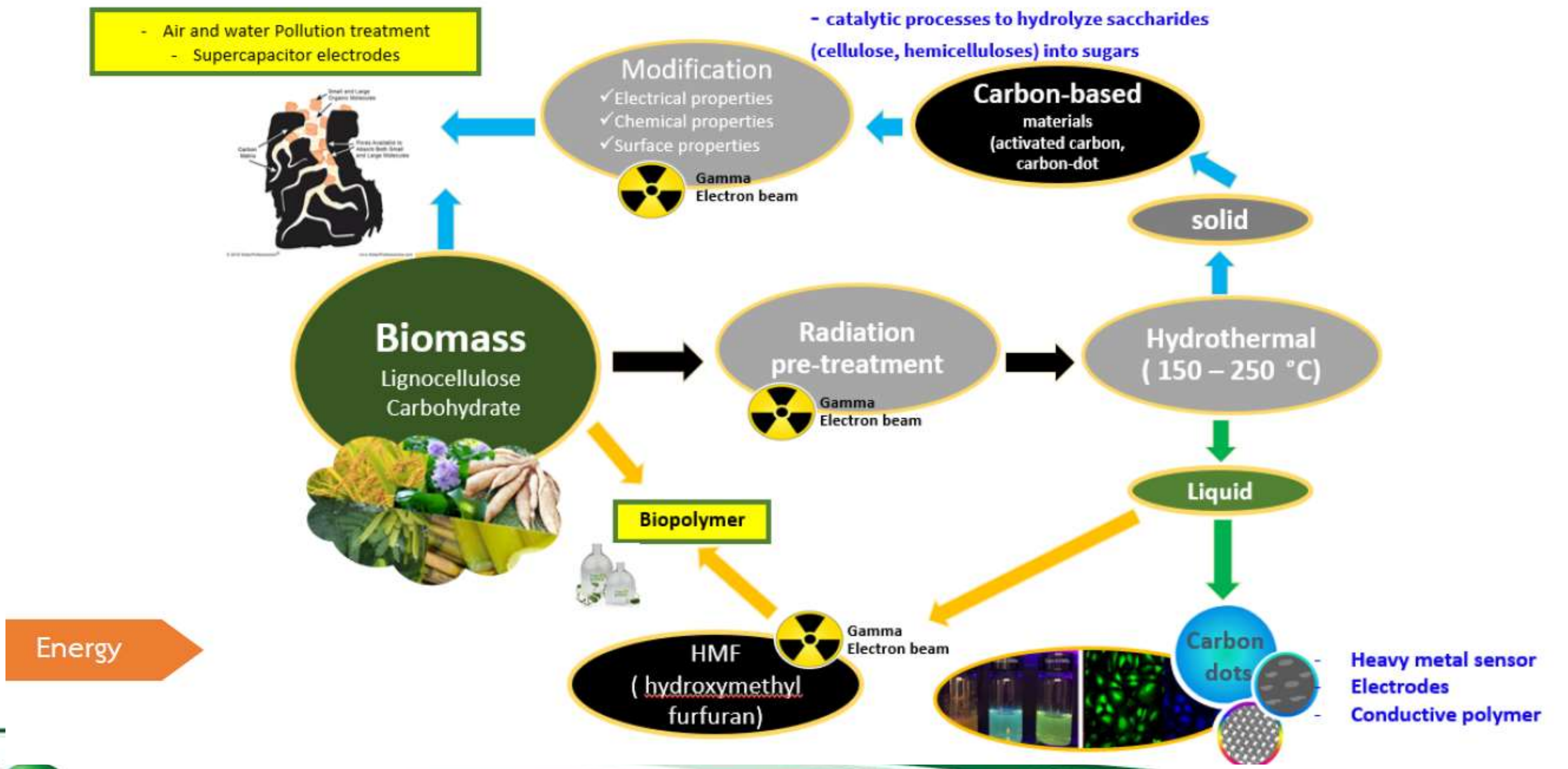
Material Innovation

Sericin extract from radiation-induced degradation of silk cocoon

Chitosan from radiation-induced degradation of chitin

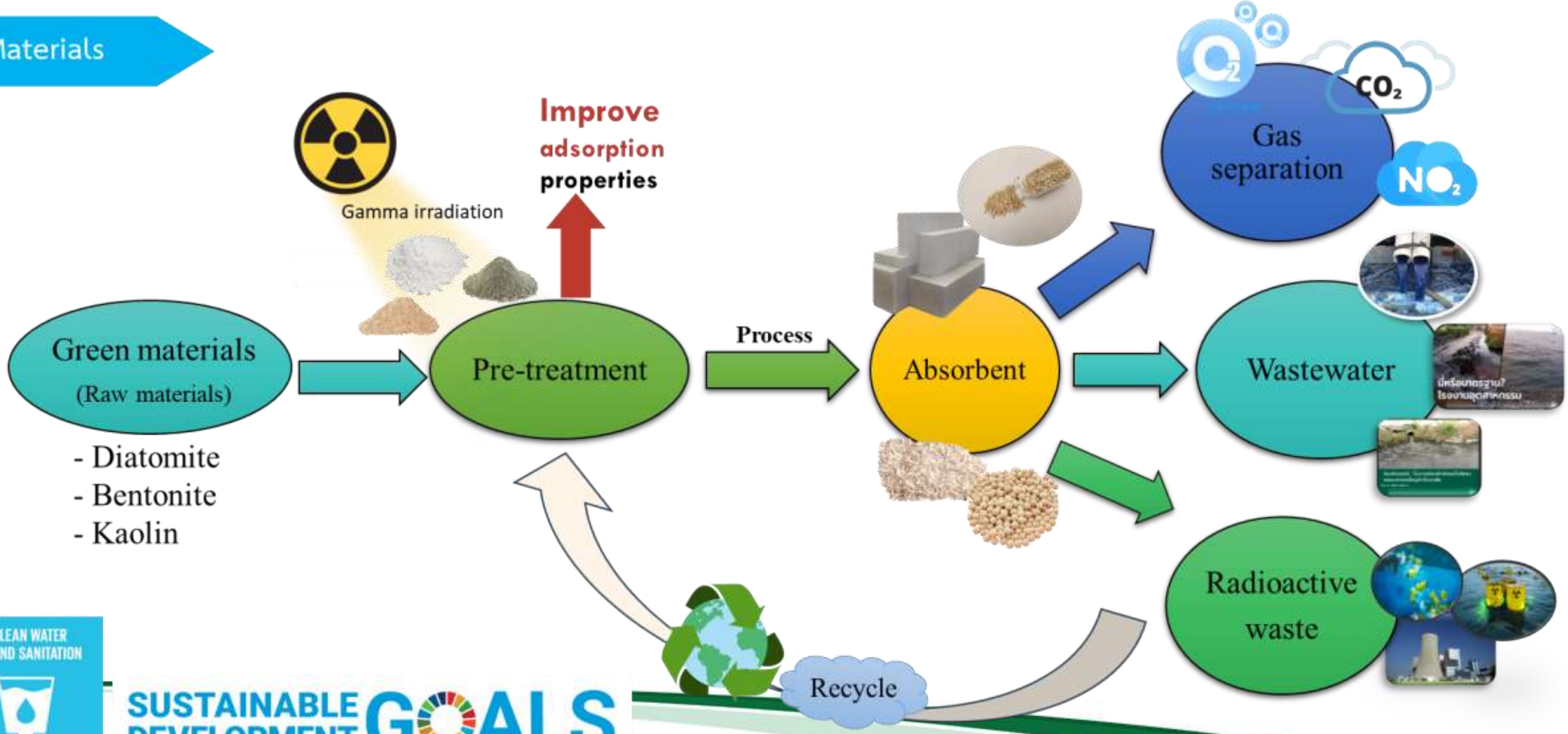
Super water absorbent (SWA) from radiation-induced graft polymerization of acrylic acid (AA) onto cassava starch

Innovative materials prepared by radiation technology



Development of absorbent from green materials using radiation process

Materials



6 CLEAN WATER AND SANITATION

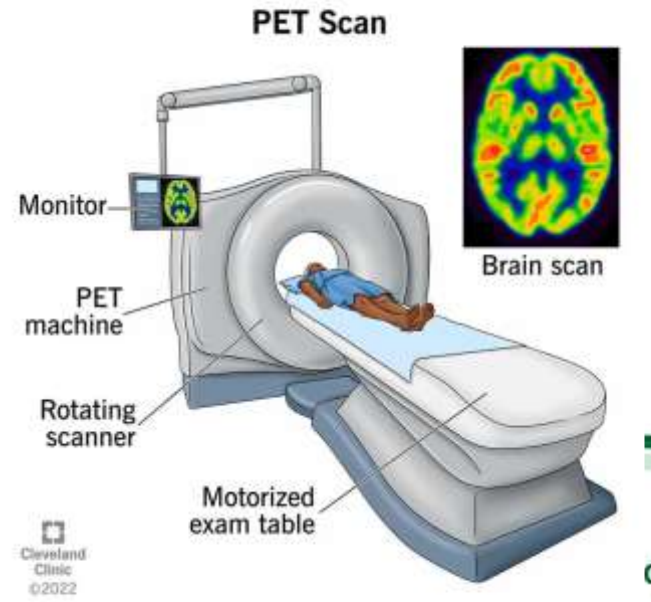
SUSTAINABLE DEVELOPMENT GOALS

Thailand Institute of Nuclear Technology (Public Organization)

Applications in medicine (global) : Diagnostic

PET (Positron Emission Tomography) scans use radioactive tracers to detect diseases like cancer, Alzheimer's, and heart conditions with precision.

The bright spot in the chest, seen best on the PET and PET-CT scans, is lung cancer.



Applications in medicine (global) : Treatment

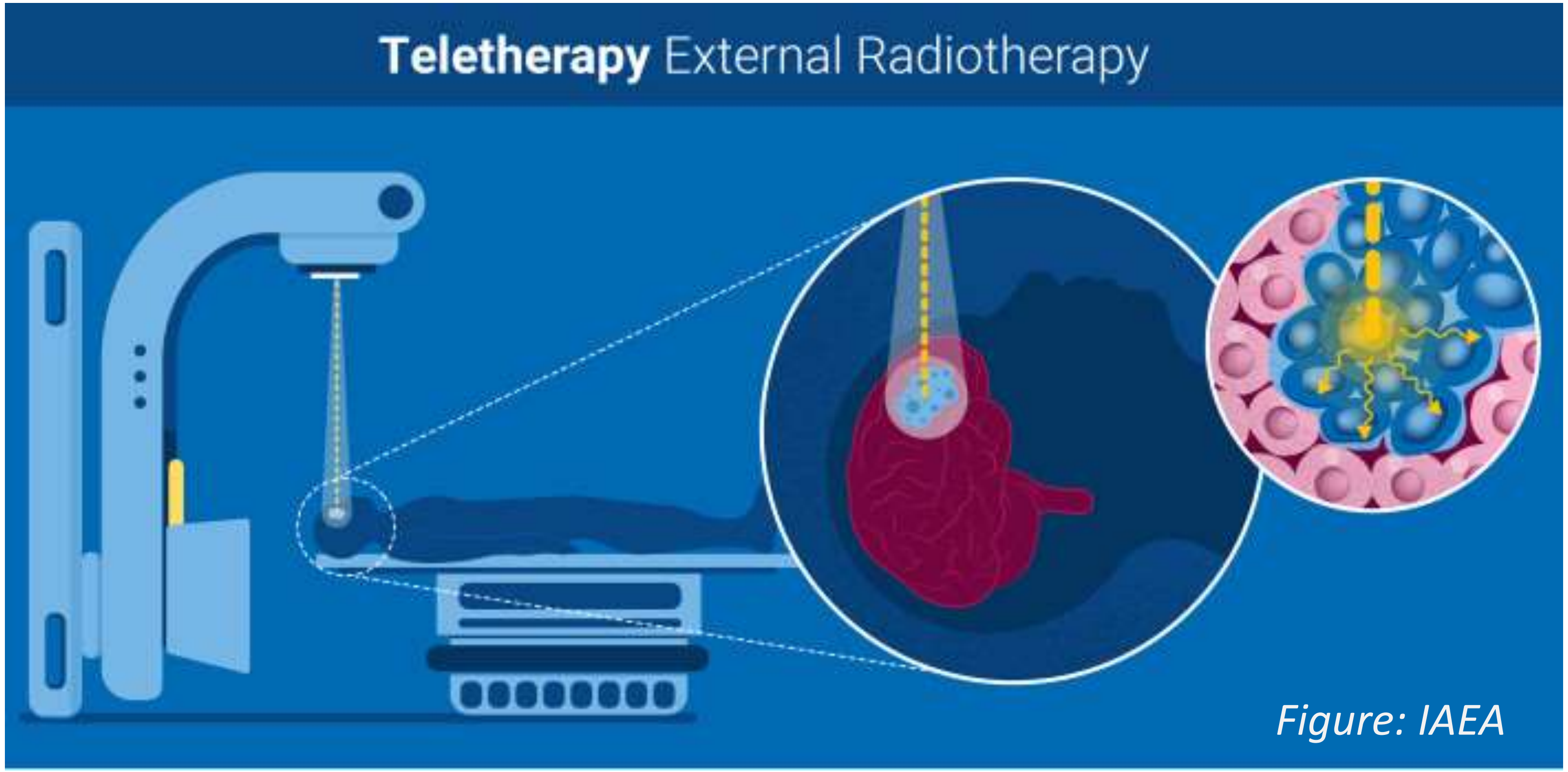


Figure: IAEA

Teletherapy: a large machine moves around you, sending gamma beams into precise points in your body.

Brachytherapy: radioisotopes are injected into patients to treat cancers from inside. Mostly the head, neck, breast, cervix, prostate, thyroid, and eye.

Dose fractioning: Therapy doses typically range from 30 to 60 Gy. Typically, these doses are divided into multiple smaller doses, given over 1-2 months.

National Cancer Instiute: www.cancer.gov

Ga-68 development for cancer imaging

Development of Ga-68 for dual targeting, binding cancer drugs two receptor types, to increase the effectiveness of cancer imaging.

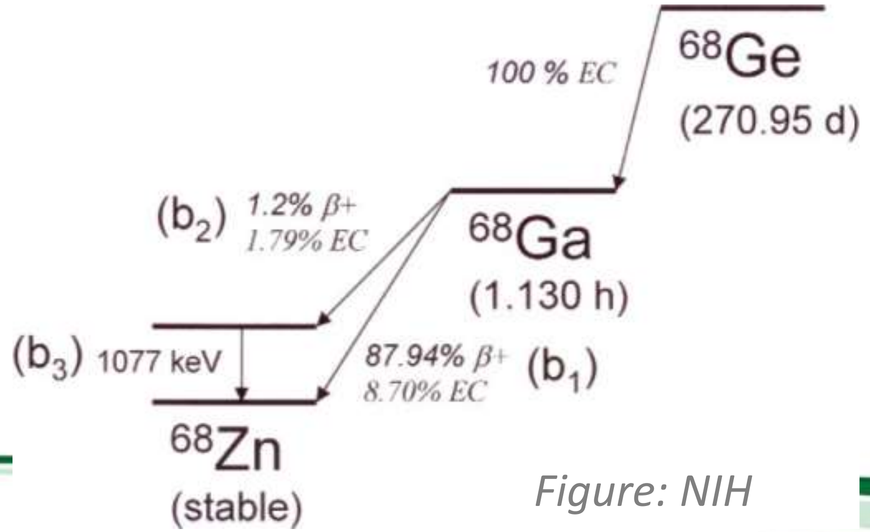
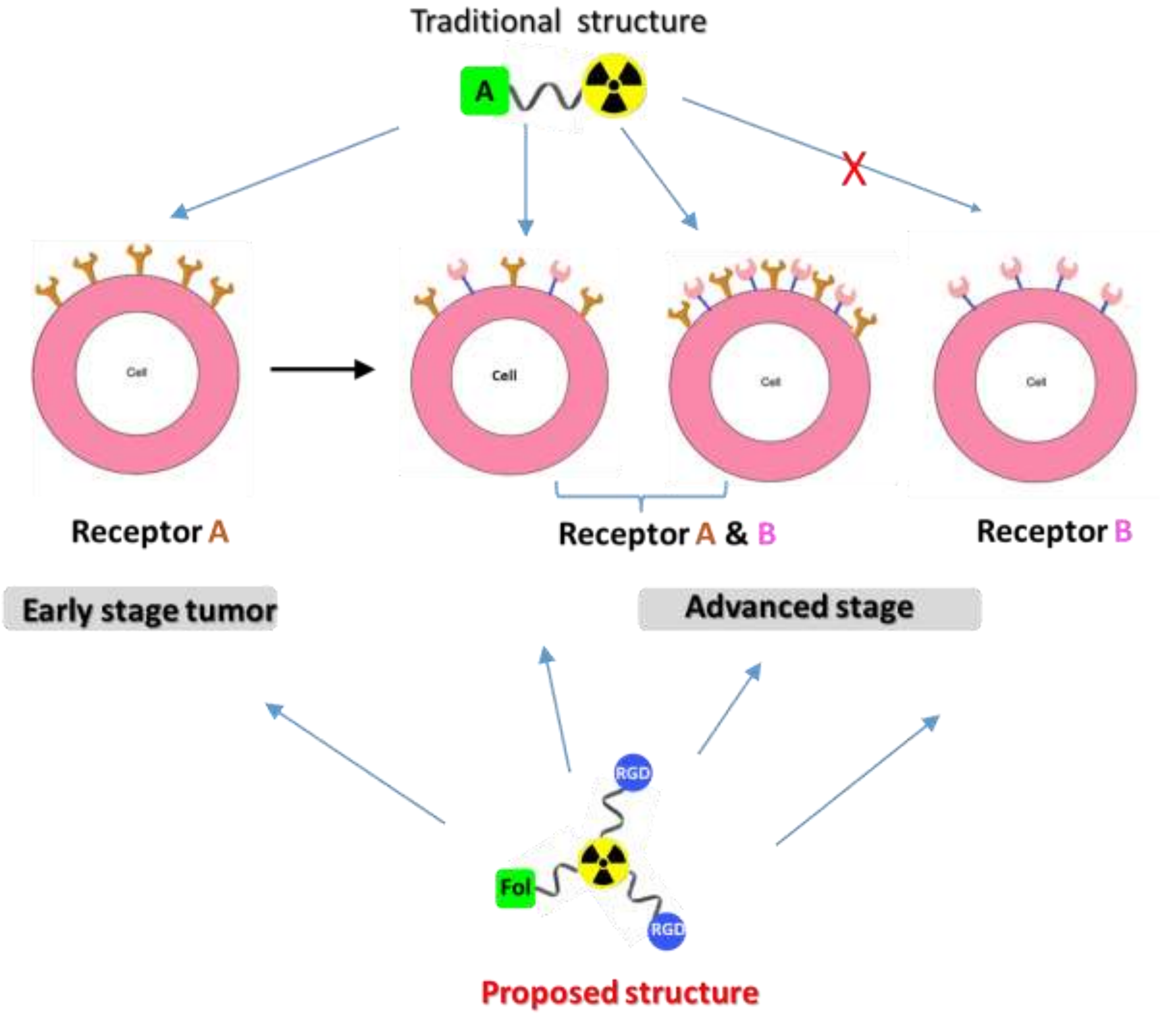


Figure: NIH

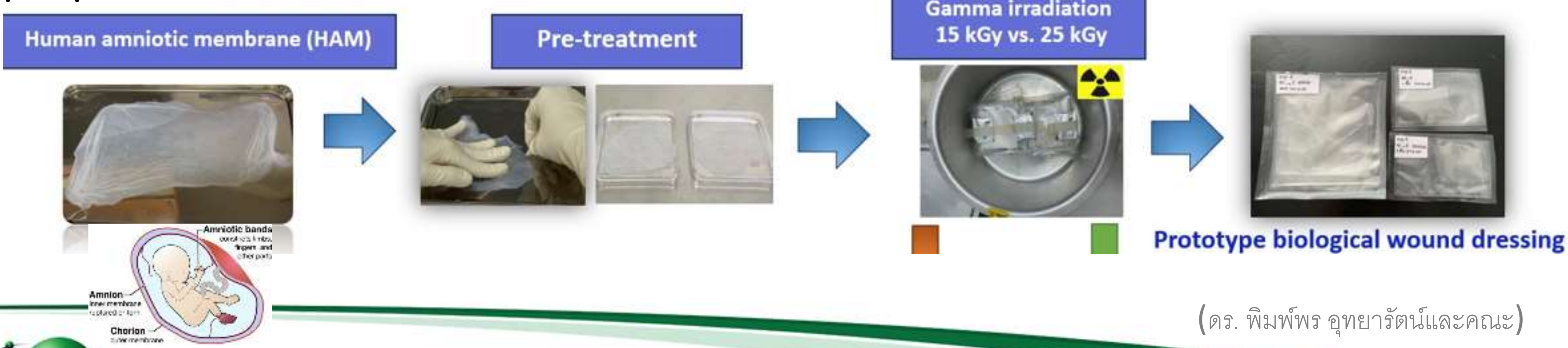


(ดร. พิริญา แก้วพุกัม และคณะ)

Health & Medical Research @ TINT

Cytotoxicity test using MTT assay of medical devices that have been irradiated.

Development of amniotic membrane using gamma and e-beam as multi-purpose biofilms.



(ดร. พิมพ์พร อุทยารัตน์และคณะ)

Thank you

Q&A