

Understanding  
Radioactive Wastes:  
*The Chalk River Legacy*

A Slide Show

prepared for  
The Pikwakanagan Algonquin Council  
July 13 2017

Gordon Edwards, Ph.D., President,  
Canadian Coalition for Nuclear Responsibility

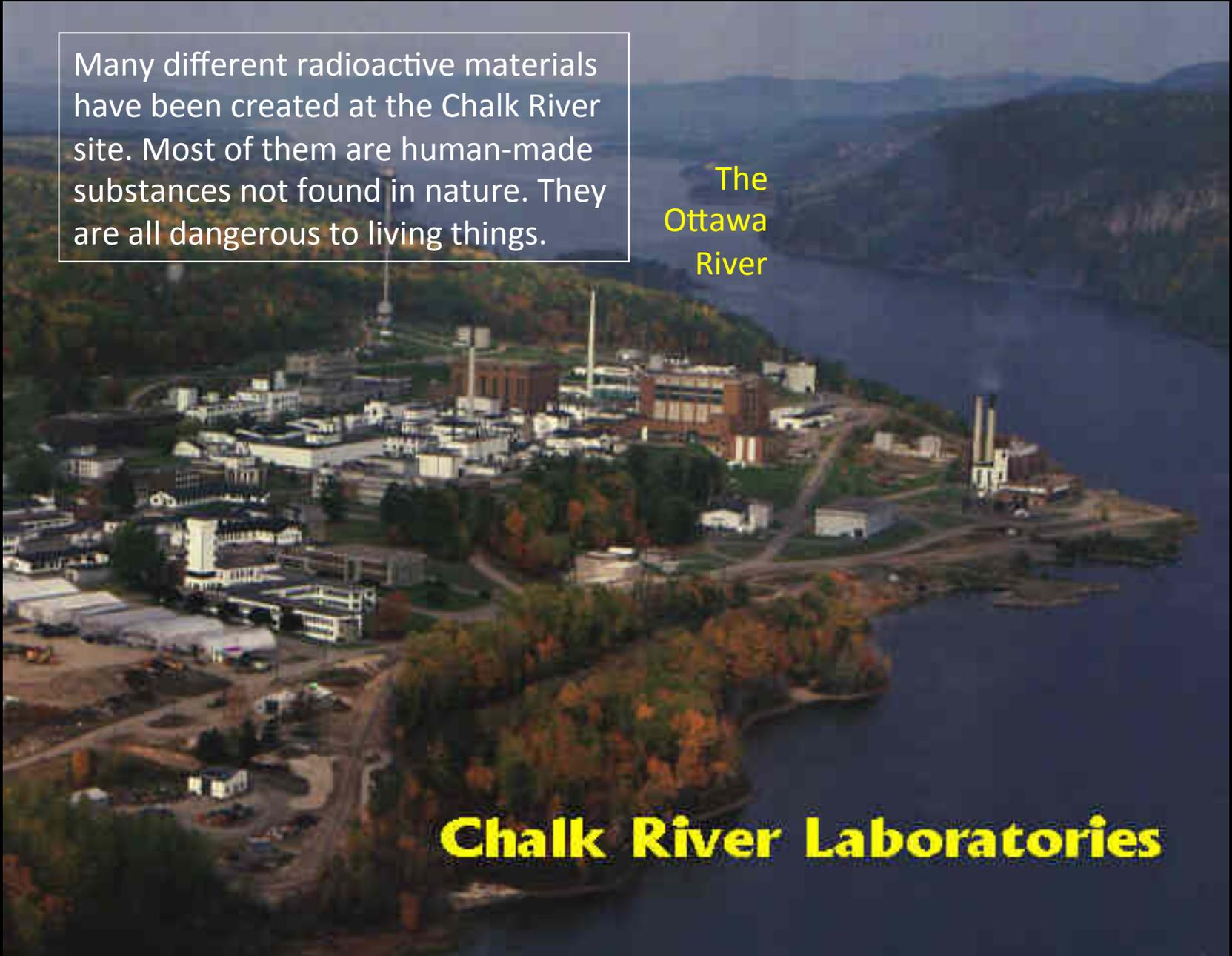
e-mail: [ccnr@web.ca](mailto:ccnr@web.ca)

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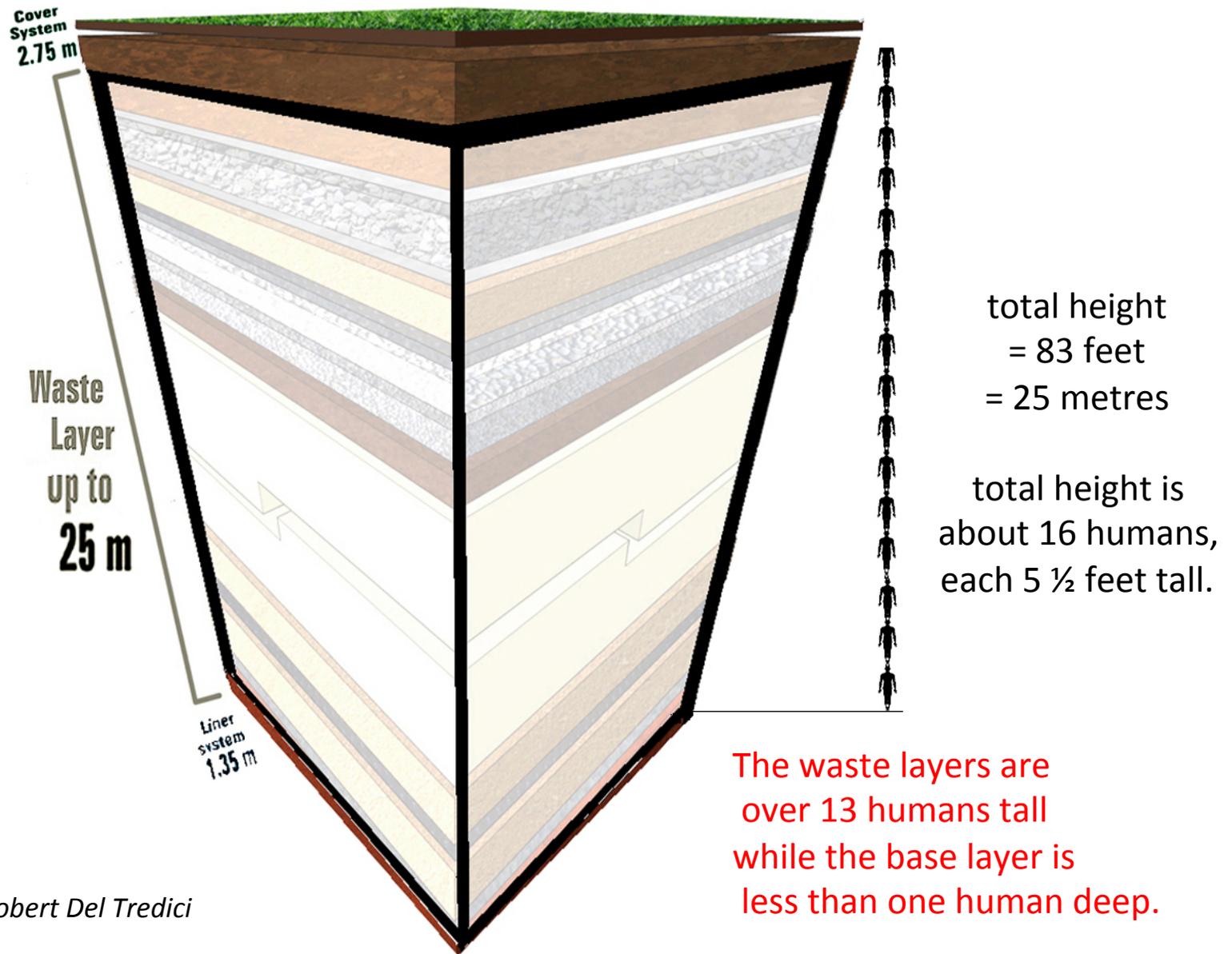
Many different radioactive materials have been created at the Chalk River site. Most of them are human-made substances not found in nature. They are all dangerous to living things.

The  
Ottawa  
River

**Chalk River Laboratories**



Low and Intermediate level radioactive waste “mound” proposed for Chalk River, Ontario.  
A surface dump, 7 stories tall, with a base = 70 hockey rinks, 1 km from Ottawa River.



Graphic by Robert Del Tredici

# What does “nuclear” mean?

Every atom has a tiny core called the **NUCLEUS**.  
The nucleus is surrounded by one or more orbiting electrons.



*Photo: Robert Del Tredici*

**Most familiar forms of energy** involve only the electrons . . .



Battlefield explosion



Forest fire

. . . **but nuclear energy** comes from the nucleus –  
and it is **millions of times more powerful !**

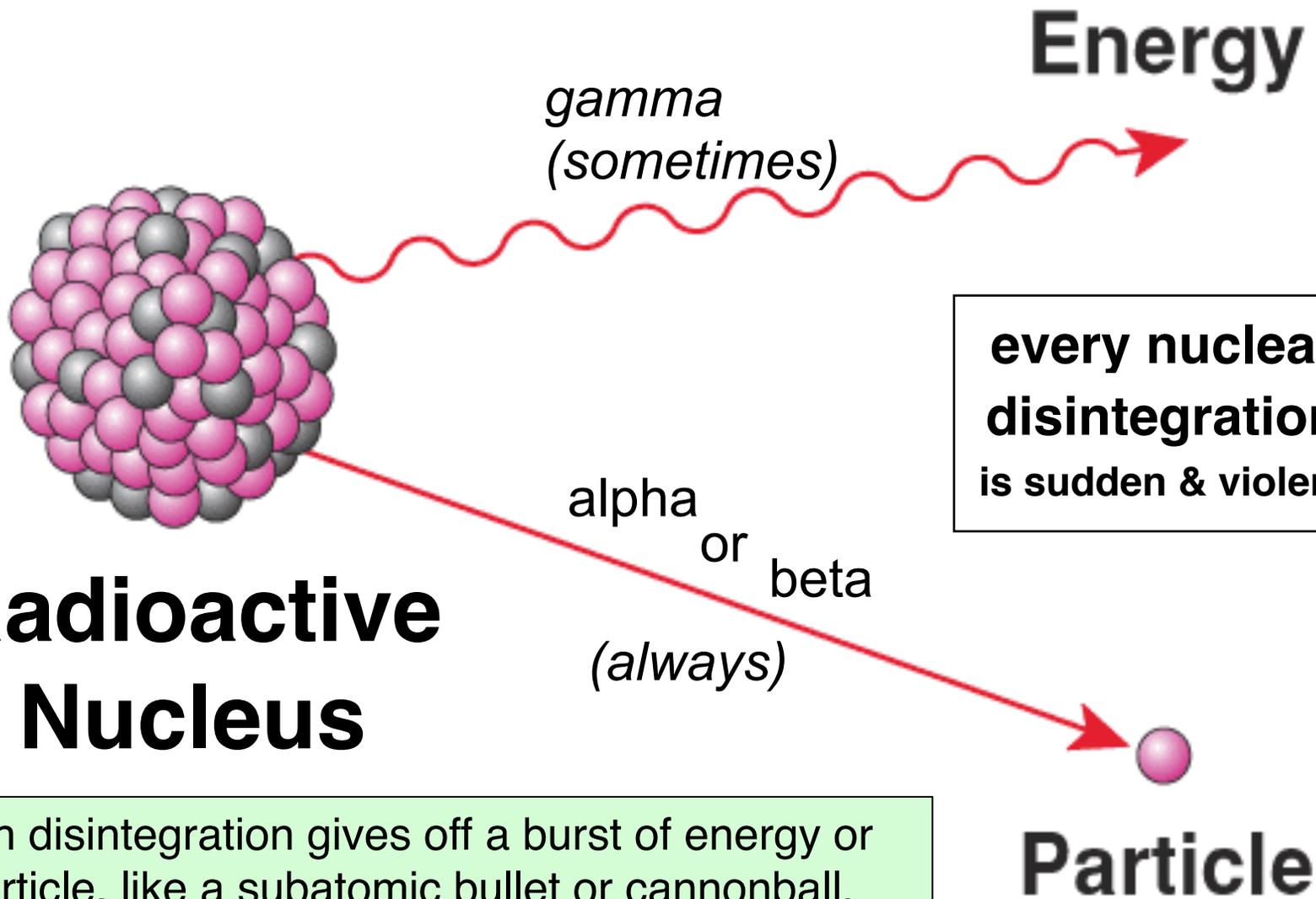


H-Bomb Blast

FACT: Radioactivity is  
a form of nuclear energy  
that *cannot be shut off.*

*That's why we have  
a nuclear waste problem.*

Radioactive materials are chemical substances with unstable atoms – the atoms “disintegrate”!



Each disintegration gives off a burst of energy or a particle, like a subatomic bullet or cannonball, that will do great damage to nearby living cells.

Alpha, Beta, and Gamma “rays” are normally invisible



*Photo: Robert Del Tredici*

But in a “cloud chamber” you can see the tracks of all 3 types of emissions from uranium ore

# RADIOACTIVE MATERIALS

## RADIOACTIVE MATERIALS

are diverse and have different pathways thru the human body.

Each one has a “target” organ inside the body

When atoms “disintegrate” damage is done – fatal & non-fatal diseases may occur years later

### THYROID

iodine-131  
beta (gamma) ; 8 days

### SKIN

sulphur-35  
beta ; 87 days

### LIVER

cobalt-60  
beta (gamma) ; 5 years

### OVARIES

iodine-131  
beta (gamma) ; 8 days

cobalt-60  
beta (gamma) ; 5 years

krypton-85  
gamma ; 10 years

ruthenium-106  
gamma ; 1 year

zinc-65  
gamma ; 245 days

barium-140  
gamma ; 13 days

potassium-42  
gamma ; 12 hours

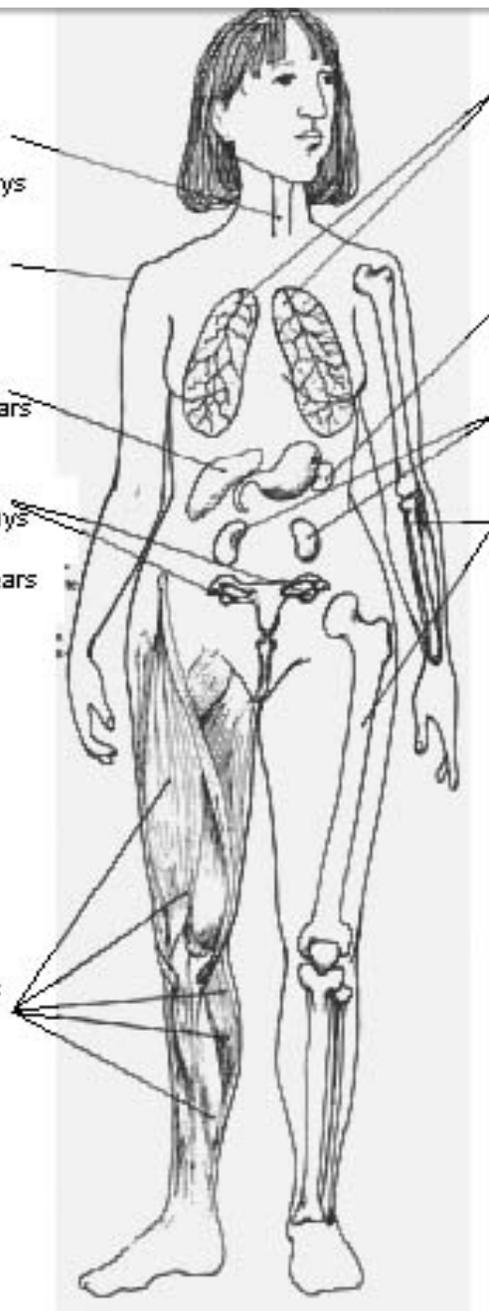
cesium-137  
gamma ; 30 years

plutonium-239  
alpha ; 24 000 years

### MUSCLE

potassium-42  
gamma ; 12 hours

cesium-137  
gamma ; 30 years



### LUNGS

radon-222 (and whole body)  
alpha ; 3,8 days

uranium-233 (et os)  
alpha ; 162 000 years

plutonium-239 (and bone)  
alpha ; 24 000 years

### SPLEEN

polonium-210 (and whole body)  
alpha ; 138 days

### KIDNEYS

uranium-238 (and bone)  
alpha ; 4 500 000 years

ruthenium-106  
gamma (beta) ; 1 year

### BONE

radium-226  
alpha ; 1 620 years

zinc-65  
gamma ; 245 days

strontium-90  
beta ; 28 years

yttrium-90  
beta ; 64 hours

promethium-147  
beta ; 2 years

barium-140  
beta (gamma) ; 13 days

thorium-234  
beta ; 24,1 days

phosphorus-32  
beta ; 14 days

carbon-14 (and fat)  
beta ; 5 600 years

# RADIOACTIVE MATERIALS

**Radioactive iodine** does not exist in nature – *it behaves like ordinary iodine.*

**Iodine** goes to the thyroid gland (in the throat) and keeps it healthy.

**But radioactive iodine** damages the thyroid – it causes cancer & other illnesses.

## THYROID

iodine-131  
beta (gamma) ; 8 days

## SKIN

sulphur-35  
beta ; 87 days

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beta (gamma) ; 5 years

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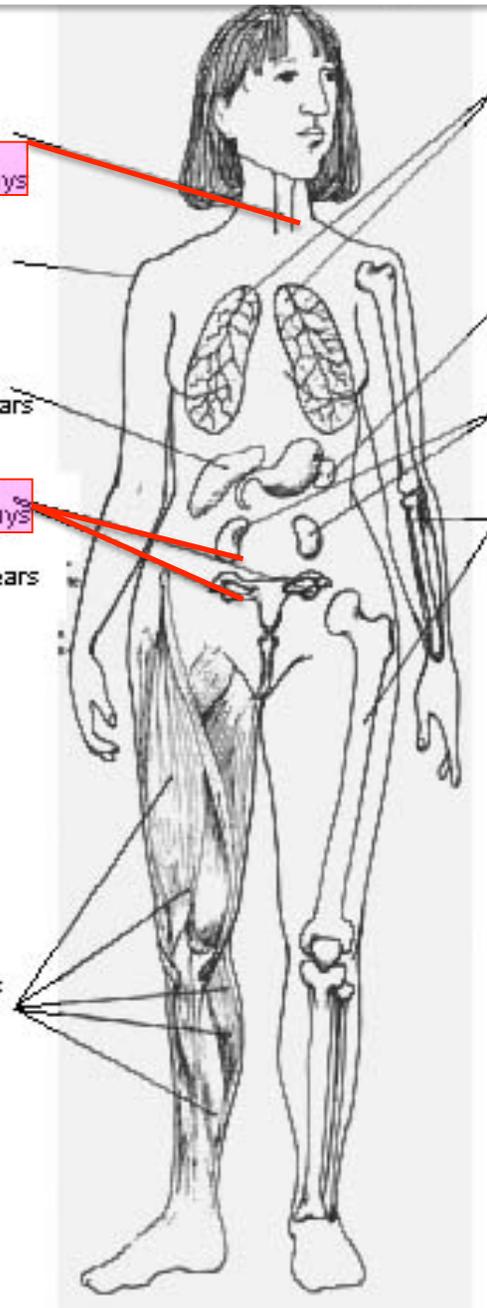
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# RADIOACTIVE MATERIALS

**Radioactive cesium** does not exist in nature – *it behaves like ordinary cesium.*

**Cesium** goes to the blood & soft tissues – it lodges in meaty tissues .

**But radioactive cesium** makes meat unfit as food for humans.

## THYROID

iodine-131  
beta (gamma) ; 8 days

## SKIN

sulphur-35  
beta ; 87 days

## LIVER

cobalt-60  
beta (gamma) ; 5 years

## OVARIES

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beta (gamma) ; 8 days

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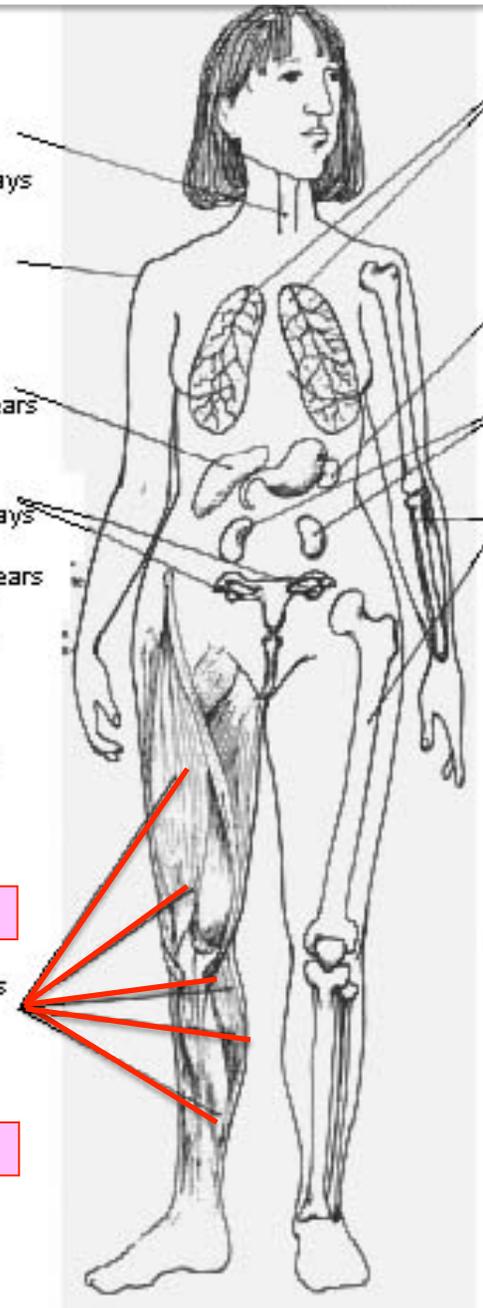
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carbon-14 (and fat)

beta ; 5 600 years

# RADIOACTIVE MATERIALS

**Radioactive strontium** is not found in nature – *it behaves like ordinary strontium.*

**Strontium** goes to the bones, teeth, & mother's milk – it is like calcium.

**But radioactive strontium** causes bone cancer and blood diseases such as leukemia.

## THYROID

iodine-131  
beta (gamma) ; 8 days

## SKIN

sulphur-35  
beta ; 87 days

## LIVER

cobalt-60  
beta (gamma) ; 5 years

## OVARIES

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potassium-42  
gamma ; 12 hours

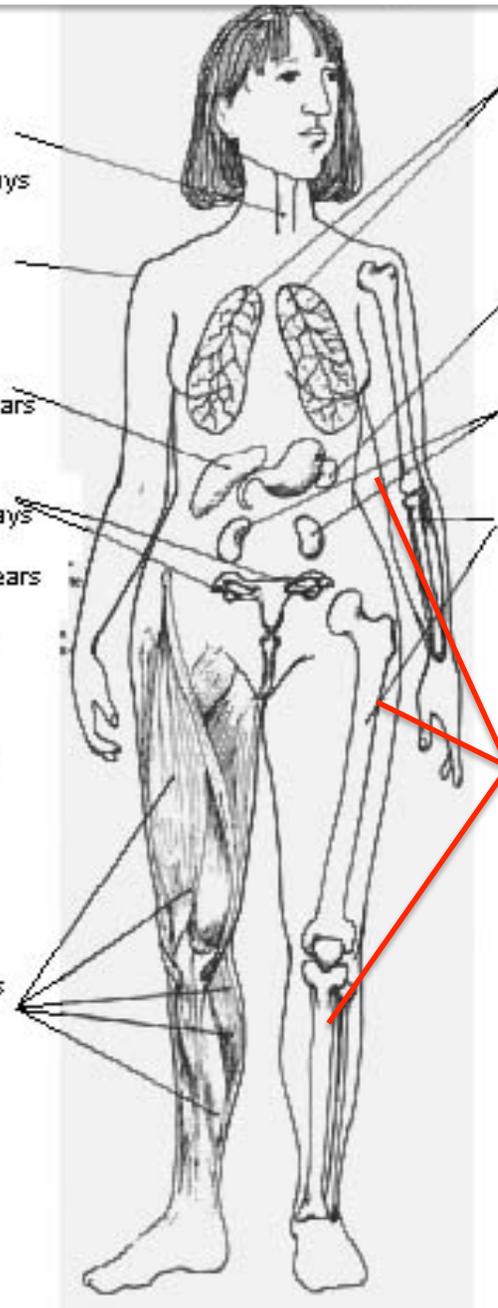
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gamma ; 30 years

plutonium-239  
alpha ; 24 000 years

## MUSCLE

potassium-42  
gamma ; 12 hours

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beta ; 14 days

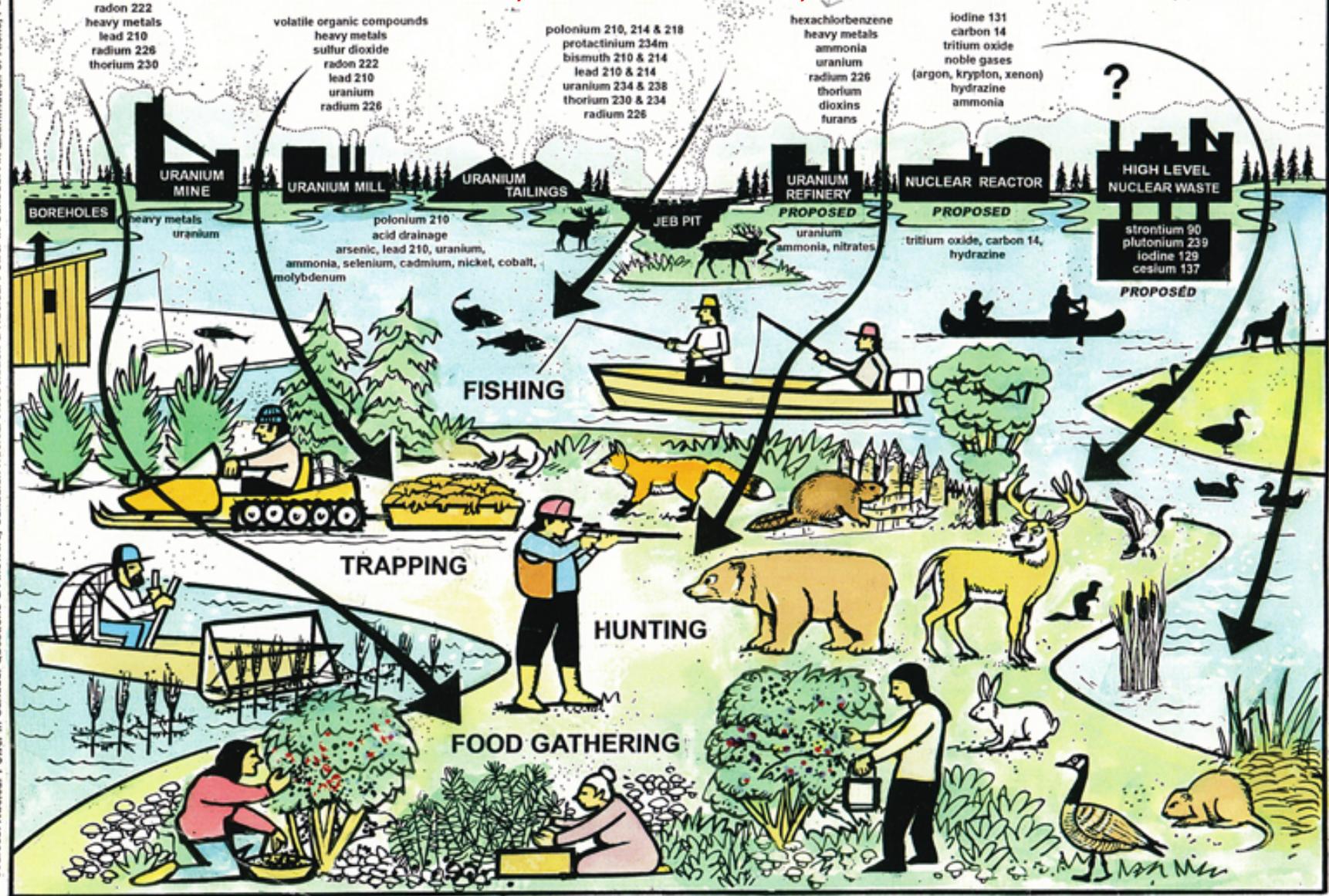
carbon-14 (and fat)

beta ; 5 600 years

# POLLUTION FROM THE NUCLEAR FUEL CHAIN

**RADIOACTIVE AND CHEMICAL POISONS CAN CONTAMINATE THE AIR WE BREATHE, THE WATER WE DRINK, AND THE FOOD WE EAT**

sources: Nuclear Power in Canada: Questions & Answers, Canadian Nuclear Association & Nuclear Power in Canada: An Examination of Risks, Pembina Institute



ARROWS SHOW GENERALIZED EXPOSURE PATHWAYS THROUGH AIR & WATER

Graphic by David Geary

graphic: Coalition for a Clean Green Saskatchewan design group cleangreensask@yahoo.ca

Chronic exposure to radioactive materials increases the incidence of cancer, leukemia, and genetic damage, as well as anemia, damaged immune systems, strokes, heart attacks, & low intelligence

BUT there is a “latency period” for exposure at low levels –

– the onset of disease may occur years or decades after exposure.

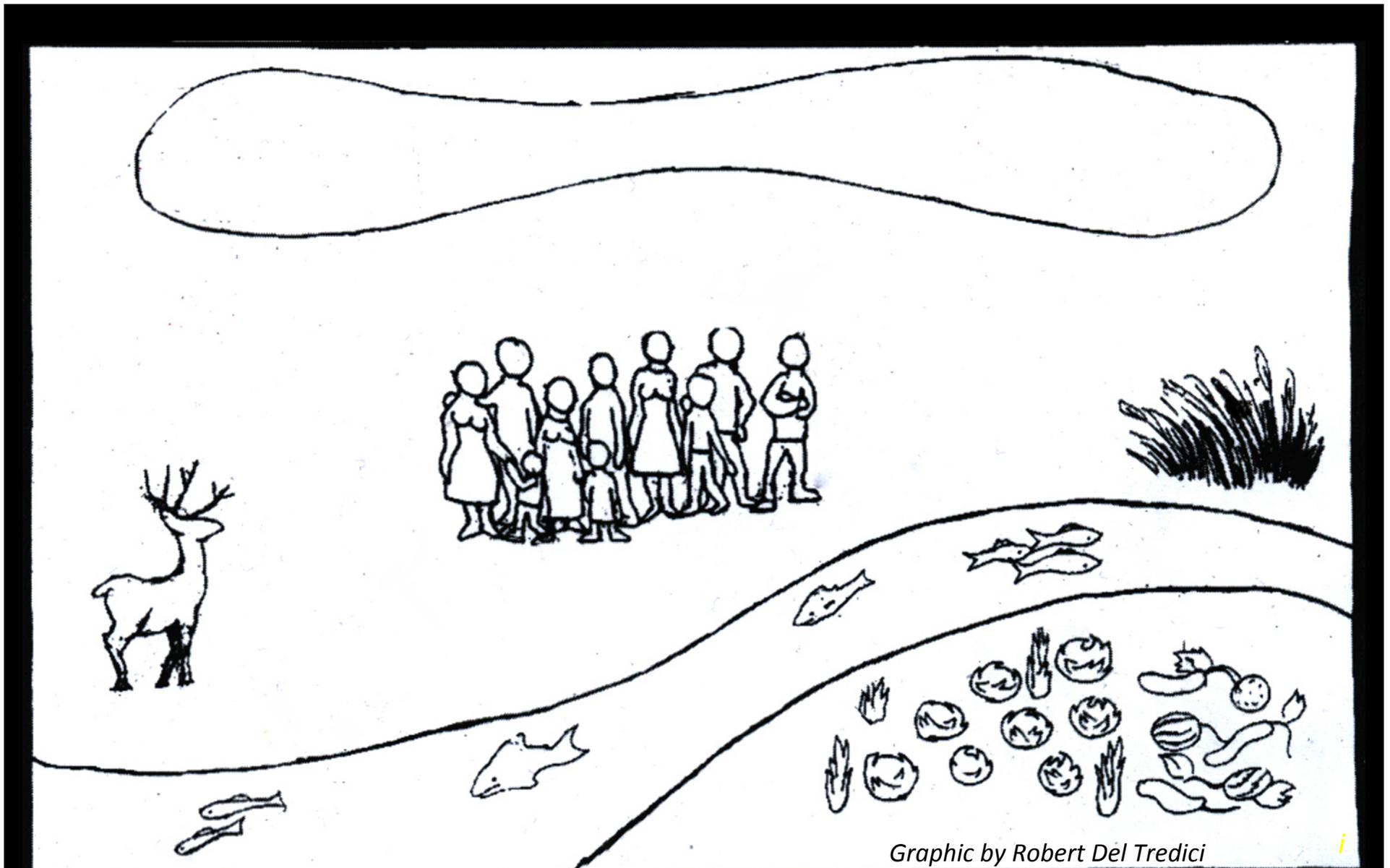
All radioactive materials  
are damaging to living things

*That's why nuclear waste  
is a public health problem.*

The incidence of  
radiation-induced disease  
depends on the “population dose”.

*The larger the population exposed,  
the larger the number of cases of illness.*

(This is often called the “Linear” Model).



At low levels of exposure, harmful biological effects like cancer do not occur until many years after exposure.



Graphic by Robert Del Tredici

KACCT

Radioactive materials enter into the air, water and soil.  
They get into fish, plants, animals, and humans.



A small fraction of the population will develop cancer, years later. Infants and children are especially vulnerable.



Graphic by Robert Del Tredici

R. Del Tredici

If a larger population is exposed to the **same** level of contamination, we say that **the “population dose” is greater.**



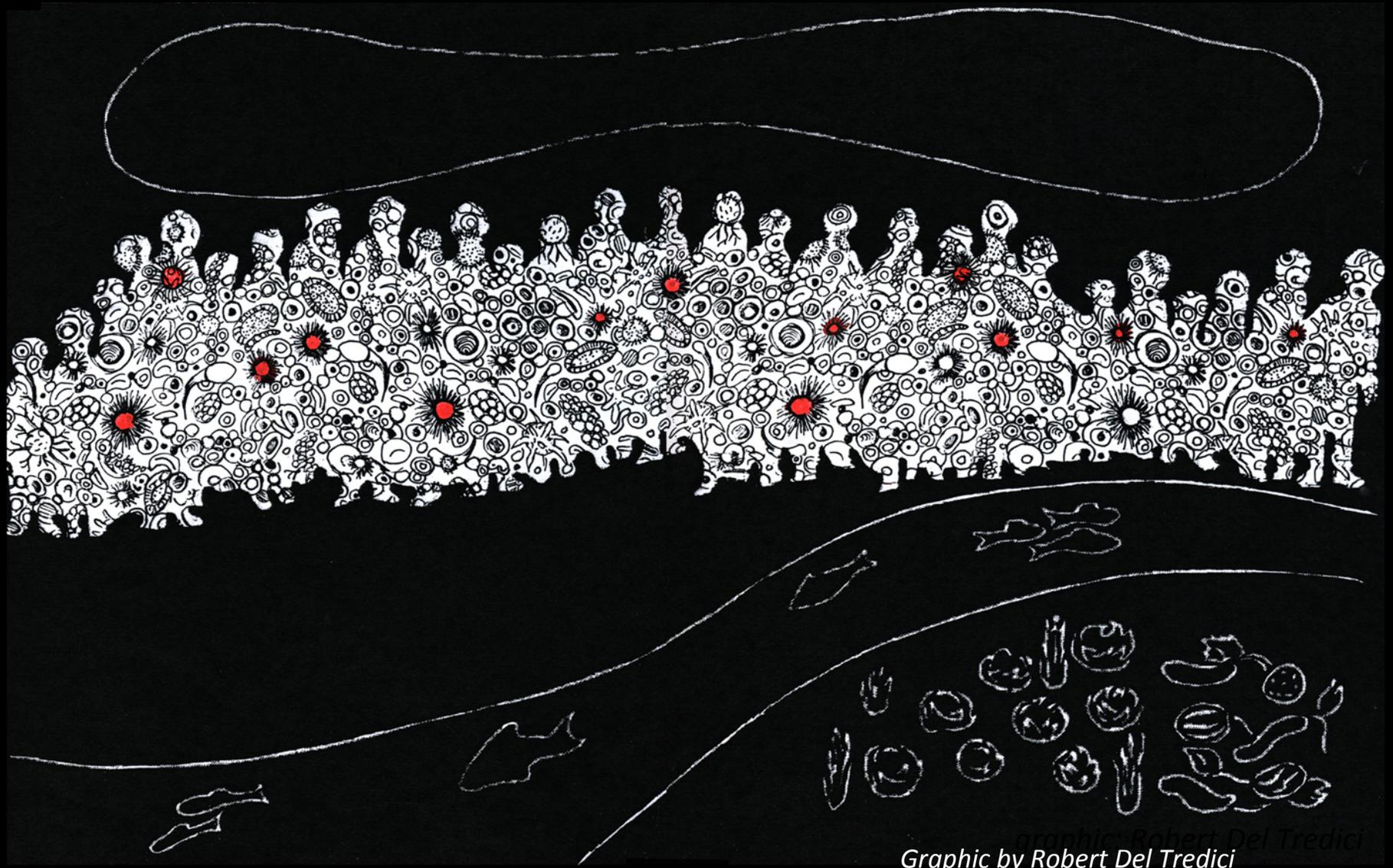
Graphic by Robert Del Tredici *R Del T*

The greater the population dose, the more cases of adverse health effects – like cancer – will be seen.



*Graphic by Robert Del Tredici*

At low levels, radioactivity does not attack humans directly  
– it damages cells. A population is like an ocean of cells.

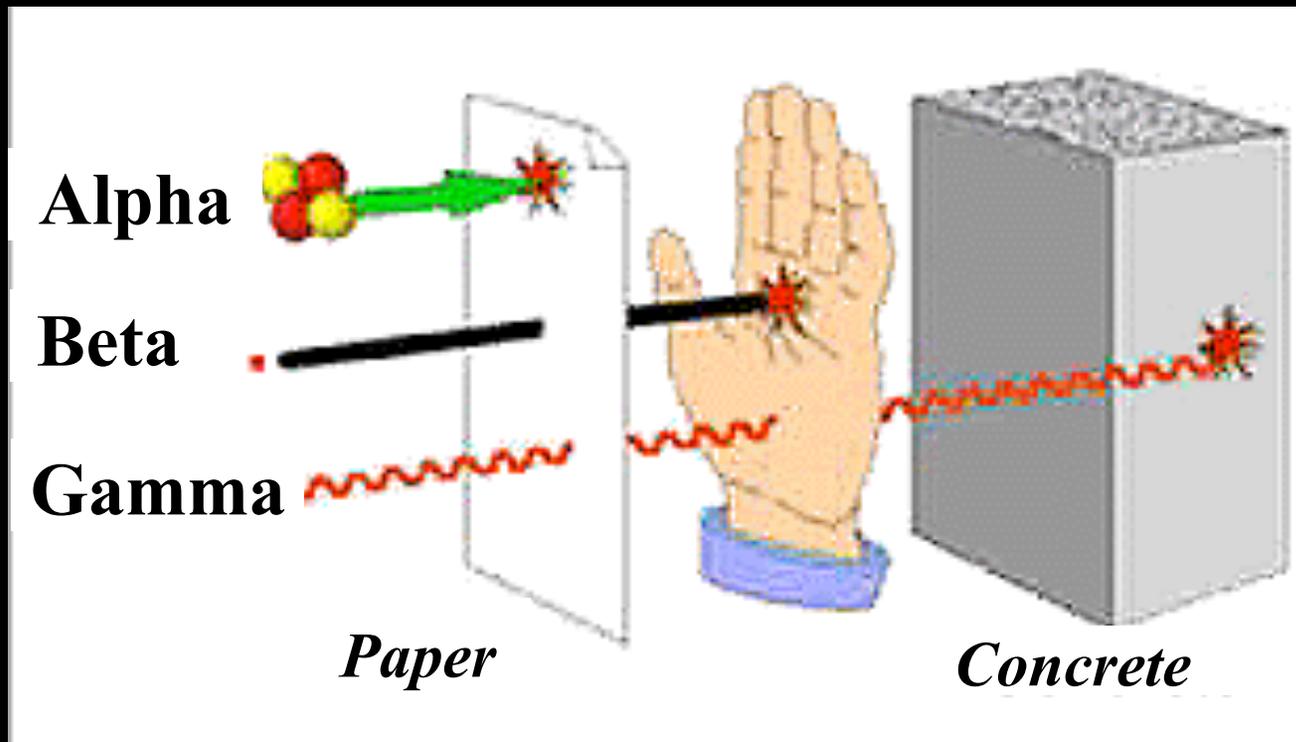


Graphic by Robert Del Tredici

A fraction of those cells will develop into cancers.  
It is largely a matter of chance whose body the cancer is in.

## Alpha radiation and beta radiation are INTERNAL HAZARDS.

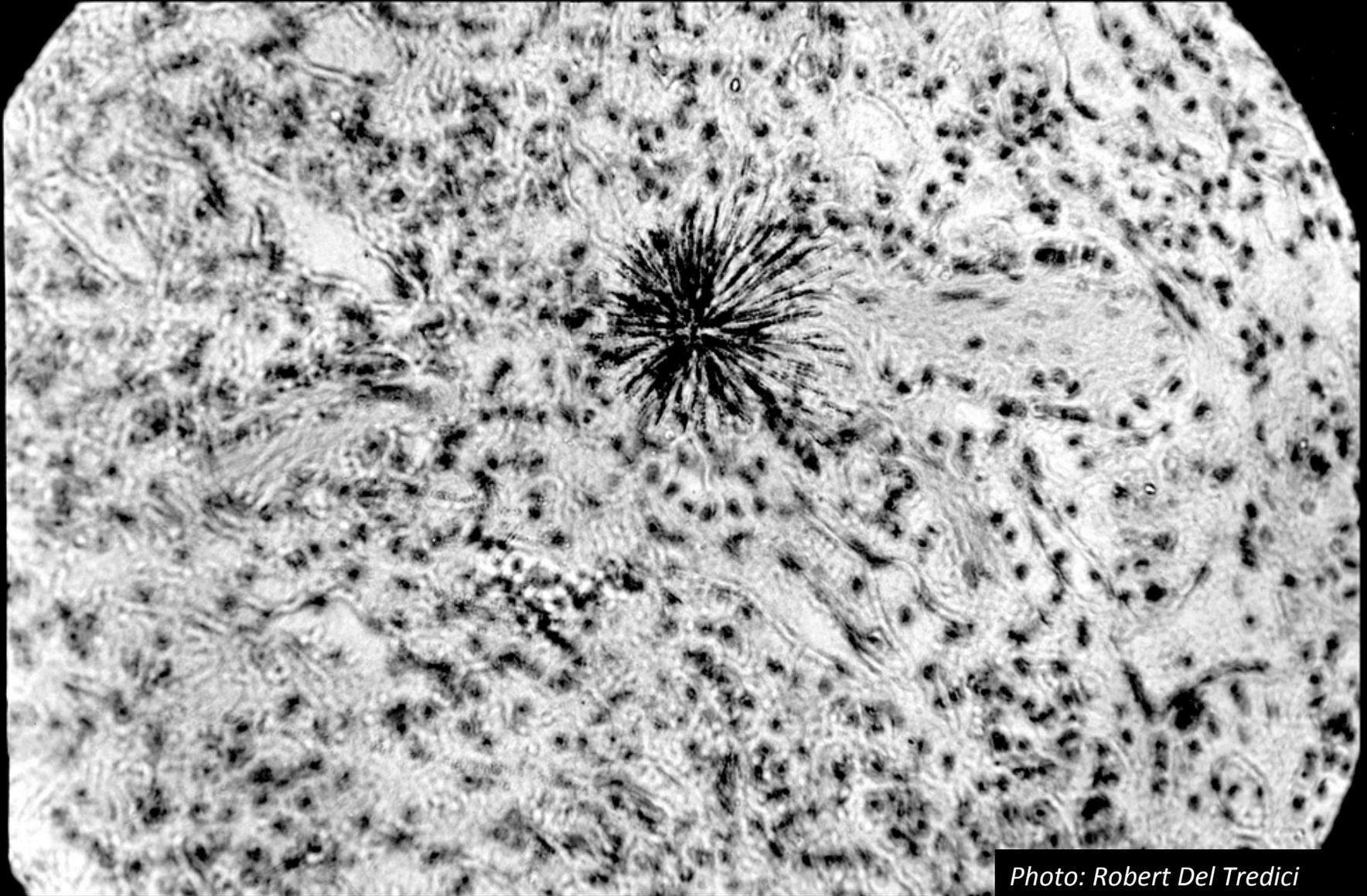
Alpha particles can be stopped by a sheet of paper.  
*Alpha emitters are harmless outside the body, but much more damaging than beta or gamma when ingested or inhaled.*



Beta particles penetrate only part-way.  
They can damage *eyes or skin* externally  
but the *main danger is internal exposure*.

Gamma rays are highly penetrating.  
They give "*whole body*" radiation.  
Heavy *shielding* is often needed.

This photo shows a tiny speck of plutonium lodged in lung tissue.



*Photo: Robert Del Tredici*

The “spikes” are the tracks of alpha particles emitted over 48 hours.

*The lung tissue of an experimental animal seen through a microscope over a period of 48 hours. At the centre of the “star” is a tiny radioactive particle of plutonium.*

*Photo: Robert Del Tredici*

*Each “spike” is the track of an alpha particle given off during that 48 hour period. These radioactive emissions do not travel very far.*

*But some of the cells that are damaged may be able to reproduce with defective genes – these cells could be the beginning of cancer.*

**radium, radon, polonium, thorium, plutonium, uranium – all alpha emitters.**

The End

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