Uranium exploration – safety, environmental and regulatory considerations

Nick Tsurikov

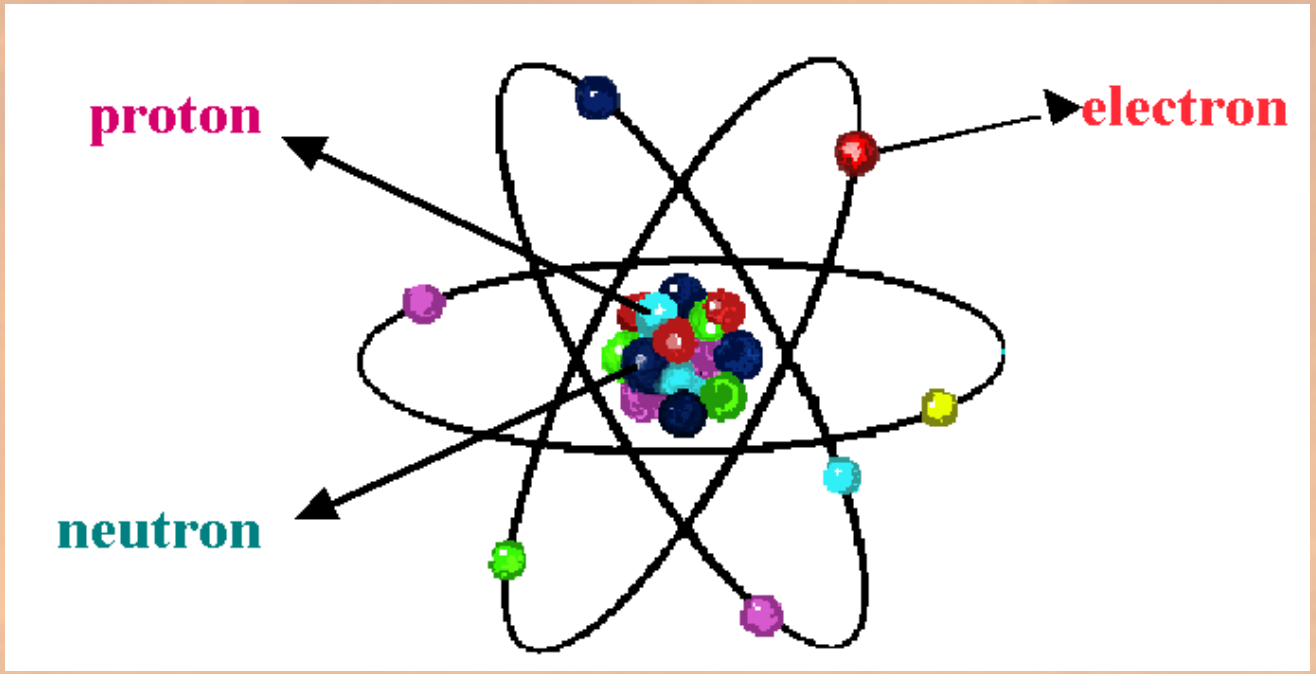
CALYTRIX CONSULTING PTY LTD

Introduction to Radioactivity

Atoms

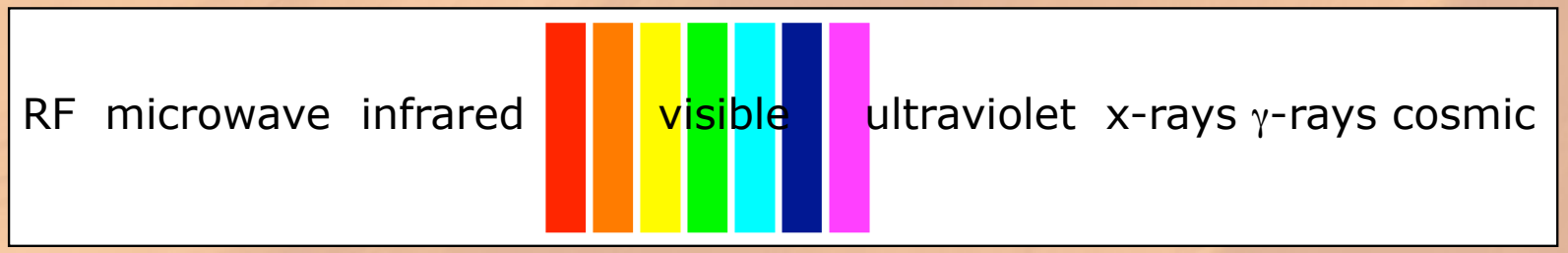
Atoms are the building blocks of all matter. Almost all atoms are very stable, but some may have too much energy and be radioactive. Unstable atoms emit energy.

The three basic particles of the atom are protons, neutrons and electrons.



All this is called RADIATION

Low energy ⇨ High energy



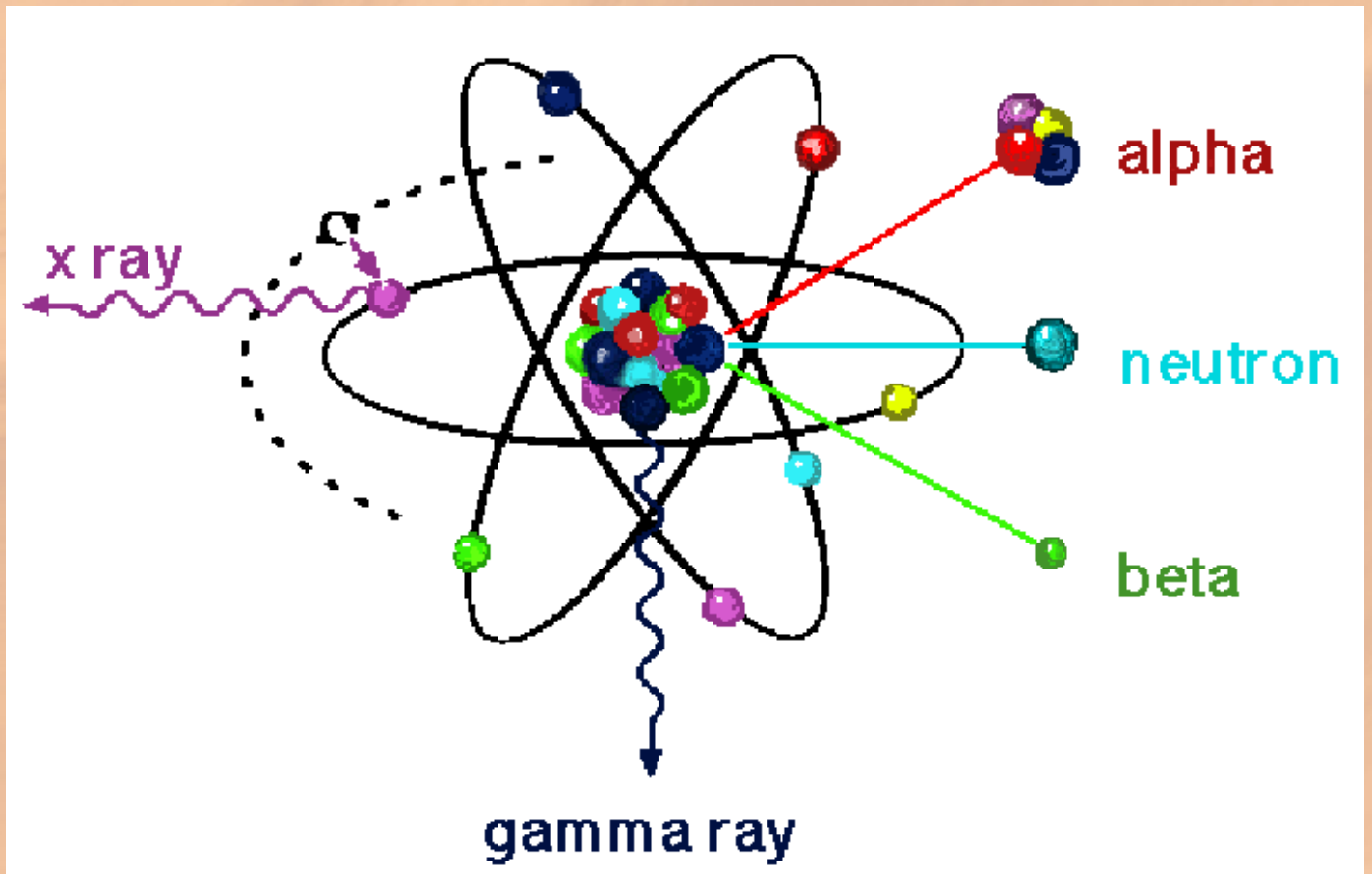
Non-Ionising radiation

Ionising radiation

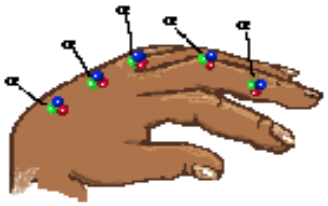
Non-ionising radiation does not have enough energy to remove electrons from atoms, but ionising radiation does.

An atom that has had electrons removed from it, is called an ion.

There are several types of ionising radiation:

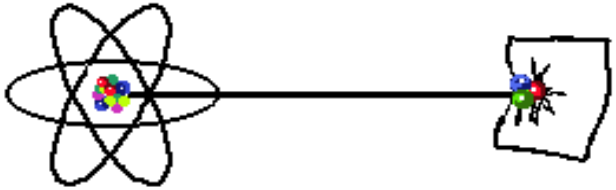


α Alpha-particles



Cannot penetrate skin

Internal hazard

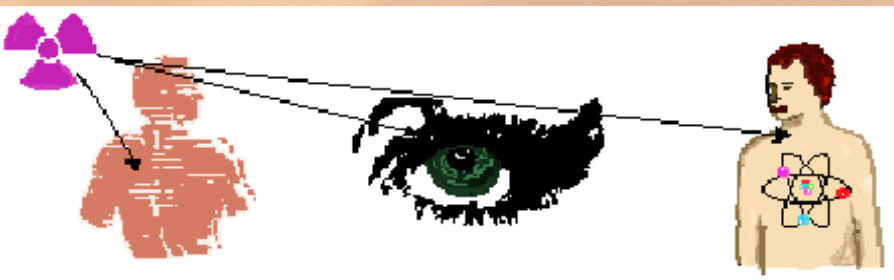


Stopped by paper

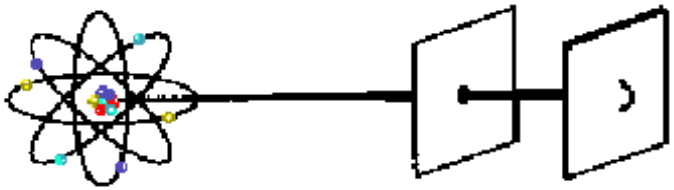
Found in soil, air (radon) and other radioactive materials

Alpha-radiation is only a hazard when inside your body (internal hazard)

β Beta-particles



Skin, eye and internal hazard

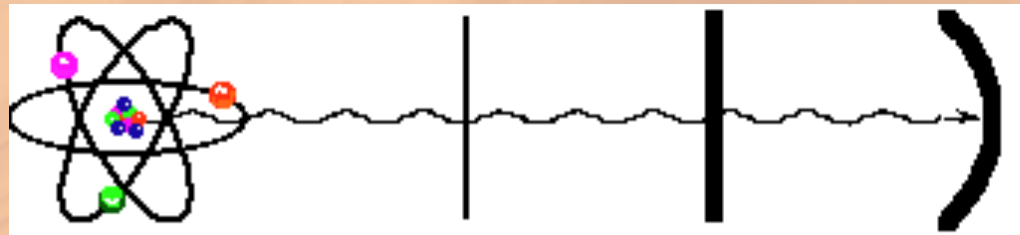


Stopped by aluminium, plastic

Found in natural food, air and water

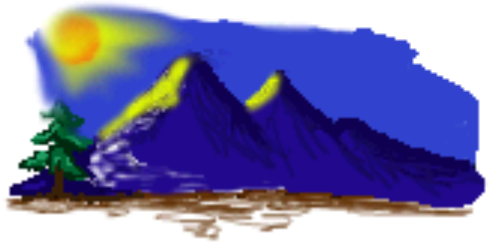
Beta-radiation is a skin, eye and internal hazard

γ Gamma-rays and X-rays



Stopped by lead

Used in medicine (X-rays)

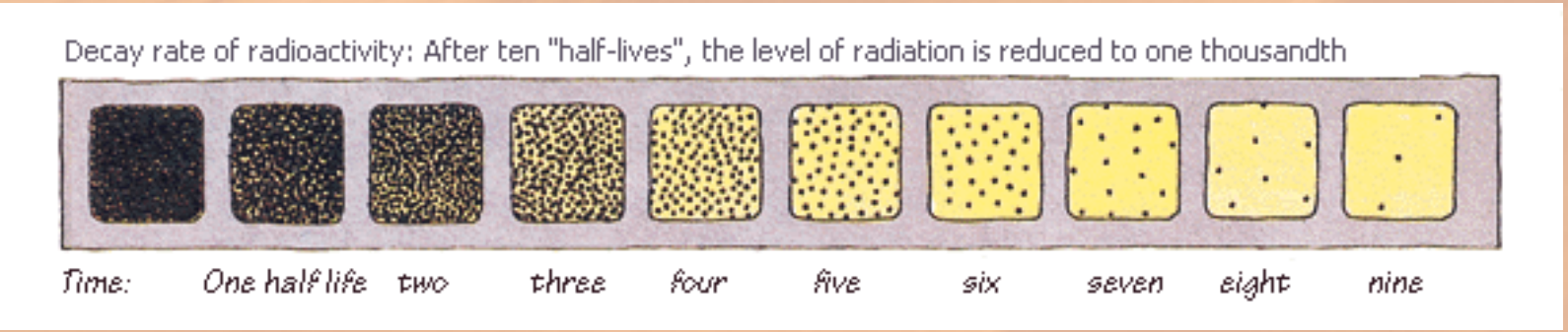


Naturally present in soil and cosmic radiation

Gamma-radiation is a hazard when outside your body (external, and to a lesser degree, internal hazard)

Half-life is a measure of activity of radioactive atoms:

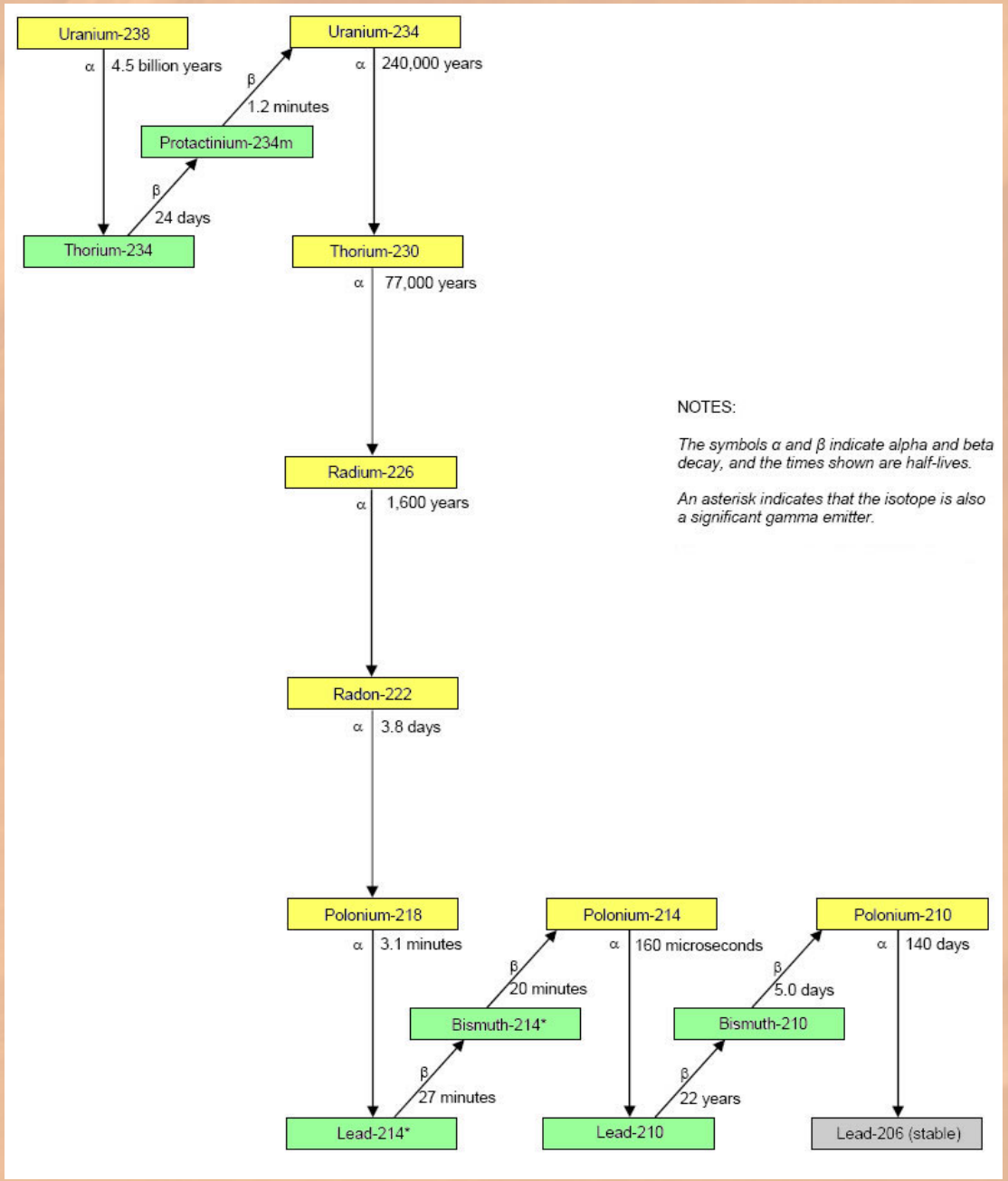
The time required for the amount of a radioactive material to decrease by one-half to another element/material (decay)



Short half-life (Cs, Co) ----> atoms are more radioactive

Long half-life (U, Th) ----> atoms are less radioactive

Decay Series is the sequence of materials that result in decay of radioactive atoms:



Units of radiation

Activity - is the number of atoms which decay per unit of time

Unit - Becquerel (Bq)

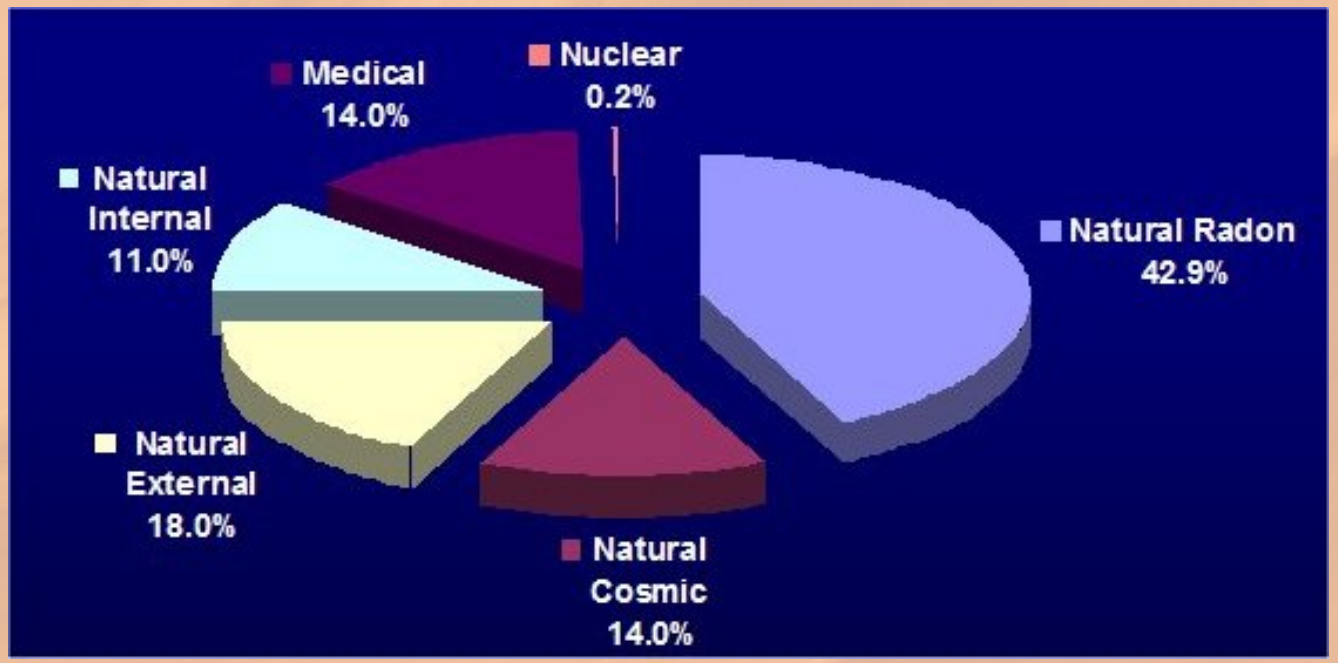
1 Bq = 1 atomic transformation per second

Dose - is the quantity of radiation (= energy) absorbed by the body

Unit - Sievert (Sv)

1 Sv = 1 Joule per kilogram of body mass

Natural radiation is the greatest source of human exposure



We are all exposed to radiation (average annual dose = 2.0 – 2.4 mSv):

- Cosmic rays from space
- Gamma rays from soil and building materials
- Radon gas emitted from soil and rock (buildings, tunnels, cellars, etc)
- Higher exposure at higher altitudes
- Traces of radioactive materials in food and drink

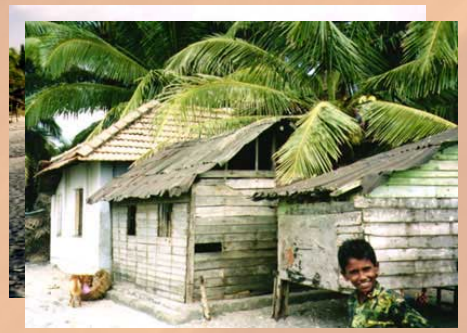
There are some areas in the world (Brazil, India, China), where the 'background' radiation exposure can be much higher, between 10 and 200 mSv per year

Exposure to natural radiation varies widely, from ~2-3 mSv/year in Australia to ~35 mSv/year in certain areas of Iran, China and Brazil.

Ramsar, Iran

Radiation doses may reach 50 mSv/year

Kerala, India



Houses built on "black" beaches, containing monazite
Radiation dose ~ 17 mSv/year

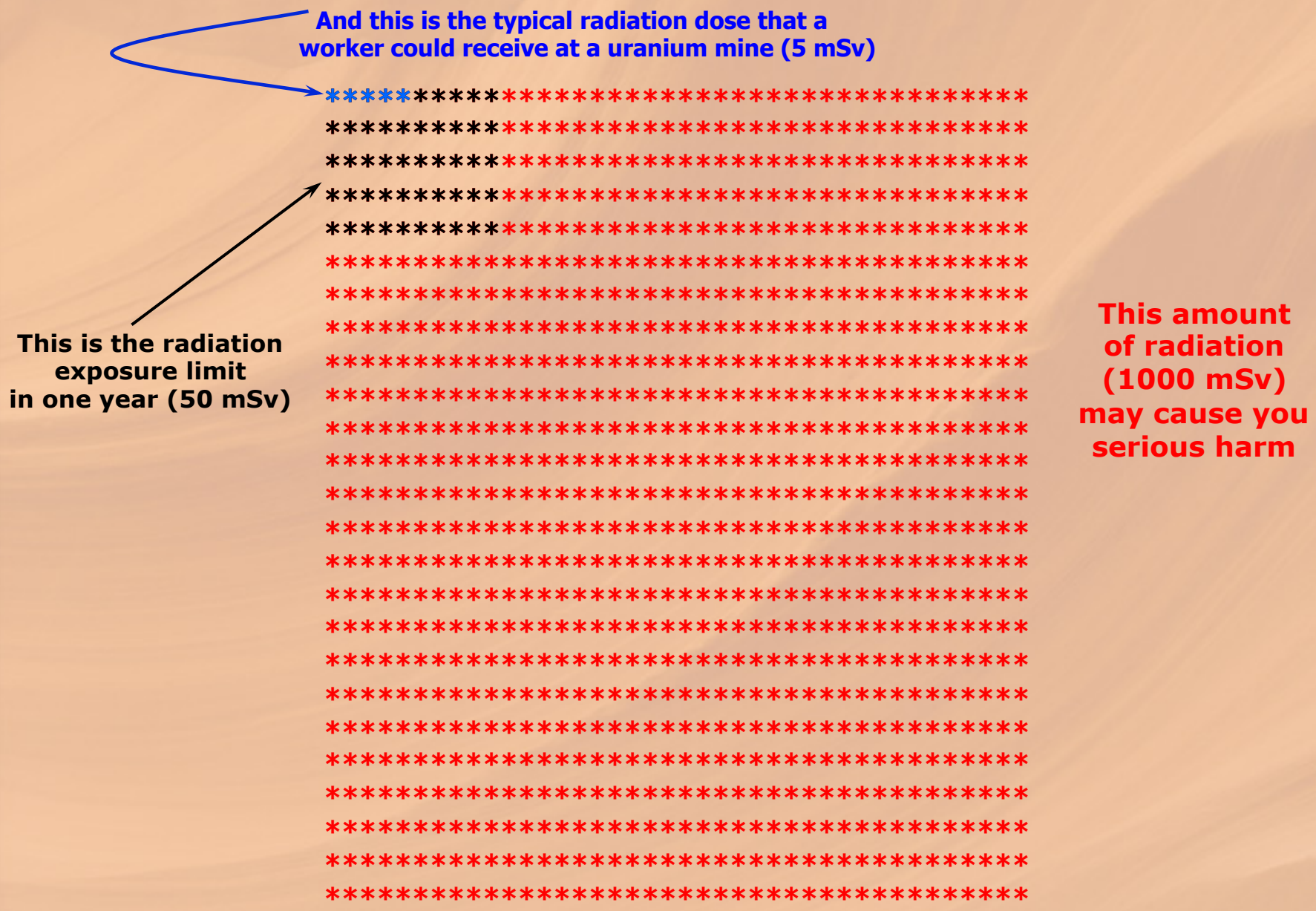
Guarapari, Brazil

"Radioactive" beaches in Brazil
Radiation dose ~ 35 mSv/year

Yangjiang, China

Bricks are made of clay containing radium
Radiation dose ~ 10 mSv/year

How dangerous is radiation?



Risk comparisons

Each of the following activities increases your risk of death by one chance in one million:

- **0.1 mSv of radiation (typical chest X-ray) - cancer**
- **Smoking 1 cigarette - cancer, heart disease**
- **Drinking 1/2 litre of wine - cirrhosis of the liver**
- **Spending 1 day in Beijing or 3 days in New York or Sydney - air pollution**
- **Rock climbing for $1^1/_2$ minutes - fatal accident**
- **Travelling 15 kilometres by bicycle - fatal accident**
- **Travelling about 70 kilometres by car - fatal accident**
- **Flying 1600 kilometres by air plane - fatal accident**
- **Eating 40 teaspoons of peanut butter - cancer caused by alpha-toxin B**
- **Drinking 30 cans of diet soft drink - cancer caused by saccharin**
- **Eating 100 charcoal-broiled steaks - cancer caused by benzopyrene**

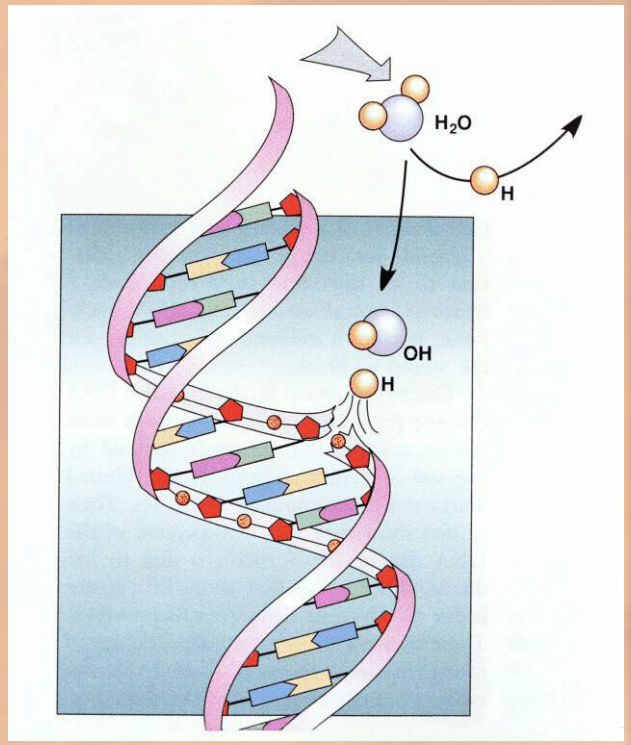
What actually happens when ionising radiation interacts with the human body

Cells

Trillions of cells make up the body
Active cells are more sensitive: white blood cells, bone marrow, stomach lining
Inactive cells are insensitive: bone, muscle, nerves, skin

Nucleus and DNA

Most cells contain center area, and this nucleus is sensitive to radiation
Holds the chromosomes - Deoxyribose Nucleic Acid (DNA) - genes
Controls the function of the cell and is sensitive to damage
Has repair mechanisms, but only to a point

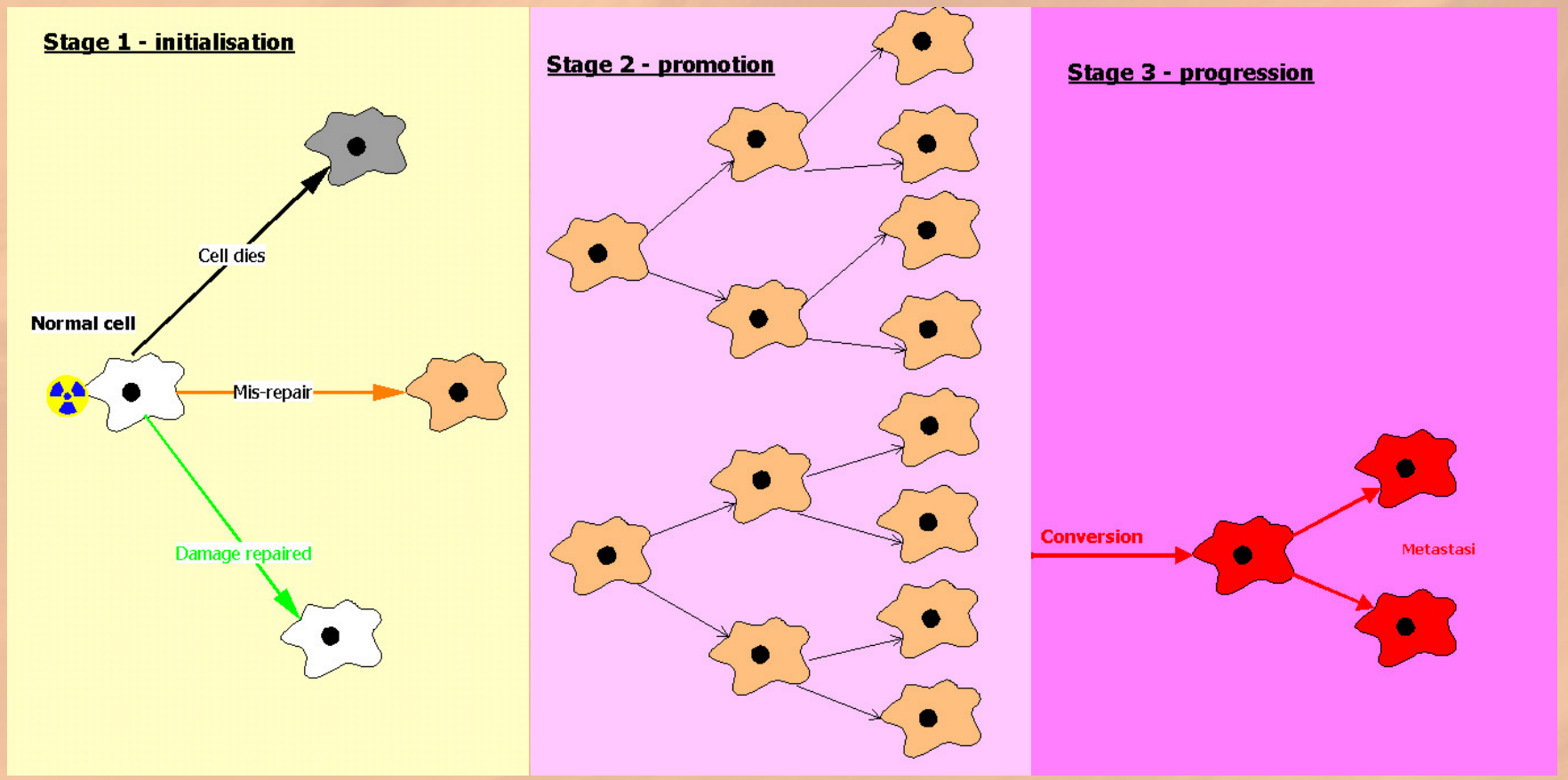


Interaction with radiation

Radiation causes ions in cell
Ions react with parts of the cell
If formed in the nucleus, it can:
- damage DNA
- affects cell behaviour

What happens next and what effects it may cause

Once damaged, the cell may: (a) Die or loose function; (b) Repair the damage; (c) Mis-repair.



Principles of radiation protection

Time
If you decrease the amount of time you spend near the source of radiation, you will decrease the amount of radiation exposure you receive.

Distance
The farther away you are from a radiation source, the less exposure you will receive.

Shielding
If you increase the shielding around a radiation source, it will decrease your exposure

Main principle

To keep the exposure to radiation As Low As Reasonably Achievable (ALARA)