Radiation Biology

Lecture

By
Dr. Hussain Ibrahim Hussain

Types of Health Effects

Health effects of ionizing radiation on humans are classified into two major types:

1- Prompt (short-term) effects that appear immediately after exposure

2- Delayed (long-term) effects that appear months or years after exposure.

Delayed (long-term) effects

- Appear years after original exposure:
  - ✓ either from previous acute (high-dose) exposures
  - ✓ or chronic low level exposure over a period of years.

- There are 3 categories of effects resulting from exposure to low doses:

A. **Genetic effect** suffered by the offspring of the individual exposed.
B. **Somatic effect** suffered by individual exposed.
C. **Embryological (teratogenic) effect** suffered by developing exposed embryo during pregnancy period.

A. Genetic Effects

- Damage DNA in germ cells lead to gene mutations passed to offspring of individual exposed.
- Genetic effects are difficult to be measured because:

✓ Fertilized egg may result nonviable organism which is aborted.

✓ Majority of mutations are recessive.

- Genetic effects can be grouped as:

1. Dominant gene disorders
2. X-Linked Single-Gene Disorders
3. Chromosome disorders
4. Multi-factorial disorders

1. Dominant gene disorders

Achondroplastic dwarfism is an example of a dominant gene disorder that could be caused by ionizing radiation.

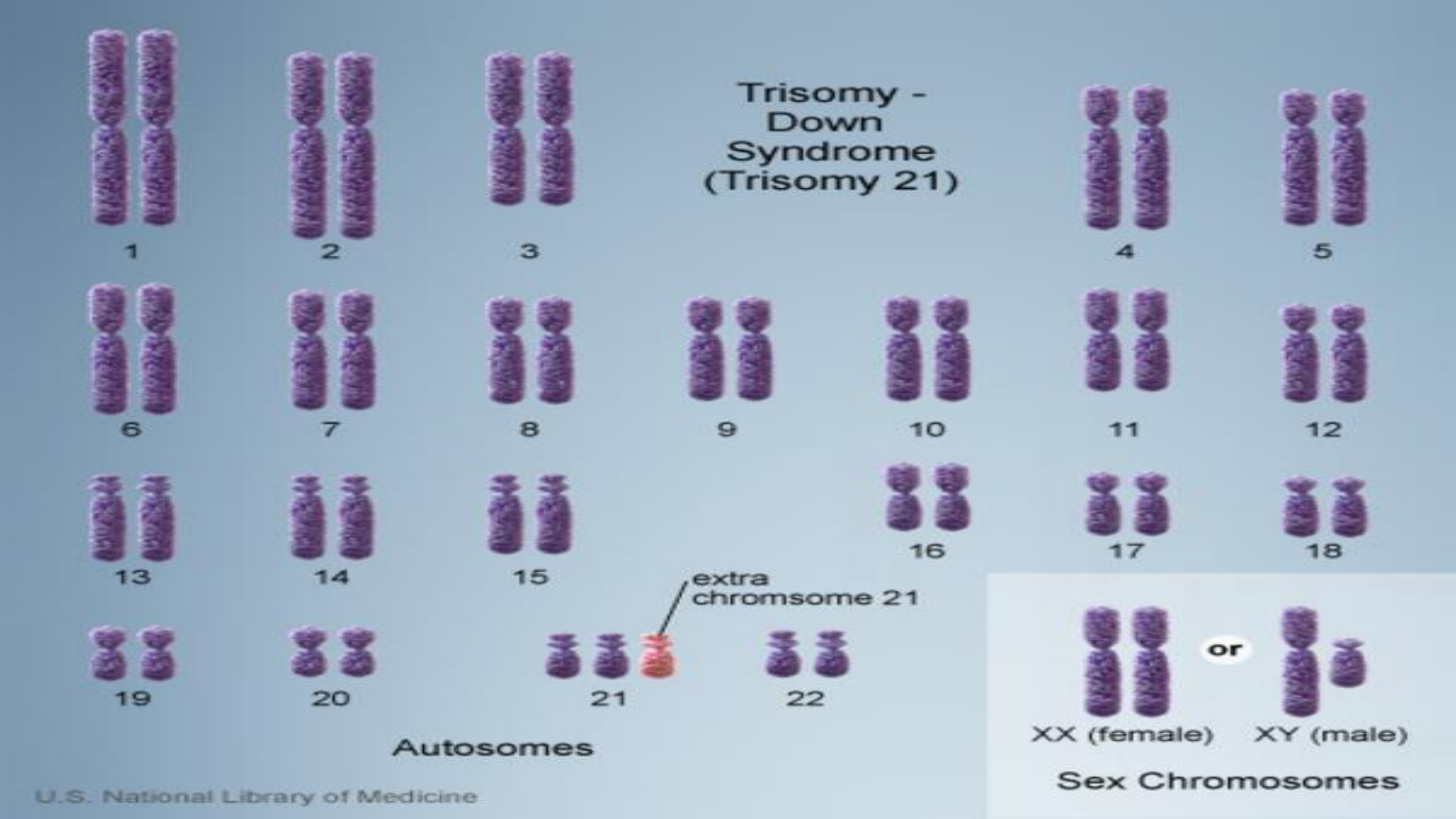
2. X-Linked Single-Gene Disorders

- Bad gene present on X-chromosome will produce effect in males because males only have one X-chromosome.
- ***Muscular dystrophy*** is an example of an X-linked effect

3. Chromosome disorders

- Abnormal number of chromosomes (*aneuploidy*) could severely affect the unborn or newborn child.
- *Down's syndrome* is caused by extra copy of chromosome 21 (*trisomy 21*) result in:

✓ reduction in their life expectancy
✓ abnormal body features
✓ infertile.


Trisomy - Down Syndrome (Trisomy 21)
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
extra chromsome 21
Autosomes
or
XX (female)
XY (male)
Sex Chromosomes
U.S. National Library of Medicine

4. Multifactorial disorders

- Associated with effects of multiple genes + lifestyles + environmental factors.
- Result in congenital malformations such as:

a) *Spina bifida* (split spine) caused by incomplete closing of embryonic neural tube, so some vertebrae are not fully formed and remain unfused and open that allows a portion of spinal cord to protrude.

b) *Cleft palate* is a fissure in mouth roof resulting from incomplete fusion of the palate during embryonic development.

B. Somatic Effects

- Late somatic effects occur in somatic cells years after brief or chronic exposure to radiation such as carcinogenic and cataractogenic effects:

1. Carcinogenic Effect:

- Radiation can cause up to 10% of invasive cancers in most parts of the body, in all animals, and at any age.
- It is random effect (10–15 years for solid tumors) (2–10 years for leukemia)

- Evidences that confirmed the carcinogenic effect of radiation in human:

a) Painters (bone cancer) (ingestion radium paint).

b) Radiologists & Dentists (skin cancer) (x-ray)

c) Miners (lung cancer) (inhalation radon)

d) Survivors of atomic bombing (leukemia, thyroid & breast cancers)

e) Irradiation during pregnancy (leukemia in children)

f) Radiotherapy (thyroid, brain, skin, breast & leukemia)



Radiation induced skin reactions (RISR)

May present as pain, itching, redness, dryness, peeling, bleeding or ulceration of the skin.

Grade 1

Grade 2

Grade 3

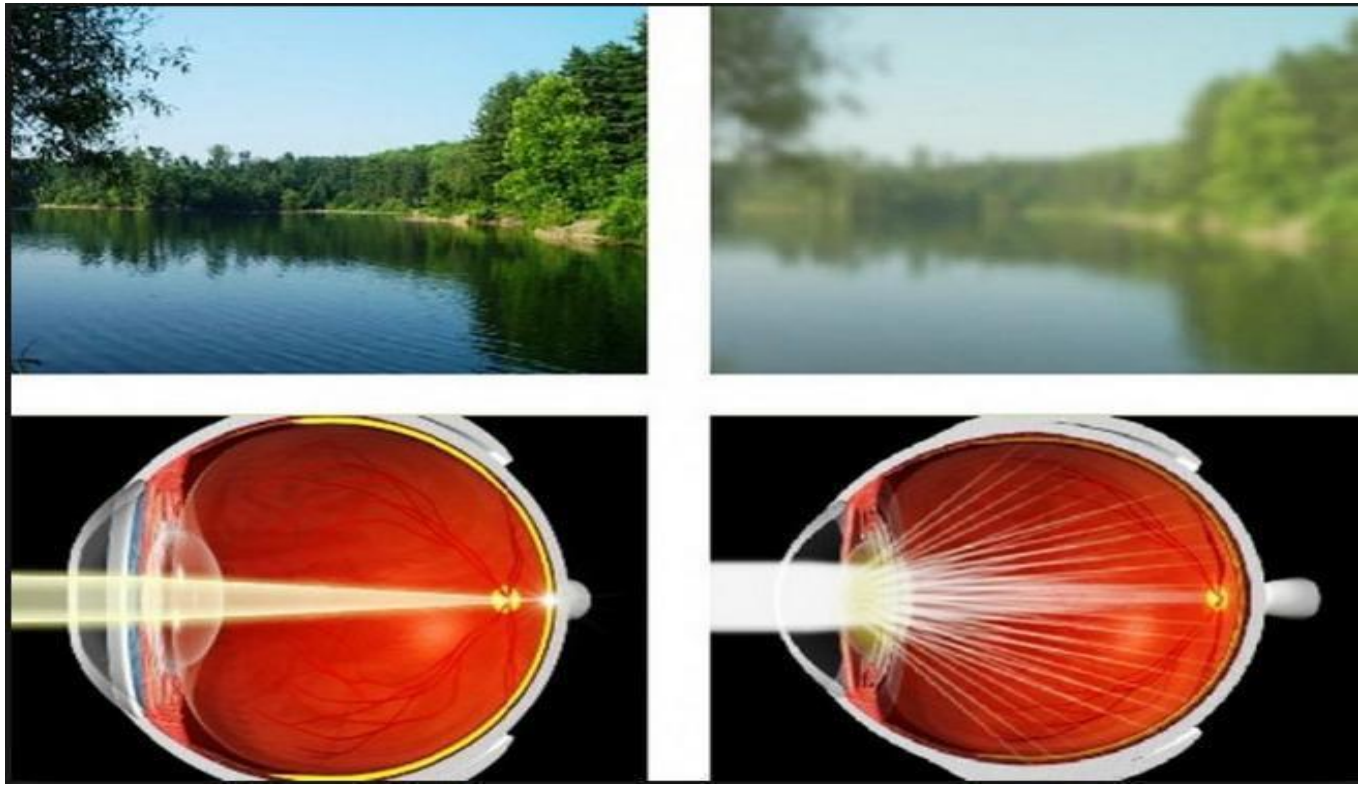
Grade 4

2. Cataractogenic Effect:

- A cataract is a cloudy area that forms in the lens which allows less light to pass into the eye leading to blurred vision (images are not clear) leading to blindness.

- Symptoms will appear in dose 200 rad up to 700 rad

- The average latent period for cataract formation is approximately 15 years and appears to be inversely related to the dose received.



Normal eye

Cataract eye

C. Embryological (Teratogenic) effects

- Teratogen (monster) is any agent that alters fetal morphology or functions if fetus is exposed during critical stage of development, such as:

- Physical (radiation),
- Chemical (drugs)
- Biological (rubella viruses which cause German measles)

- It is a special case of somatic effect because the somatic cells of the embryo/fetus are exposed to radiation, not the reproductive cells of the parents.

- Developing embryo is very radiosensitive and its response depends on:

  1)total dose

  2)rate of dose

  3)type of radiation

  4)stage of development

Fetal Stages

1. Pre-implantation Stage (The 1st 9 days after fertilization):

Radiation damage cause **death** either before birth *(**intrauterine death**)*, or few days after birth *(**neonatal death**)*.

2. Embryonic Stage (2-8 weeks of conception):

Radiation damage cause **morphological abnormalities** which appear directly after birth such as ***growth retardation*** & ***developmental abnormalities***.

3. Fetal Stage (continue until term):

Radiation damage cause **physiological abnormalities** which involve nervous system and sense organs and are not appear until later in life such as ***reduced intelligence*** *(IQ)*, ***behavioral changes***, and ***cancer***.

Conclusions

From this lecture we conclude the following:

1. The radiation has a direct negative effect on the tissues.

2. The radiation has a severe degenerative effect on the nucleus, which may affect the occurrence of mutations.

انتهت المحاضرة

شكراً لكم