Belarussian State Pedagogical University named after M. Tank
Inclusive Education Institute
Correction and Development Technologies Department

Human Genetics Foundations
Mutagens

D. L. Nikolaev, associate professor
Introduction

- Definition- Mutagen is a physical or chemical agent that causes mutation i.e. changes the genetic material, usually DNA of an organism.

- Not all mutations are caused by mutagens only induced mutations were caused by mutagens. Spontaneous mutations are naturally occurring mutations.

- Mutagens causing cancer, are likely to be known as carcinogens.
MUTAGENS

PHYSICAL
- RADIATION
- HEAT

CHEMICAL
- BASE ANALOGS
- INTERCALATING AGENTS
- ALKYLATING AGENTS
- DEAMINATING AGENTS
- METALS

BIOLOGICAL
- TRANSPONSON
- VIRUS
- BACTERIA
MUTAGENS

LESSE R CRITICAL EFFECTS M... 0.1 7

CONCENTRATION MUTAGEN

LESSE R VITALITY MUTAGEN 0.1 13
GREATER CRITICAL EFFECTS ... 0.1 33
STRENGTH MUTAGEN 0.1 18
CRITICAL EFFECTS MUTAGEN 0.1 13
14 LESSER ENHANCEMENT MUT... 1.4 126

CONCENTRATION MUTAGEN

Mutagen EPIC
Damage bonus on Signs +1
ORENS 44
WEIGHT 0.1
Sources for mutation:

- Radiation
  - UV Radiation
  - X-rays
  - Medical, dental, airport security screening

- Chemicals
  - Cigarette Smoke
    - Contains dozens of mutagenic chemicals
  - Benzoyl Peroxide
    - Common ingredient in acne products
  - Nitrate & Nitrate Preservatives
    - In hot dogs and other processed meats
  - Barbecuing
    - Creates mutagenic chemicals in foods

- Infectious Agents
  - Human Papillomavirus (HPV)
    - Sexually transmitted virus
  - Helicobacter pylori
    - Bacteria spread through contaminated food
Chemical Mutagens

chemicals that cause changes to DNA sequences
Chemical Mutagens

<table>
<thead>
<tr>
<th>Type of mutagen</th>
<th>Chemical action of mutagen</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Replace a base:</td>
<td>Base analogs have a chemical structure almost</td>
</tr>
<tr>
<td></td>
<td>identical to that of a DNA base.</td>
</tr>
<tr>
<td></td>
<td>5-Bromouracil—normal state, behaves like thymine</td>
</tr>
<tr>
<td></td>
<td>Adenine</td>
</tr>
<tr>
<td></td>
<td>5-Bromouracil—rare state, behaves like cytosine</td>
</tr>
<tr>
<td></td>
<td>Guanine</td>
</tr>
<tr>
<td></td>
<td>5-Bromouracil: almost identical to thymine.</td>
</tr>
<tr>
<td></td>
<td>Normally pairs with A; in transient state, pairs</td>
</tr>
<tr>
<td></td>
<td>with G.</td>
</tr>
</tbody>
</table>

How mutagens induce mutations:

- Base analog (5B.u.) incorporated during DNA replication or repair
- Wild type
- Replication
- T:A → C:G substitution
Mutagens are chemical agents that alter the composition of DNA.
Biological mutagens

- Retroviruses can convert their RNA genome into DNA and integrates into the host genome
- Integration may cause insertional mutagenesis
Ultraviolet light

Thymine dimer

G C T G G T A
C G A C A A C C A T

Copyright © 2006 Pearson Education, Inc., publishing as Benjamin Cummings.
Physical Mutagens

Radiation was the first mutagenic agent known; its effects on genes were first reported in the 1920's.

Radiations are of two types.

I. EM radiations

II. Ionizing radiations
<table>
<thead>
<tr>
<th>Mutagens</th>
<th>Effects</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carcinogens</td>
<td>Carcinogenesis and tumor formation.</td>
<td>Chemical: Aflatoxins</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Biological: Retroviruses</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Physical: X-ray Irradiation</td>
</tr>
<tr>
<td>Clastogens</td>
<td>Chromosome breaks, deletions, rearrangements.</td>
<td>Chemical: Bleomycin</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Biological: HIV virus</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Physical: UV waves</td>
</tr>
<tr>
<td>Teratogens</td>
<td>Congenital malformations.</td>
<td>Chemical: Valproate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Biological: Toxoplasma gondii</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Physical: X-ray irradiation</td>
</tr>
<tr>
<td>Non-specific</td>
<td>Non-specific damage to the genetic material.</td>
<td>Chemical: Innumerable types</td>
</tr>
<tr>
<td>mutagens</td>
<td></td>
<td>Physical: X-ray irradiation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Biological: Toxoplasma, Viruses</td>
</tr>
</tbody>
</table>
Effects of mutagens

- Mutagens cause changes to the DNA that can affect the transcription and replication of the DNA, which in severe cases can lead to cell death.

- The mutagen produces mutations in the DNA, loss of function for a particular gene, and accumulation of mutations may lead to cancer.

- Powerful mutagens may result in chromosomal instability, causing chromosomal breakages and rearrangement of the chromosomes such as translocation, deletion, and inversion. Such mutagens are called clastogens