4-Cell Structure and Function

Reproduction of Cells

**Mitosis** in somatic cells:

- Parental cell: 46
- 2 daughter cells identical to parental cell: 46

**Meiosis** in sex cells:

- Germ cell: 46
- Many divisions including a reduction division
- 1 ova or 4 spermatozoa (sex cells): 23
  - With ½ the number of chromosomes

2 spermatozoa + 1 ova

Fertilized egg = zygote then grows by mitosis
Normal Cell Division

• 2 Types of normal cell division occur in the body.
• 1. The most common type of cell division that occurs in the body is known as **mitosis**.
  • **Mitosis** takes place in **somatic (general body cells)** cells. Example: skin cells of epidermis.
  • In the process of mitosis, **2 daughter cells** are produced that are **genetically identical** to the parent cell.
• 2. **Meiosis** is another type of normal cell division and **only occurs in sex cells**.
  • In **meiosis** the **chromosome numbers are halved** in a process called **reduction division**. Therefore, sperm and egg carry ½ the number of chromosomes as seen in the somatic cells of the species.
  • When the egg and sperm unite in fertilization, a **zygote (fertilized egg)** is produced and the chromosome number is restored.
Mitosis Vs. Meiosis

**Mitosis in somatic cells**
- Parental cell: 46
- 2 daughter cells identical to parental cell: 46

**Meiosis in sex cells**
- Germ cell: 46
- Many divisions including a reduction division
- 1 Ova or 4 Spermatozoa (Sex Cells): 23
- With \( \frac{1}{2} \) the number of chromosomes

Spermatozoa + Ova = 23 + 23

Fertilized egg: 46
- Zygote then grows by mitosis
Abnormal Cell Reproduction

- **Cell reproduction Gone Wild (Astray)!** =“cancer”- a homeostatic imbalance.
- Typically the number of cells produced by the body balance the number of cells that have died or are lost.
- **Neoplasm**- Literally means "new formation" but it generally carries with it the connotation of non-beneficial formation of cells.
- These new cells have no useful function, but like all other cells require nutrients for nourishment (at the expense of other cells). Due to rapid growth may out compete other cells in the area.
There are 2 major types of neoplasms: **benign** and **malignant**.

- **Benign neoplasms**
  - 1. Usually grow slowly.
  - 2. Localized within a fibrous capsule that separates them from normal tissue.
  - Show no extreme structural differences from other cells.

  Can benign neoplasms cause problems?

- Create problems if they put pressure on delicate areas like the brain.
- (Or if they cause excessive output of chemicals like hormones.)
There are 2 major types of neoplasms: **benign** and **malignant**.

- **Malignant neoplasms** - Differ from benign in that they:
  - 1. Grow rapidly.
  - 2. Usually lack fibrous capsules.
  - 3. Commonly release cells into blood or lymph circulation. **= metastasis** - movement from one part of body to another (e.g. cancer cells in this case)
- Malignant neoplasms are the **second leading cause of death**. (#1 = heart disease)
- The word ‘tumor’ is used commonly but does not tell us much about the problem. Tumor means swelling or mass.
Causes of Cancer

- **Neoplasms** are believed to be caused by many agents.
- **Carcinogens** are any cancer causing agent.
- **Carcinogens** are responsible for about 60-90% of cancers.
- **Hereditity** has been demonstrated to also play a major role in cancer development.
- **Viruses** are responsible for about 25%.
7 Danger Signals of Cancer
(American Cancer Society)

• 1. Any unusual bleeding or discharge.
• 2. Sore that does not heal.
• 3. Any change in normal bowel habits lasting greater than 3 weeks.
• 4. Change in size or color of wart or mole.
• 5. Chronic indigestion or difficulty in swallowing.
• 6. Lump or thickening in breast or elsewhere in body.
• 7. Persistent hoarseness or cough.
## US Mortality, 2003

<table>
<thead>
<tr>
<th>Rank</th>
<th>Cause of Death</th>
<th>No. of deaths</th>
<th>% of all deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Heart Diseases</td>
<td>685,089</td>
<td>28.0</td>
</tr>
<tr>
<td>2.</td>
<td>Cancer</td>
<td>556,902</td>
<td>22.7</td>
</tr>
<tr>
<td>3.</td>
<td>Cerebrovascular diseases</td>
<td>157,689</td>
<td>6.4</td>
</tr>
<tr>
<td>4.</td>
<td>Chronic lower respiratory diseases</td>
<td>126,382</td>
<td>5.2</td>
</tr>
<tr>
<td>5.</td>
<td>Accidents (Unintentional injuries)</td>
<td>109,277</td>
<td>4.5</td>
</tr>
<tr>
<td>6.</td>
<td>Diabetes mellitus</td>
<td>74,219</td>
<td>3.0</td>
</tr>
<tr>
<td>7.</td>
<td>Influenza and pneumonia</td>
<td>65,163</td>
<td>2.7</td>
</tr>
<tr>
<td>8.</td>
<td>Alzheimer disease</td>
<td>63,457</td>
<td>2.6</td>
</tr>
<tr>
<td>9.</td>
<td>Nephritis</td>
<td>42,453</td>
<td>1.7</td>
</tr>
<tr>
<td>10.</td>
<td>Septicemia</td>
<td>34,069</td>
<td>1.4</td>
</tr>
</tbody>
</table>

Change in the US Death Rates* by Cause, 1950 & 2003

* Age-adjusted to 2000 US standard population.
2006 Estimated US Cancer Cases*

**Men**
- Prostate: 33%
- Lung & bronchus: 13%
- Colon & rectum: 10%
- Urinary bladder: 6%
- Melanoma of skin: 5%
- Non-Hodgkin lymphoma: 4%
- Kidney: 3%
- Oral cavity: 3%
- Leukemia: 3%
- Pancreas: 2%
- All Other Sites: 18%

**Women**
- Breast: 31%
- Lung & bronchus: 12%
- Colon & rectum: 11%
- Uterine corpus: 6%
- Non-Hodgkin lymphoma: 4%
- Melanoma of skin: 4%
- Kidney: 3%
- Oral cavity: 3%
- Thyroid: 3%
- Ovary: 3%
- Urinary bladder: 2%
- Pancreas: 2%
- All Other Sites: 22%

*Excludes basal and squamous cell skin cancers and in situ carcinomas except urinary bladder.
Source: American Cancer Society, 2006.
## 2006 Estimated US Cancer Deaths*

<table>
<thead>
<tr>
<th>Cancer Site</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lung &amp; bronchus</td>
<td>31%</td>
<td>26%</td>
</tr>
<tr>
<td>Colon &amp; rectum</td>
<td>10%</td>
<td>15%</td>
</tr>
<tr>
<td>Prostate</td>
<td>9%</td>
<td>10%</td>
</tr>
<tr>
<td>Pancreas</td>
<td>6%</td>
<td>6%</td>
</tr>
<tr>
<td>Leukemia</td>
<td>4%</td>
<td>4%</td>
</tr>
<tr>
<td>Liver &amp; intrahepatic bile duct</td>
<td>4%</td>
<td>4%</td>
</tr>
<tr>
<td>Esophagus</td>
<td>4%</td>
<td>3%</td>
</tr>
<tr>
<td>Non-Hodgkin lymphoma</td>
<td>3%</td>
<td>3%</td>
</tr>
<tr>
<td>Urinary bladder</td>
<td>3%</td>
<td>3%</td>
</tr>
<tr>
<td>Kidney</td>
<td>3%</td>
<td>2%</td>
</tr>
<tr>
<td>All other sites</td>
<td>23%</td>
<td>23%</td>
</tr>
</tbody>
</table>

ONS=Other nervous system.
Source: American Cancer Society, 2006.
Cancer Incidence Rates* by Sex and Race, All Sites, 1975-2002

*Age-adjusted to the 2000 US standard population.
### Lifetime Probability of Developing Cancer, by Site, Men, 2000-2002

<table>
<thead>
<tr>
<th>Site</th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>All sites†</td>
<td>1 in 2</td>
</tr>
<tr>
<td>Prostate</td>
<td>1 in 6</td>
</tr>
<tr>
<td>Lung and bronchus</td>
<td>1 in 13</td>
</tr>
<tr>
<td>Colon and rectum</td>
<td>1 in 17</td>
</tr>
<tr>
<td>Urinary bladder‡</td>
<td>1 in 28</td>
</tr>
<tr>
<td>Non-Hodgkin lymphoma</td>
<td>1 in 46</td>
</tr>
<tr>
<td>Melanoma</td>
<td>1 in 52</td>
</tr>
<tr>
<td>Kidney</td>
<td>1 in 64</td>
</tr>
<tr>
<td>Leukemia</td>
<td>1 in 67</td>
</tr>
<tr>
<td>Oral Cavity</td>
<td>1 in 73</td>
</tr>
<tr>
<td>Stomach</td>
<td>1 in 82</td>
</tr>
</tbody>
</table>

* For those free of cancer at beginning of age interval. Based on cancer cases diagnosed during 2000 to 2002.

‡ Includes invasive and *in situ* cancer cases

# Lifetime Probability of Developing Cancer, by Site, Women, US, 2000-2002*

<table>
<thead>
<tr>
<th>Site</th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>All sites†</strong></td>
<td>1 in 3</td>
</tr>
<tr>
<td>Breast</td>
<td>1 in 8</td>
</tr>
<tr>
<td>Lung &amp; bronchus</td>
<td>1 in 17</td>
</tr>
<tr>
<td>Colon &amp; rectum</td>
<td>1 in 18</td>
</tr>
<tr>
<td>Uterine corpus</td>
<td>1 in 38</td>
</tr>
<tr>
<td>Non-Hodgkin lymphoma</td>
<td>1 in 55</td>
</tr>
<tr>
<td>Ovary</td>
<td>1 in 68</td>
</tr>
<tr>
<td>Melanoma</td>
<td>1 in 77</td>
</tr>
<tr>
<td>Pancreas</td>
<td>1 in 79</td>
</tr>
<tr>
<td>Urinary bladder‡</td>
<td>1 in 88</td>
</tr>
<tr>
<td>Uterine cervix</td>
<td>1 in 135</td>
</tr>
</tbody>
</table>

† All Sites exclude basal and squamous cell skin cancers and in situ cancers except urinary bladder.
‡ Includes invasive and *in situ* cancer cases
Screening Guidelines for the Early Detection of Breast Cancer, American Cancer Society

- Yearly mammograms are recommended starting at age 40.
- A clinical breast exam should be part of a periodic health exam, about every three years for women in their 20s and 30s, and every year for women 40 and older.
- Women should know how their breasts normally feel and report any breast changes promptly to their health care providers. Breast self-exam is an option for women starting in their 20s.
- Women at increased risk (e.g., family history, genetic tendency, past breast cancer) should talk with their doctors about the benefits and limitations of starting mammography screening earlier, having additional tests (i.e., breast ultrasound and MRI), or having more frequent exams.
Screening Guidelines for the Early Detection of Cervical Cancer, American Cancer Society

- Screening should begin approximately three years after a woman begins having vaginal intercourse, but no later than 21 years of age.
- Screening should be done every year with regular Pap tests or every two years using liquid-based tests.
- At or after age 30, women who have had three normal test results in a row may get screened every 2-3 years. However, doctors may suggest a woman get screened more frequently if she has certain risk factors, such as HIV infection or a weakened immune system.
- Women 70 and older who have had three or more consecutive Pap tests in the last ten years may choose to stop cervical cancer screening.
- Screening after a total hysterectomy (with removal of the cervix) is not necessary unless the surgery was done as a treatment for cervical cancer.
Screening Guidelines for the Early Detection of Colorectal Cancer, American Cancer Society

• Beginning at age 50, men and women should follow one of the following examination schedules:
  ▪ A fecal occult blood test (FOBT) every year
  ▪ A flexible sigmoidoscopy (FSIG) every five years
  ▪ Annual fecal occult blood test and flexible sigmoidoscopy every five years*
  ▪ A double-contrast barium enema every five years
  ▪ A colonoscopy every ten years

• *Combined testing is preferred over either annual FOBT or FSIG every 5 years alone.

People who are at moderate or high risk for colorectal cancer should talk with a doctor about a different testing schedule
Screening Guidelines for the Early Detection of Prostate Cancer, American Cancer Society

- The prostate-specific antigen (PSA) test and the digital rectal examination (DRE) should be offered annually, beginning at age 50, to men who have a life expectancy of at least 10 years.
- Men at high risk (African-American men and men with a strong family history of one or more first-degree relatives diagnosed with prostate cancer at an early age) should begin testing at age 45.
- For men at average risk and high risk, information should be provided about what is known and what is uncertain about the benefits and limitations of early detection and treatment of prostate cancer so that they can make an informed decision about testing.
Cancer Cures

• 1. May require extensive treatment.
• 2. Are becoming more common all the time.
• 3. Are increased by.....
• **Early Detection!!**
Detection of Cancer

1. **Biopsy** - removal of tissue for microscopic exam for diagnosis by a pathologist.

2. **Imaging** - X-ray, Cat scans, MRI scans, Ultrasound

3. **Blood markers** - PSA, prostatic specific antigen, CA125, used to detect ovarian cancer. Proteins found in the blood that originates from cancerous tissue.

4. **Genetic markers** - BRCA genes for breast cancer in females. Others genes also described for familial colon cancer.
Treatment of Cancer

1. **Surgery** - surgical removal of a well-defined tumor and possibly regional lymph nodes.

2. **Chemotherapy** - the chance to selectively damage neoplasm by cytotoxic drugs. Usually multiple drug treatments.

3. **Radiation therapy** - focused beam of x-rays to region of tumor to kill malignant cells. Usually multiple treatments.

4. **Cryotherapy** – using cold temperatures (freezing) to kill cells.

5. **Hyperthermia** – using high temperatures (laser) to kill cells.

6. **Immune therapy** - Helps body to recognize cancer cells and fight them. Target malignant cells with an antibody to a unique marker on tumor cells with adjunct therapy to induce a vigorous immune response (e.g. IL2).
Other Cancer Terms

• **Oncology** - the study of tumors
• **Oncologist** - a physician that specializes in diagnosis and treatment of tumors.