Understanding Cancer

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What Is Cancer?

What causes cancer?

What is the link between genes and cancer?

What is cancer?

How is cancer diagnosed?

Can cancer be prevented?
Different Kinds of Cancer

Some common carcinomas:
- Lung
- Breast (women)
- Colon
- Bladder
- Prostate (men)

Leukemias:
- Bloodstream

Lymphomas:
- Lymph nodes

Some common sarcomas:
- Fat
- Bone
- Muscle

## Naming Cancers

Cancer Prefixes Point to Location

<table>
<thead>
<tr>
<th>Prefix</th>
<th>Meaning</th>
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<tbody>
<tr>
<td>adeno-</td>
<td>gland</td>
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<tr>
<td>chondro-</td>
<td>cartilage</td>
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<tr>
<td>erythro-</td>
<td>red blood cell</td>
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<tr>
<td>hemangio-</td>
<td>blood vessels</td>
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<tr>
<td>hepato-</td>
<td>liver</td>
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<tr>
<td>lipo-</td>
<td>fat</td>
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<tr>
<td>lympho-</td>
<td>lymphocyte</td>
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<tr>
<td>melano-</td>
<td>pigment cell</td>
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<tr>
<td>myelo-</td>
<td>bone marrow</td>
</tr>
<tr>
<td>myo-</td>
<td>muscle</td>
</tr>
<tr>
<td>osteo-</td>
<td>bone</td>
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</tbody>
</table>
Example of Normal Growth

- Dead cells shed from outer surface
- Epidermis
- Dividing cells in basal layer
- Dermis
- Cell migration
Loss of Normal Growth Control

Normal cell division

Cell damage—no repair

Cell Suicide or Apoptosis

Cancer cell division

First mutation
Second mutation
Third mutation
Fourth or later mutation

Uncontrolled growth
Invasion and Metastasis

1. Cancer cells invade surrounding tissues and blood vessels
2. Cancer cells are transported by the circulatory system to distant sites
3. Cancer cells reinvade and grow at new location

Malignant versus Benign Tumors

Benign (not cancer) tumor cells grow only locally and cannot spread by invasion or metastasis.

Malignant (cancer) cells invade neighboring tissues, enter blood vessels, and metastasize to different sites.

Time
Why Cancer Is Potentially Dangerous

Melanoma cells travel through bloodstream

Brain

Liver

Melanoma (initial tumor)
Cancer Detection and Diagnosis
Biopsy

Patient’s tissue sample or blood sample

Pathology

Proteomic profile

Genomic profile
# Microscopic Appearance of Cancer Cells

<table>
<thead>
<tr>
<th>Normal</th>
<th>Cancer</th>
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</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Normal cells" /></td>
<td><img src="image2.png" alt="Cancer cells" /></td>
</tr>
<tr>
<td><img src="image3.png" alt="Normal nuclei" /></td>
<td><img src="image4.png" alt="Cancer nuclei" /></td>
</tr>
<tr>
<td><img src="image5.png" alt="Normal cytoplasm" /></td>
<td><img src="image6.png" alt="Cancer cytoplasm" /></td>
</tr>
<tr>
<td><img src="image7.png" alt="Normal cell size and shape" /></td>
<td><img src="image8.png" alt="Cancer cell size and shape" /></td>
</tr>
<tr>
<td><img src="image9.png" alt="Normal specialized cell features" /></td>
<td><img src="image10.png" alt="Cancer specialized cell features" /></td>
</tr>
<tr>
<td><img src="image11.png" alt="Normal cell arrangement" /></td>
<td><img src="image12.png" alt="Cancer cell arrangement" /></td>
</tr>
<tr>
<td><img src="image13.png" alt="Normal tumor boundary" /></td>
<td><img src="image14.png" alt="Cancer tumor boundary" /></td>
</tr>
</tbody>
</table>

- Large number of irregularly shaped dividing cells
- Large, variably shaped nuclei
- Small cytoplasmic volume relative to nuclei
- Variation in cell size and shape
- Loss of normal specialized cell features
- Disorganized arrangement of cells
- Poorly defined tumor boundary
Cancer in 50+

WOMEN
• Lung
• Breast
• Colon

MEN
• Lung
• Prostate
• Colon
Early detection/diagnosis

• Leads to better outcomes
• Many types of cancer have vague or no symptoms
• Preventative measures
  – Don’t smoke
  – Sun protection
  – Healthy diet & exercise
• Regular screenings
  – Mammograms
  – Pap smears
  – Prostate exam
Lung cancer

LOCAL SYMPTOMS
- Cough
- Wheezing
- Difficulty breathing
- Chest pain
- Pneumonia
- Swollen lymph nodes

SYSTEMIC SYMPTOMS
- Headache
- Pain
- Anemia
- Anorexia/weight loss
- Fatigue
Lung cancer

INCIDENCE
• Most common cancer for men & women in US
• Five-year survival = 15%
• Incidence for women continues to rise
• Deaths > breast and all other gynecologic, breast, colorectal cancers

RISK FACTORS
• Tobacco exposure
• Asbestos, arsenic, nickel exposure
• Genetic predisposition
• Inflammation (COPD, emphysema)
• Diet lacking in carotenoids
• Age 65 older
Lung Cancer

PROGNOSIS

• Clinical stage at time of diagnosis
• Size and accessibility of tumor
• Male and older = negative predictor of survival
• Co-morbidities
Prostate Cancer

**SYMPTOMS**
- Asymptomatic in early disease
- Decreased urinary flow
- Hesitancy
- Urinary frequency
- Nocturia
- Hematuria/pain

**STATISTICS**
- Second most common tumor in men
- Second-leading cause of death
- Accounts for 1/3 new cancers in men
Prostate Cancer

RISK FACTORS

• Age (75% in men >65)
• African American race
• Family history
• BRCA1/2 mutations in family
• High fat diet

SCREENING

• Beginning age 50, digital rectal examination
• Annual prostate-specific antigen (PSA) blood test
• For high risk individuals, screening may begin earlier
Prostate Cancer Screening
Breast Cancer

• Signs and symptoms
• Redness, dimpling of breast
• Peau d’orange
• Changes in breast shape
• Bloody or yellow discharge from breast
• Nipple retraction or deviation
• Lump or thickening in or near breast/underarm area
Breast Cancer

INCIDENCE

• 1 in 8 women will develop breast cancer
• Men account for 1% of all breast cancer
• Survival rates are high
  – 89%= 5 years after dx
  – 82%= 10 years after dx
  – 77%= 15 years after dx

RISK FACTORS

• Female
• Increasing age
• Family/personal history
• No children, or having children later in life
• Hormone therapy after menopause
• Alcohol use
• Obesity
Breast Cancer Screening
Colon Cancer

STATISTICS
• Third most commonly diagnosed cancer in US
• Third leading cause of cancer deaths for both men & women

SCREENING
• Age 50+ (average risk)
  – Fecal occult blood test (FOBT) annually OR
  – Colonoscopy every 10 years
  – Contrast barium enema every 5 years
Colon Cancer

SIGNS AND SYMPTOMS
• Change in bowel habits
• Blood in stool
• Cramping pain in lower abdomen
Colon Cancer

NON-MODIFIABLE

• Age
• History of polyps
• History of FAP or Lynch syndrome in family
• Inflammatory bowel disease
• Ashkenazi Jews and African Americans

MODIFIABLE

• Diet high in red & processed meat
• Diet low in fruits/vegetables
• Obesity
• Physical inactivity
• Heavy alcohol use
• Smoking
• Diabetes
Colon Cancer Screening

FOBT Screening Kit

FROM

FOBT 1 2 3
What Causes Cancer?

- Some viruses or bacteria
- Heredity
- Diet
- Hormones
- Some chemicals
- Radiation
Low-Strength Radiation

Skin Cancer Incidence

Annual Sunshine (UV radiation)

High

Most

Low

Least

Dallas

Pittsburgh

Detroit
Tobacco Use and Cancer

Some Cancer-Causing Chemicals in Tobacco Smoke

- aminostilbene
- arsenic
- benzo[a]anthracene
- benzo[a]pyrene
- benzene
- benzo[b]fluoranthene
- benzo[c]phenanthrene
- benzo[f]fluoranthene
- cadmium
- chrysene
- dibenz[a,c]anthracene
- dibenzo[a,e]fluoranthene
- dibenz[a,h]acridine
- dibenz[a,j]acridine
- dibenzo[c,g]carbazone
- N-dibutylnitrosamine
- 2,3-dimethylchrysene
- indeno[1,2,3-c,d]pyrene
- S-methylchrysene
- S-methylfluoranthene
- alpha-naphthylamine
- nickel compounds
- N-nitrosodimethylamine
- N-nitrosomethylethylamine
- N-nitrosodiethylamine
- N-nitrosonornicotine
- N-nitrosoanabasine
- N-nitrosopiperidine
- polonium-210
High-Strength Radiation

Leukemia Incidence vs. X-ray Dose (atomic radiation)

- High Strength Radiation
- Low X-ray Dose (Least)
- High X-ray Dose (Most)
### Examples of Human Cancer Viruses

#### Some Viruses Associated with Human Cancers

<table>
<thead>
<tr>
<th>Virus</th>
<th>Type of Cancer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epstein-Barr virus</td>
<td>Burkitt’s lymphoma</td>
</tr>
<tr>
<td>Human papillomavirus</td>
<td>Cervical cancer</td>
</tr>
<tr>
<td>Hepatitis B virus</td>
<td>Liver cancer</td>
</tr>
<tr>
<td>Human T-cell lymphotrophic virus</td>
<td>Adult T-cell leukemia</td>
</tr>
<tr>
<td>Kaposi’s sarcoma-associated herpesvirus</td>
<td>Kaposi’s sarcoma</td>
</tr>
</tbody>
</table>
### Inherited Conditions That Increase Risk for Cancer

<table>
<thead>
<tr>
<th>Name of Condition</th>
<th>Type of Cancer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hereditary retinoblastoma</td>
<td>Retinoblastoma</td>
</tr>
<tr>
<td>Xeroderma pigmentosum</td>
<td>Skin</td>
</tr>
<tr>
<td>Wilms’ tumor</td>
<td>Kidney</td>
</tr>
<tr>
<td>Li-Fraumeni syndrome</td>
<td>Sarcomas, brain, breast, leukemia</td>
</tr>
<tr>
<td>Familial adenomatous polyposis</td>
<td>Colon, rectum</td>
</tr>
<tr>
<td>Paget’s disease of bone</td>
<td>Bone</td>
</tr>
<tr>
<td>Fanconi’s aplastic anemia</td>
<td>Leukemia, liver, skin</td>
</tr>
</tbody>
</table>
Genetic Testing
Cancer Risk and Aging

Number of Cancer Cases (per 100,000 people)

Age of Person (in years)

Cancer Risk and Aging

Colon

Breast

0         20         40         60          80
Cancer Tends to Involve Multiple Mutations

Benign tumor cells grow only locally and cannot spread by invasion or metastasis.

Malignant cells invade neighboring tissues, enter blood vessels, and metastasize to different sites.

Mutation inactivates suppressor gene

Cells proliferate

Mutations inactivate DNA repair genes

Proto-oncogenes mutate to oncogenes

Time

More mutations, more genetic instability, metastatic disease
Cancer Prevention

- Carcinogenic radiation
- Cancer viruses or bacteria
- Carcinogenic chemicals
Avoid Tobacco

Lung Cancer Risk Increases with Cigarette Consumption

- 0 cigarettes smoked per day = Non-smoker
- 15x, 10x, 5x increase in lung cancer risk with increasing cigarettes smoked per day

Cigarettes Smoked per Day:
- 0
- 15
- 30

Lung Cancer Risk:
- 0
- 15
- 30

Artwork by Jeanette Kelly © 2004

NATIONAL CANCER INSTITUTE
Protect Yourself From Excessive Sunlight
Limit Alcohol and Tobacco

Combination of Alcohol and Cigarettes Increases Risk for Cancer of the Esophagus

- 40x
- 30x
- 20x
- 10x

Risk Increase

Alcoholic Drinks Consumed per Day

0 4+ 0 4+

Packs of Cigarettes Consumed per Day

0 0 2+ 2+
Diet: Limit Fats and Calories

Correlation Between Meat Consumption and Colon Cancer Rates in Different Countries

Number of Cases (per 100,000 people)

Grams (per person per day)
Diet: Consume Fruits and Vegetables
Avoid Cancer Viruses

HPV Infection Increases Risk for Cervical Cancer

Cervical Cancer Risk

High

Low

Noninfected women

Women infected with HPV
## Avoid Carcinogens at Work

### Some Carcinogens in the Workplace

<table>
<thead>
<tr>
<th>Carcinogen</th>
<th>Occupation</th>
<th>Type of Cancer</th>
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<tbody>
<tr>
<td>Arsenic</td>
<td>Mining, pesticide workers</td>
<td>Lung, skin, liver</td>
</tr>
<tr>
<td>Asbestos</td>
<td>Construction workers</td>
<td>Lung, mesothelioma</td>
</tr>
<tr>
<td>Benzene</td>
<td>Petroleum, rubber, chemical workers</td>
<td>Leukemia</td>
</tr>
<tr>
<td>Chromium</td>
<td>Metal workers, electroplaters</td>
<td>Lung</td>
</tr>
<tr>
<td>Leather dust</td>
<td>Shoe manufacturing</td>
<td>Nasal, bladder</td>
</tr>
<tr>
<td>Naphthylamine</td>
<td>Chemical, dye, rubber workers</td>
<td>Bladder</td>
</tr>
<tr>
<td>Radon</td>
<td>Underground mining</td>
<td>Lung</td>
</tr>
<tr>
<td>Soots, tars, oils</td>
<td>Coal, gas, petroleum workers</td>
<td>Lung, skin, liver</td>
</tr>
<tr>
<td>Vinyl chloride</td>
<td>Rubber workers, polyvinyl chloride manufacturing</td>
<td>Liver</td>
</tr>
<tr>
<td>Wood dust</td>
<td>Furniture manufacturing</td>
<td>Nasal</td>
</tr>
</tbody>
</table>
Industrial Pollution

Incidence of Most Cancers

Year

1930 1950 1970 1990
Is There a Cancer "Epidemic"?

**MYTH**

*The Daily News 5¢*

Cancer Rates Reach Epidemic Proportions

**FACT**

Colon Cancer Deaths (per 100,000 men, age adjusted)

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National Cancer Institute
Questions?