

Chapter 5

Cancer:

DNA Synthesis, Mitosis, and Meiosis

What Is Cancer?

- **Benign** tumors do not invade surrounding tissue
- **Malignant** tumors invade surrounding structures:
 - are cancer
- Properties of Cancer cells
 - Promote Angiogenesis
 - Loss of contact inhibition
 - Loss of anchorage dependence

Properties of Cancer cells

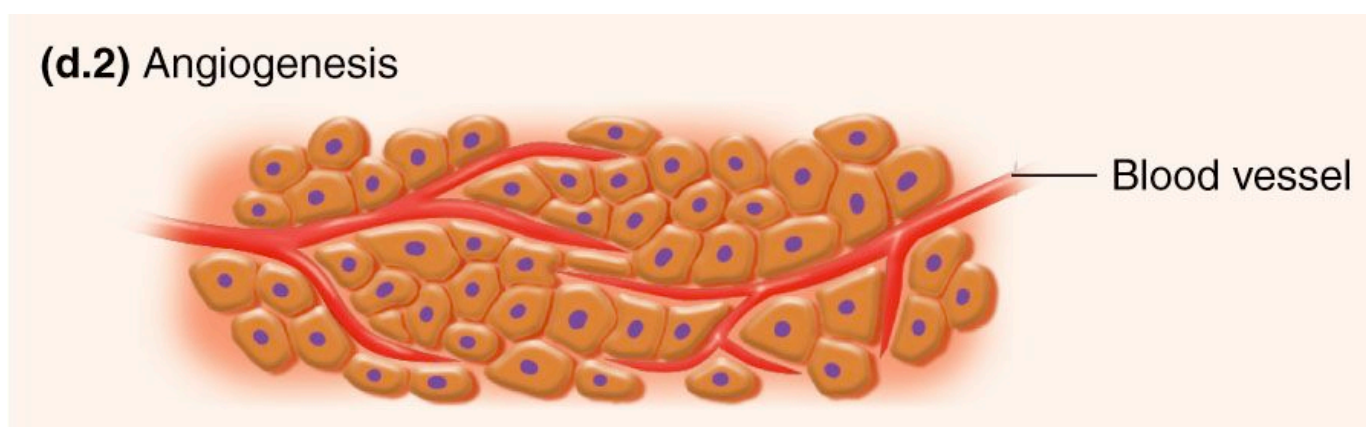
- **Angiogenesis**

- growth of blood vessels caused by secretions from cancer cells

- Increases the blood supply to cancer cells:
 - more oxygen and nutrients

- Cancer cells can divide more

- Tumors develop, sometimes filling entire organs



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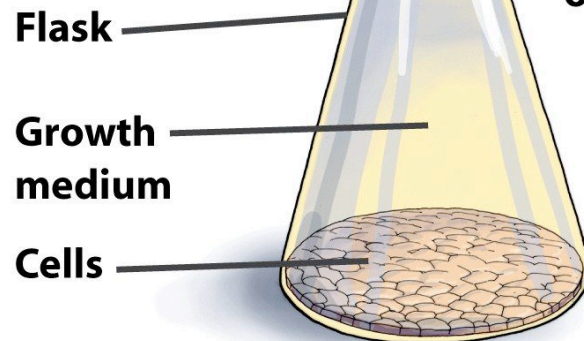
Properties of Cancer cells

- **Contact inhibition**

- in normal cells prevents them from dividing all the time
- Divisions would force the new cells to pile up on each other

Contact Inhibition

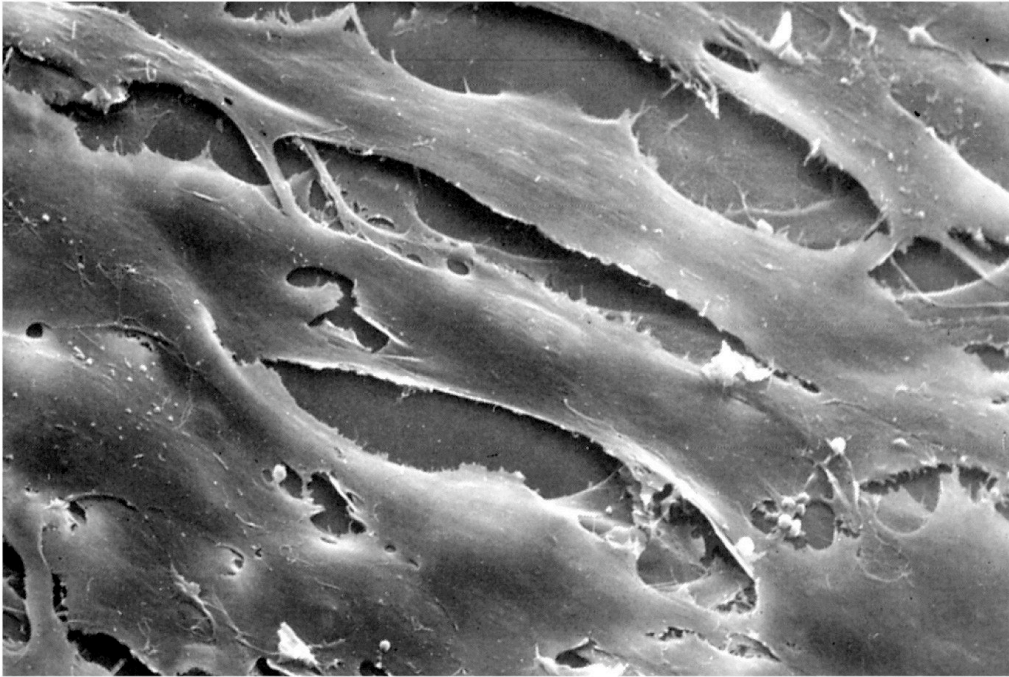
Normal cells stop dividing when they come in contact with other cells.



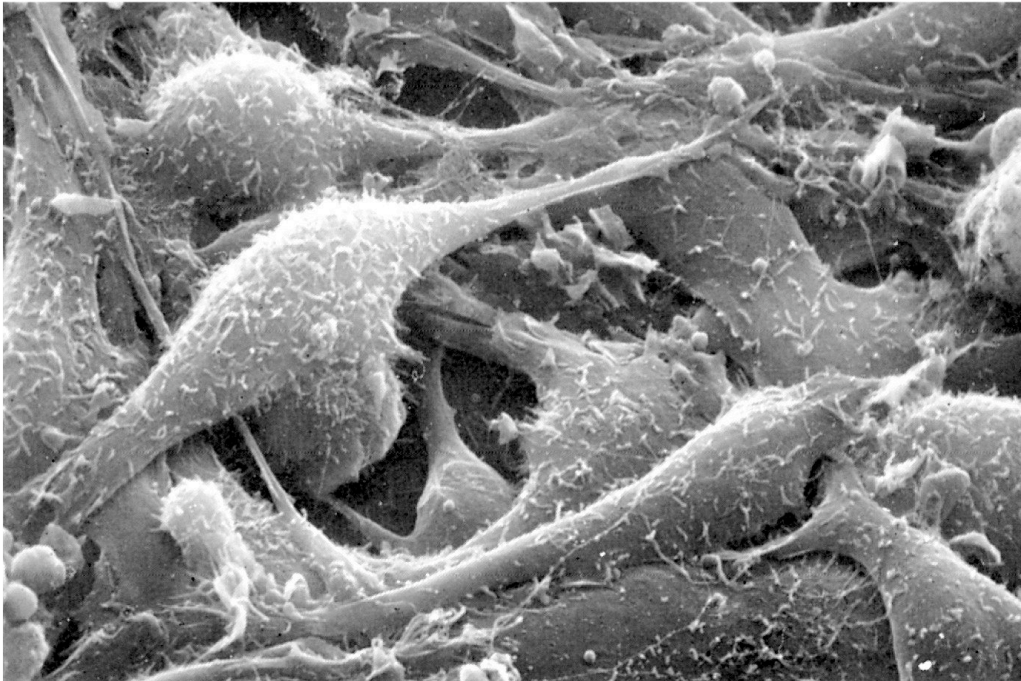
Cancer cells continue to divide, piling up on top of each other.



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Normal skin cells
Grow in monolayer



Skin cancer cells
Do not grow in monolayer
Pile up on each other

Properties of Cancer cells

- **Anchorage dependence** in normal cells keeps the cells in place

Anchorage Dependence

Normal cells always stay anchored to other cells (or to a surface).

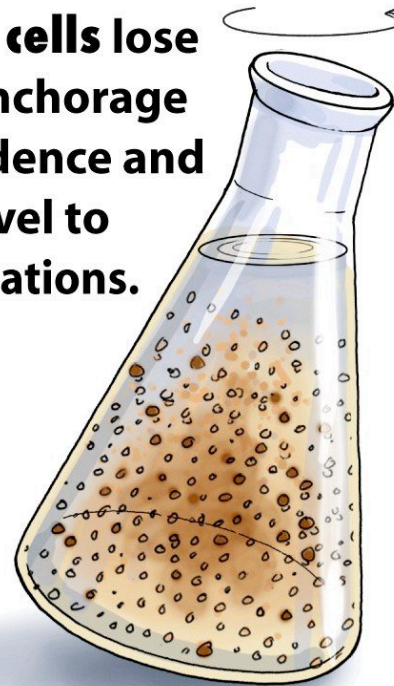
Flask

Growth medium

Cells



Cancer cells lose their anchorage dependence and can travel to new locations.



Multiple Hit Model of Cell Transformation to Cancer

- Many mutations, or hits, in a cell are required for it to become malignant or cancer
- **Multiple hit model** describes the process of cancer development from a normal cell
- Mutations can be inherited and/or can stem from environmental exposures

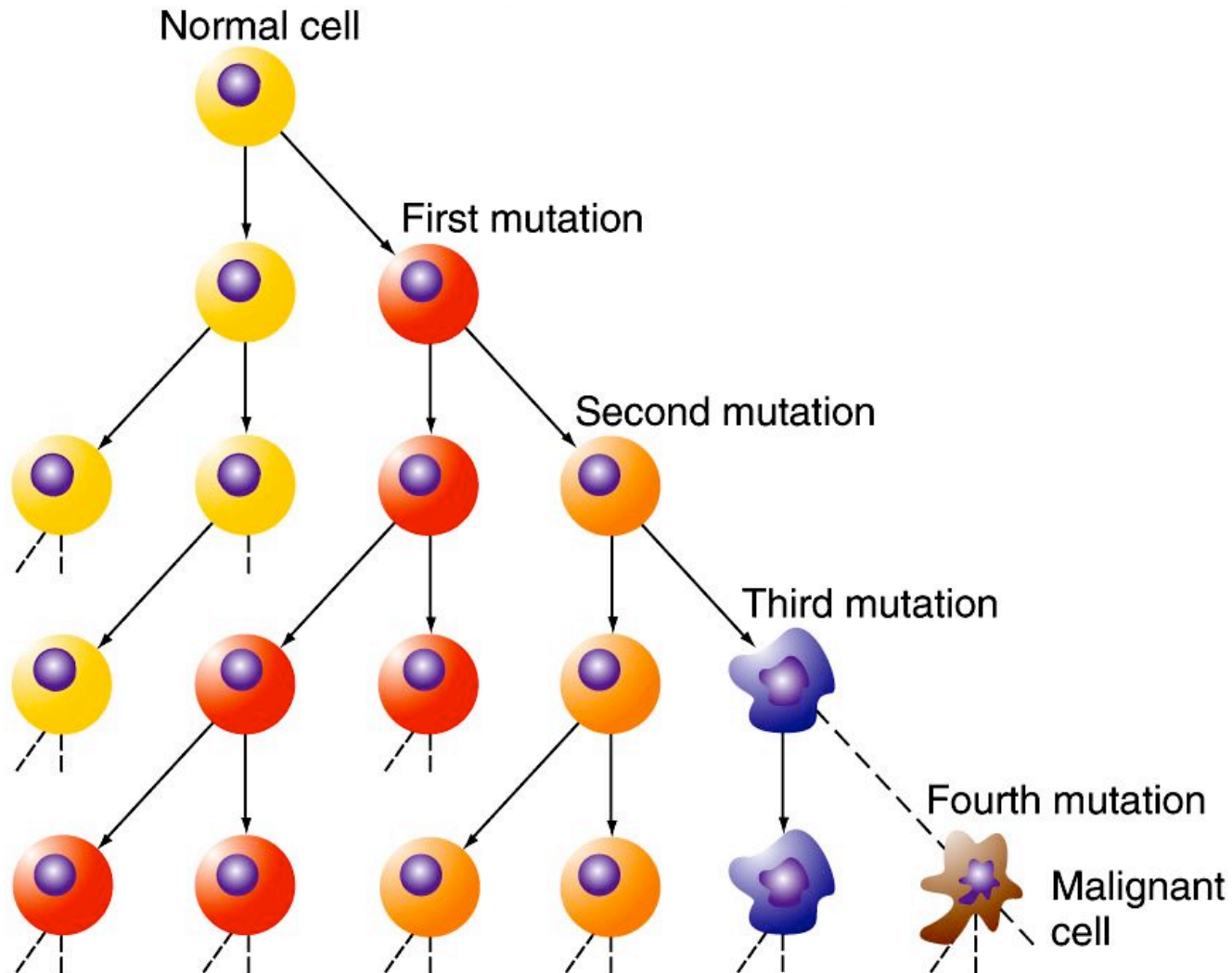
Most cancers result from exposures to mutagens

- If one sib or twin gets cancer, other usually does not
- Populations that migrate – profile of cancer becomes more like people indigenous to new location

TABLE 18.2 The Incidence of Some Common Cancers Varies Between Countries

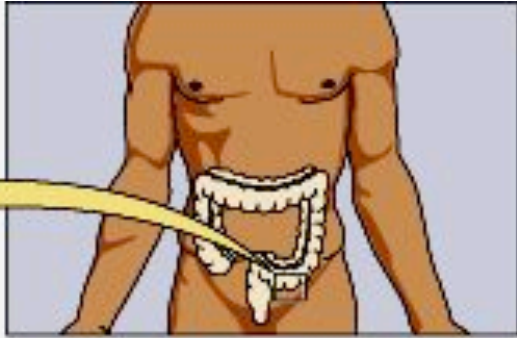
Site of Origin of Cancer	High-Incidence Population		Low-Incidence Population	
	Location	Incidence*	Location	Incidence*
Lung	USA (New Orleans, blacks)	110	India (Madras)	5.8
Breast	Hawaii (Hawaiians)	94	Israel (non-Jews)	14.0
Prostate	USA (Atlanta, blacks)	91	China (Tianjin)	1.3
Cervix	Brazil (Recife)	83	Israel (non-Jews)	3.0
Stomach	Japan (Nagasaki)	82	Kuwait (Kuwaitis)	3.7
Liver	China (Shanghai)	34	Canada (Nova Scotia)	0.7
Colon	USA (Connecticut, whites)	34	India (Madras)	1.8
Melanoma	Australia (Queensland)	31	Japan (Osaka)	0.2
Nasopharynx	Hong Kong	30	UK (southwestern)	0.3
Esophagus	France (Calvados)	30	Romania (urban Cluj)	1.1
Bladder	Switzerland (Basel)	28	India (Nagpur)	1.7
Ovary	New Zealand (Polynesian Islanders)	26	Kuwait (Kuwaitis)	3.3
Pancreas	USA (Los Angeles, Koreans)	16	India (Poona)	1.5
Lip	Canada (Newfoundland)	15	Japan (Osaka)	0.1

Multiple Hit Model of Cell Transformation to Cancer



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Tumor suppressor genes: *APC*, *DCC*, *p53*
Oncogene: *ras*



Normal colon cells

APC gene loss



Increased cell growth

DNA hypomethylation



Adenoma class I

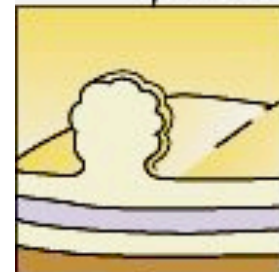
ras gene mutation

The Multiple Hit Model for Colon Cancer



Adenoma class II

DCC gene loss



Adenoma class III

p53 gene loss



Carcinoma

Other gene losses



Metastasis

5.5 Cancer Detection and Treatment

- Earlier detection and treatment of cancer greatly increase the odds of survival
- Knowing the warning signs of cancer is important to health
- Cancer screenings extremely important
- Self exams can catch early tumors both benign and malignant

Cancer Detection



- C** hange in bowel or bladder habits
- A** sore that does not heal
- U** nusual bleeding or discharge
- T** hickening or lump
- I** ndigestion or difficulty swallowing
- O** bvious change in wart or mole
- N** agging cough or hoarseness

Figure 5-17 Biology: Science for Life, 2/e

Cancer Detection Methods

- **Blood tests for**
- High blood cell counts
 - May indicate a leukemia or lymphoma
- High protein concentration
 - May indicate a tumor is making lots of protein
 - Prostate cancer PSA
 - Ovarian cancer CA125
- **Biopsy**
 - When a tumor is found and cancer is suspected
 - the surgical removal of cells, tissue, or fluid for analysis
 - Under a microscope:
 - benign tumors appear orderly and resemble other normal cells
 - Malignant tumors do not resemble normal tissue

Cancer Detection Methods: Biopsy

Normal ovarian tissue

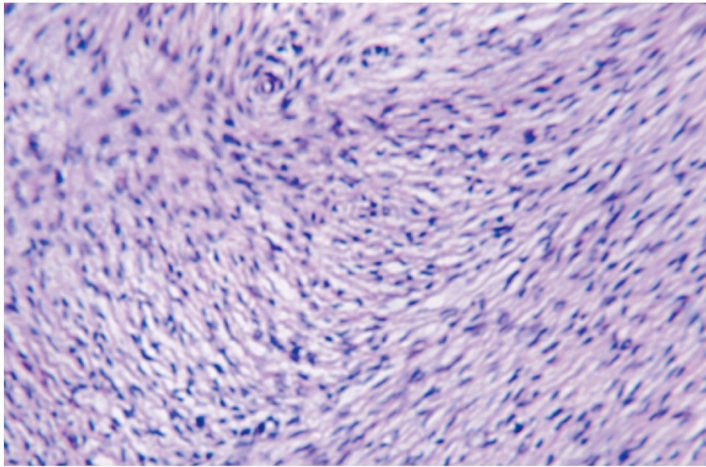


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Benign ovarian tumor

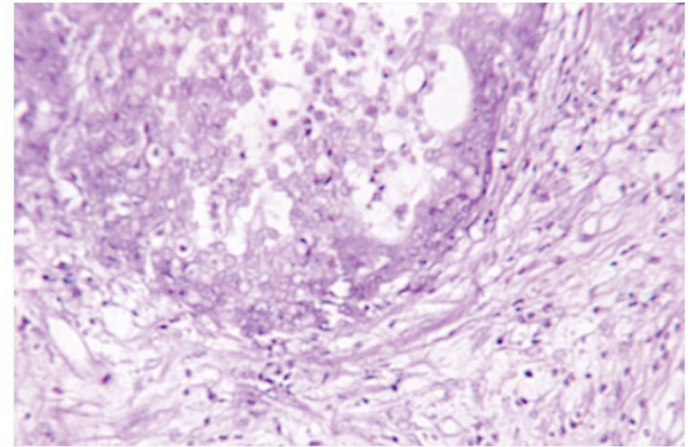


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Malignant ovarian tumor

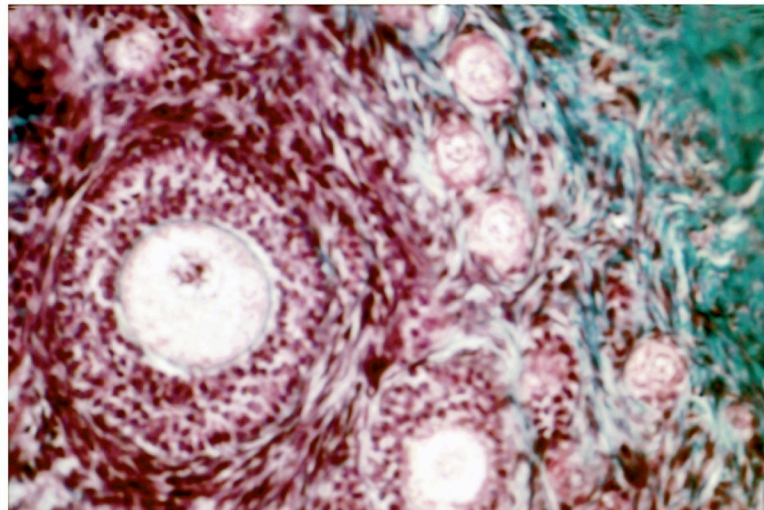


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c.

Treatment Methods

- When possible, surgeons remove tumors with a **laparoscope** through small incisions
 - generally lead to quicker, easier recoveries
 - 1 to 2 weeks
 - are possible only when growths are small
- Others are surgically removed and require much longer recovery time
 - 6-8 weeks
- Continued monitoring and other treatments may come after surgery

Treatment Methods: Chemotherapy

- **Chemotherapy** is used for cancer that cannot be surgically removed or that has metastasized
 - Any Chemical or drug that kills cancer cells is considered chemotherapy
- Classical chemotherapy kills all dividing cells and is usually injected into the bloodstream
- Combinations of chemical agents are usually used since cancer cells can become resistant
- Adverse effects on chemotherapy patients during treatment
 - Hair loss
 - Nausea
 - Immunosuppression
 - fatigue

Treatment Methods: Chemotherapy

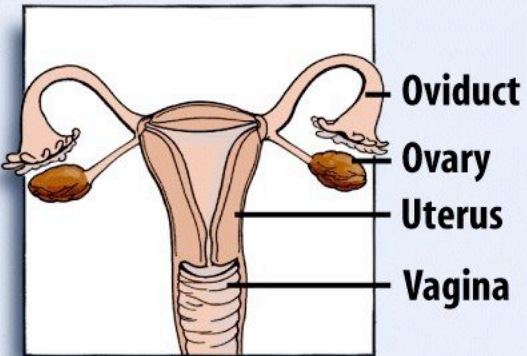
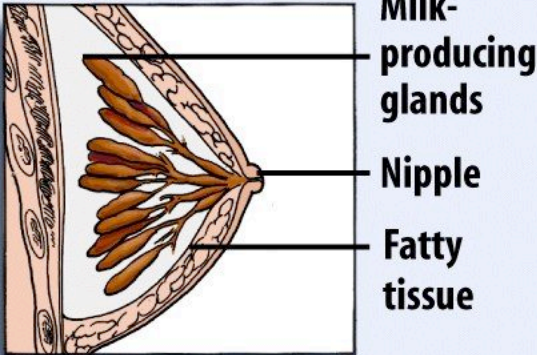
- Newer chemotherapy drugs target just cancer cells
 - Not all dividing cells
- Successful tumor specific drugs
 - Her2/neu = Herceptin for Breast Cancer
 - Bcr/abl = Gleevec for CML
 - CD20 = Rituxan for Non Hodgkin Lymphoma (NHL)
- Block necessary component for tumor cell growth
- Does not harm normal cells
- Very few if any side effects
- Activate our own immune system to specifically kill tumor cells

Treatment Methods: Radiation

- **Radiation therapy**
 - High energy radioactive particles damage DNA and kill cells
 - Highly focused on tumor area
- Radiation therapy is can be administered with or without chemotherapy
- A patient is in **remission** if the patient is no longer suffering negative impacts from cancer after a given period

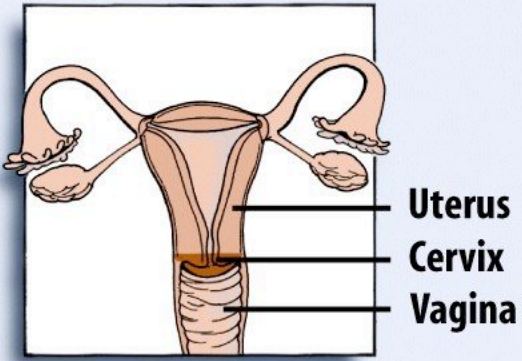
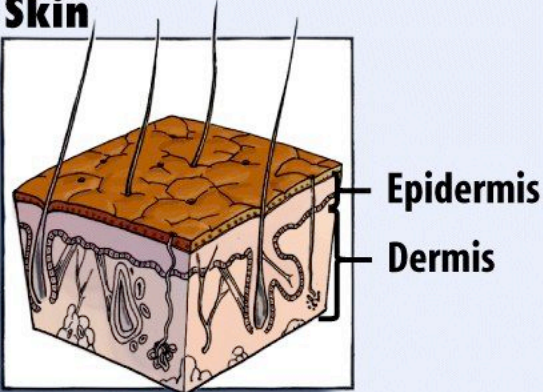
Essay 5.1 Cancer Risk Factors

Known risk factors are linked to particular cancers...

Cancer Location	Risk Factors	Detection	Comments
<p>Ovary</p>  <p>Oviduct Ovary Uterus Vagina</p>	<ul style="list-style-type: none"> • Smoking • Mutation to <i>BRCA2</i> gene • Advanced age • Oral contraceptive use and pregnancy decrease risk 	<ul style="list-style-type: none"> • Blood test for elevated CA125 level • Gynecological exam 	<ul style="list-style-type: none"> • Fifth leading cause of death among women in the United States
<p>Breast</p>  <p>Milk-producing glands Nipple Fatty tissue</p>	<ul style="list-style-type: none"> • Smoking • Mutation to <i>BRCA1</i> gene • High-fat, low-fiber diet • Use of oral contraceptives may slightly increase risk. 	<ul style="list-style-type: none"> • Monthly self exams, look and feel for lumps or changes in contour • Mammogram 	<ul style="list-style-type: none"> • Only 5% of breast cancers are due to <i>BRCA1</i> mutations • Second-highest cause of cancer-related deaths • 1% of breast cancer occurs in males

Essay 5.1 Cancer Risk Factors

Known risk factors are linked to particular cancers...

Cancer Location	Risk Factors	Detection	Comments
<p>Cervix</p> 	<ul style="list-style-type: none"> • Smoking • Exposure to sexually transmitted Human Papilloma Virus (HPV) 	<ul style="list-style-type: none"> • Annual Pap-smear tests for the presence of pre-cancerous cells 	<ul style="list-style-type: none"> • Precancerous cells can be removed by laser surgery or cryotherapy (freezing) before they become cancerous.
<p>Skin</p> 	<ul style="list-style-type: none"> • Smoking • Fair skin • Exposure to ultraviolet light from the sun or tanning beds 	<ul style="list-style-type: none"> • Monthly self-exams, look for growths that change in size or shape 	<ul style="list-style-type: none"> • Skin cancer is the most common of all cancers and is usually curable if caught early.

Essay 5.1 Cancer Risk Factors

Known risk factors are linked to particular cancers...

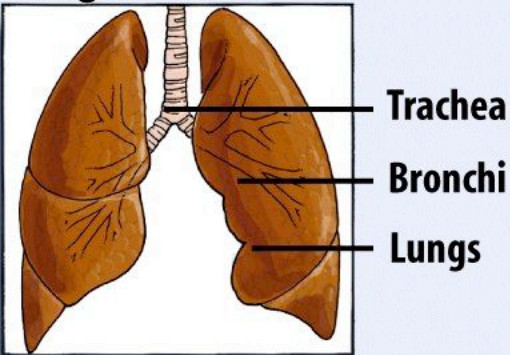
Cancer Location	Risk Factors	Detection	Comments
Lung  <p>The diagram shows a frontal view of the human respiratory system. The trachea is the central airway, branching into the bronchi which lead to the lungs. Labels with lines pointing to the respective parts are: Trachea, Bronchi, and Lungs.</p>	<ul style="list-style-type: none">• Smoking• Exposure to second-hand smoke• Asbestos inhalation	<ul style="list-style-type: none">• X-ray	<ul style="list-style-type: none">• Lung cancer is the most common cause of death from cancer, and the best prevention is to quit, or never start, smoking.

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Essay 5.1 Cancer Risk Factors

Known risk factors are linked to particular cancers...

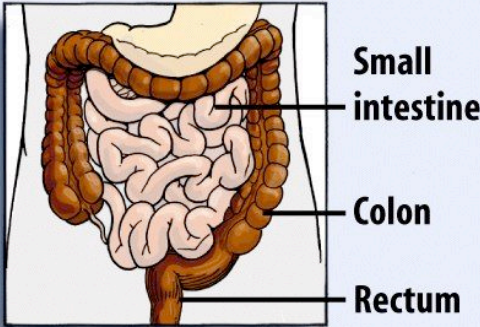
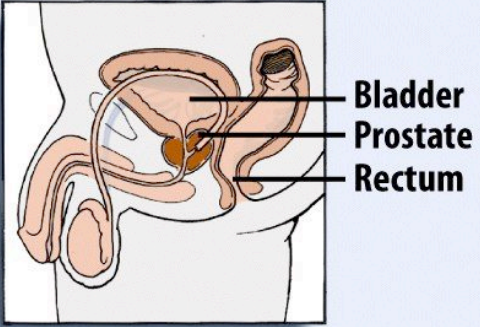
Cancer Location	Risk Factors	Detection	Comments
<p>Colon and rectum</p> 	<ul style="list-style-type: none"> • Smoking • <i>Polyps</i> in the colon • Advanced age • High-fat, low-fiber diet 	<ul style="list-style-type: none"> • Change in bowel habit • Colonoscopy is an examination of the rectum and colon using a lighted instrument. 	<ul style="list-style-type: none"> • Benign buds called polyps can grow in the colon; removal prevents them from mutating and becoming cancerous.
<p>Prostate</p> 	<ul style="list-style-type: none"> • Smoking • Advanced age • High-fat, low-fiber diet 	<ul style="list-style-type: none"> • Blood test for elevated level of prostate specific antigen (PSA) • Physical exam by physician, via rectum 	<ul style="list-style-type: none"> • More common in African-American men than Asian, white, or Native American men.

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Essay 5.1 Cancer Risk Factors

Known risk factors are linked to particular cancers...

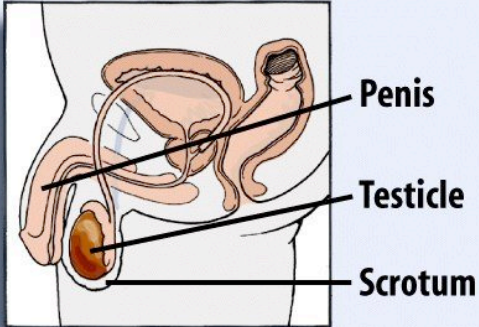
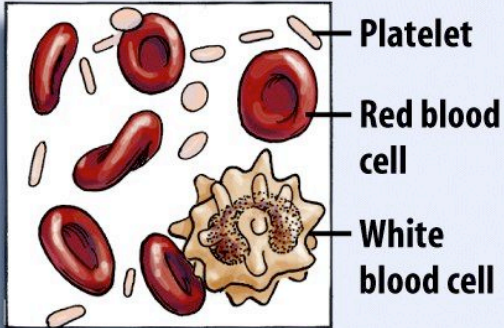
Cancer Location	Risk Factors	Detection	Comments
<p>Testicle</p>  <p>Penis Testicle Scrotum</p>	<ul style="list-style-type: none"> • Abnormal testicular development 	<ul style="list-style-type: none"> • Monthly self exam, inspect for lumps and changes in contour 	<ul style="list-style-type: none"> • Testicular cancer accounts for only 1% of all cancers in men, but is the most common form of cancer found in males between the ages of 15 and 35.
<p>Blood (Leukemia)</p>  <p>Platelet Red blood cell White blood cell</p>	<ul style="list-style-type: none"> • Exposure to high-energy radiation such as that produced by atomic bomb explosions in Japan during World War II 	<ul style="list-style-type: none"> • A sample of blood is examined under a microscope. 	<ul style="list-style-type: none"> • Cancerous white blood cells cannot fight infection efficiently: people with leukemia often succumb to infections.

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