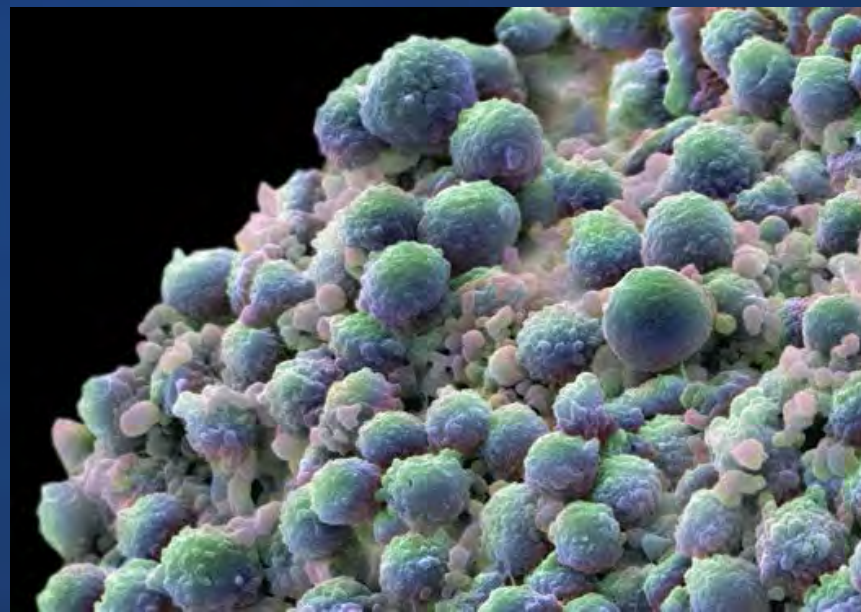


Oncology 101

Cancer Basics

What Will You Learn?

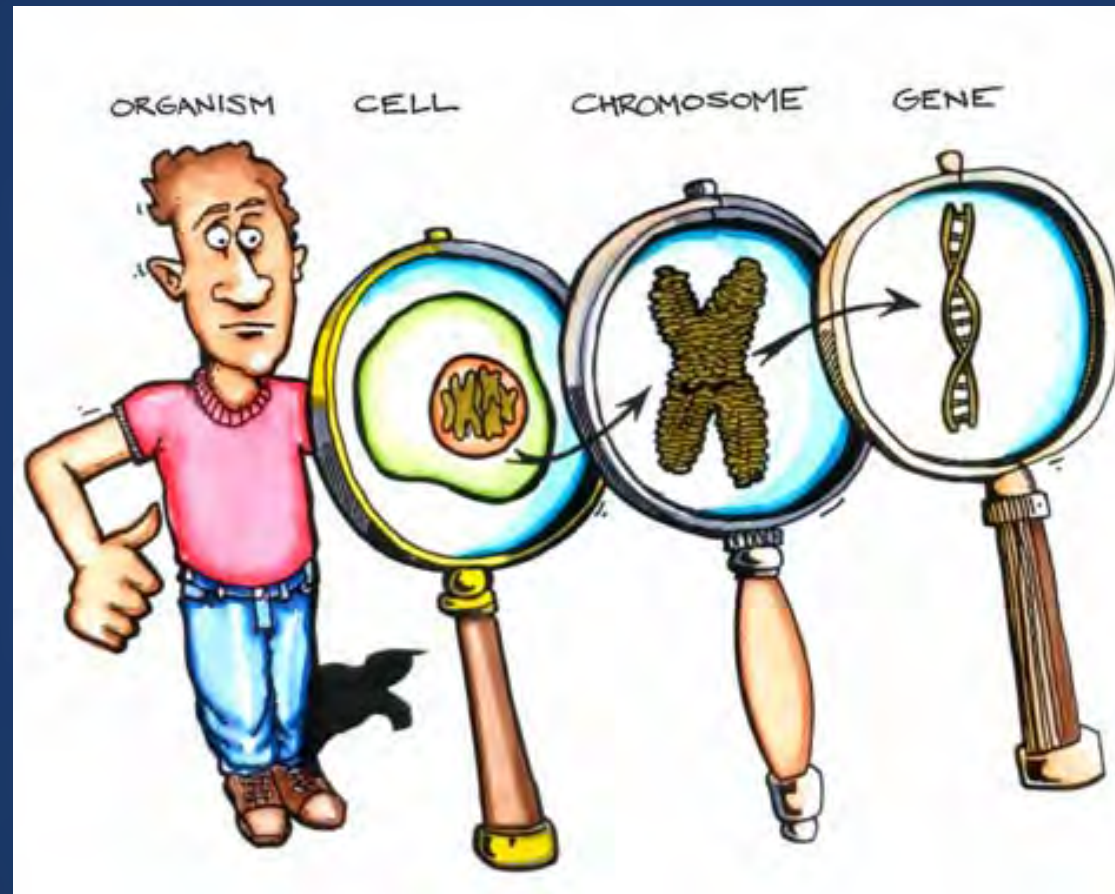
- What is Cancer and How Does It Develop?
- Cancer Diagnosis and Staging
- Cancer Treatment



What is Cancer?

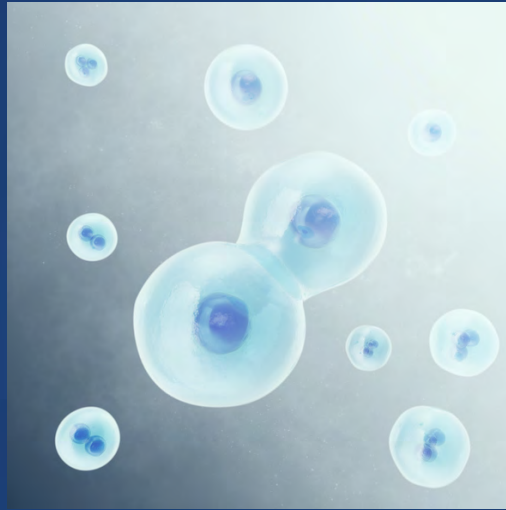
Cancer is a group of more than 100 different diseases characterized by the *uncontrolled, abnormal growth of cells*.

We are made up of cells, which contain genes



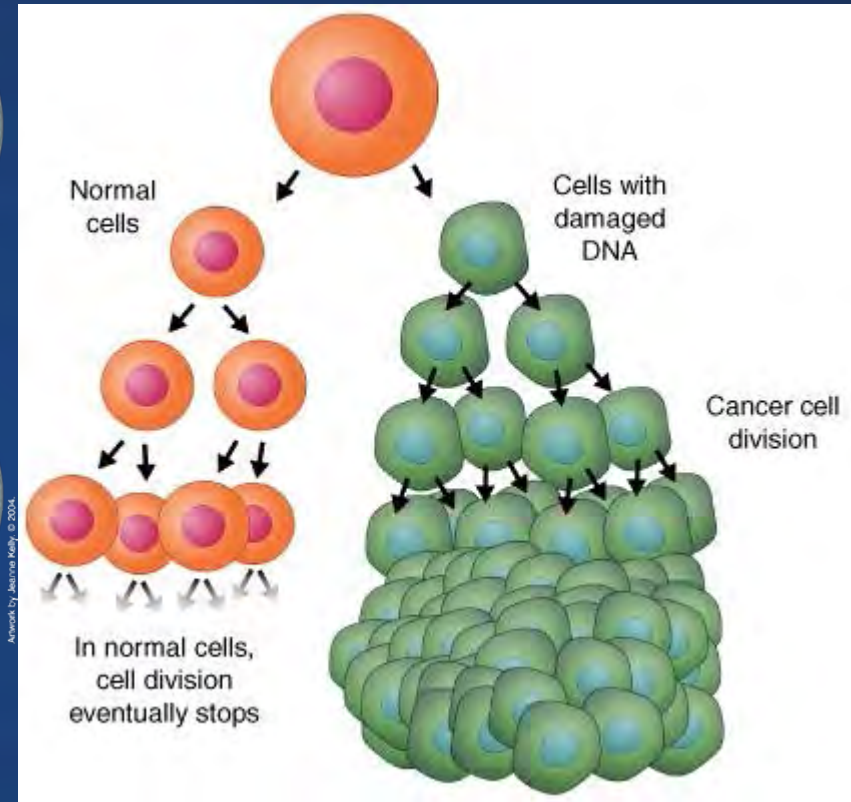
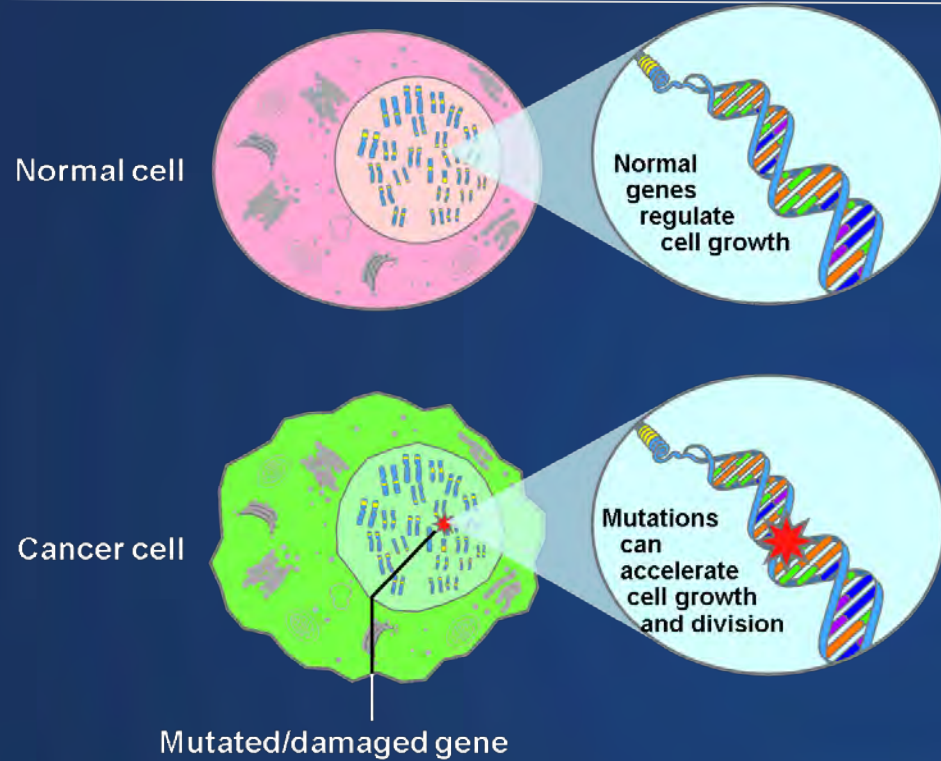
First Things First: Normal Cell Division

- Cells grow and divide (copy themselves) to form new cells






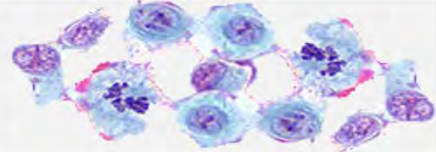

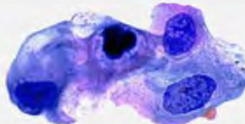


- When cells grow old or become damaged, they die and new cells take their place

It all starts in the genes

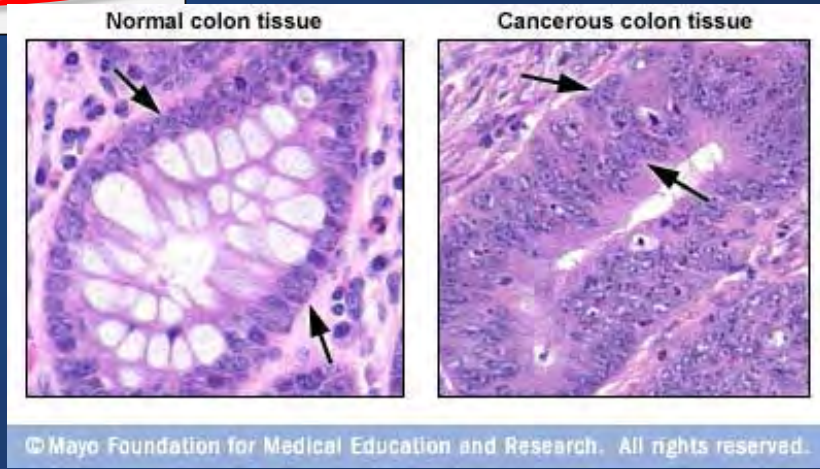


Adapted from NCI



Normal	Cancer	
		Large, variably shaped nuclei
		Many dividing cells; Disorganized arrangement
		Variation in size and shape
		Loss of normal features

**Under a microscope,
cancerous tissue
looks very different from
normal
(healthy) tissue**



What is Cancer? Summary Points

- Cancer is uncontrolled, abnormal growth of cells.
- Cancer results from changes or mutations in the genetic material (DNA).
- Because it takes years for mutations to accumulate, cancer is primarily a disease of aging.
- Tumors form when abnormal cells growing out of control form a mass.



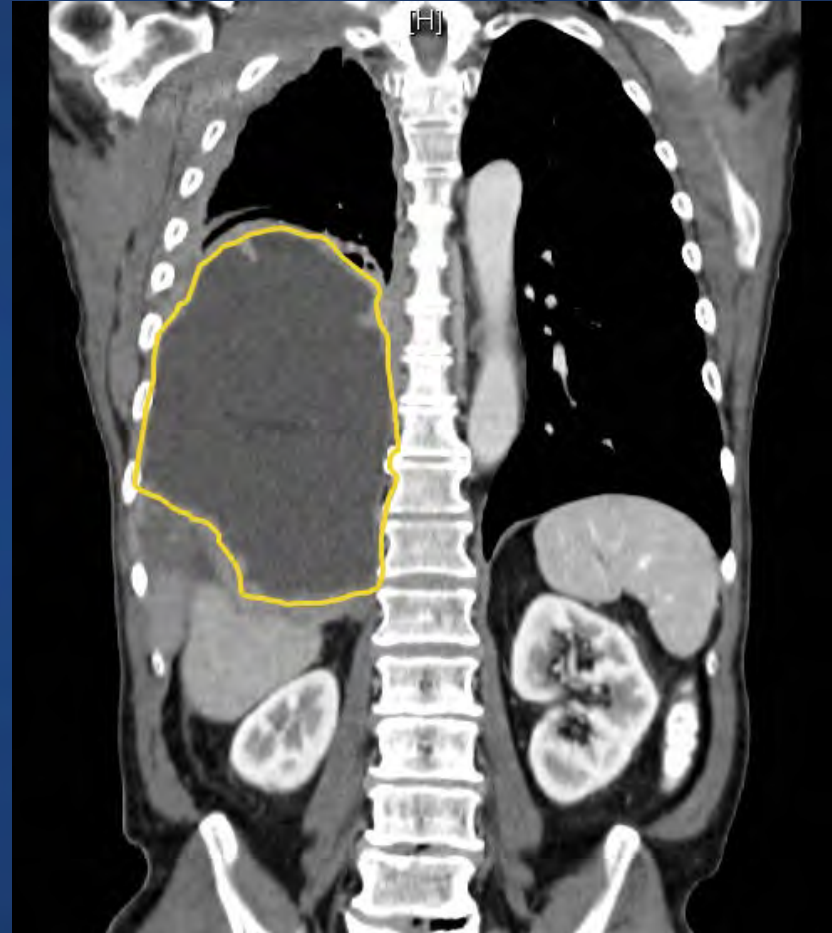
Two Main Groups of Cancer

Blood cancers
(e.g., leukemia, lymphoma)

Solid tumors (e.g., breast,
prostate, colon, lung
cancers)

What is a Tumor?

- A tumor is an abnormal growth of cells that forms a mass.
- Cancers can begin almost anywhere in the body.



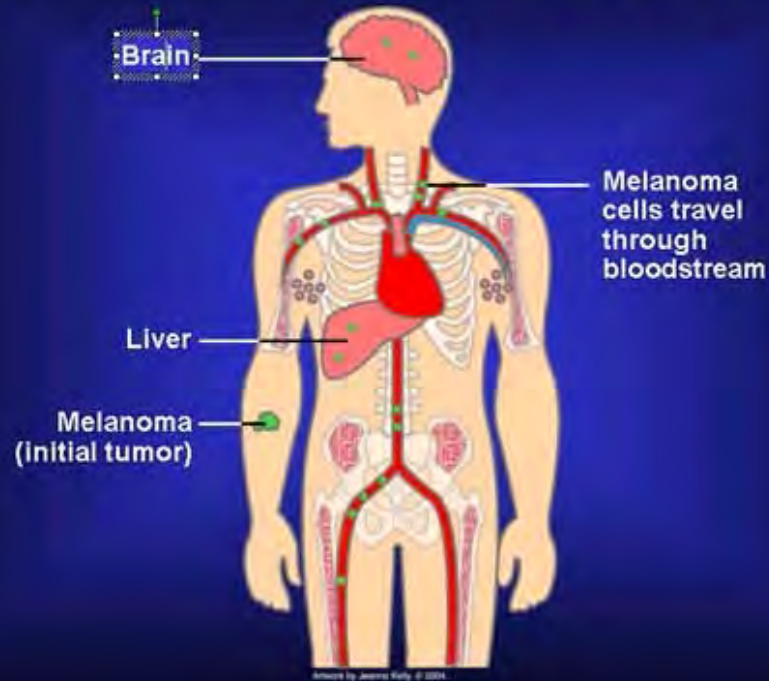
Benign Versus Malignant Tumors

Benign Tumors	Malignant Tumors
Do not spread to other parts of the body	Can invade and destroy the tissue around them
They can be removed and seldom come back	They can move to other parts of the body and form new tumors there (metastasis)
Rarely life-threatening	May be life-threatening

Major Classes of Cancer

- **Carcinomas** begin in the skin or in tissues covering glands or major organs (80-90% of all cancers; e.g., breast cancer, colon cancer). Major subtypes are **adenocarcinoma** and **squamous cell carcinoma**.
- **Sarcomas** begin in the connective tissue such as muscle or bone (Ewing sarcoma). Soft-tissue sarcomas can begin in fatty tissue.
- **Lymphomas** begin in the lymphatic system, a network of glands and vessels that carries lymph and white blood cells (e.g., Hodgkin lymphoma)
- **Leukemias** are cancers of blood-forming tissues including the bone marrow and the spleen (e.g., acute lymphocytic leukemia)

Why Cancer Is Potentially Dangerous



90% of cancer deaths are due to metastases



Liver with pancreatic cancer metastases

NATIONAL
CANCER
INSTITUTE

If the cancer spreads, or **metastasizes**, from the place where it started to another part of the body, the metastatic cancer is named for the part of the body where it started.

So, if a melanoma spreads to the liver, it's called metastatic melanoma, *not* liver cancer.



How Common is Cancer?

- **4 out of 10** Americans will be diagnosed with cancer during their lifetime
- **1.6 million**: The estimated number of new cancer diagnoses in 2016.
- Due to the aging and growing population, by 2030, this number will rise to **2.3 million per year**.

How Common is Cancer?

- 14.1 million: people diagnosed with cancer in 2012
- 22 million: estimated number of new cancer diagnoses in 2030

Global Cancer Facts & Figures, 2015

Cancer is a Leading Cause of Death

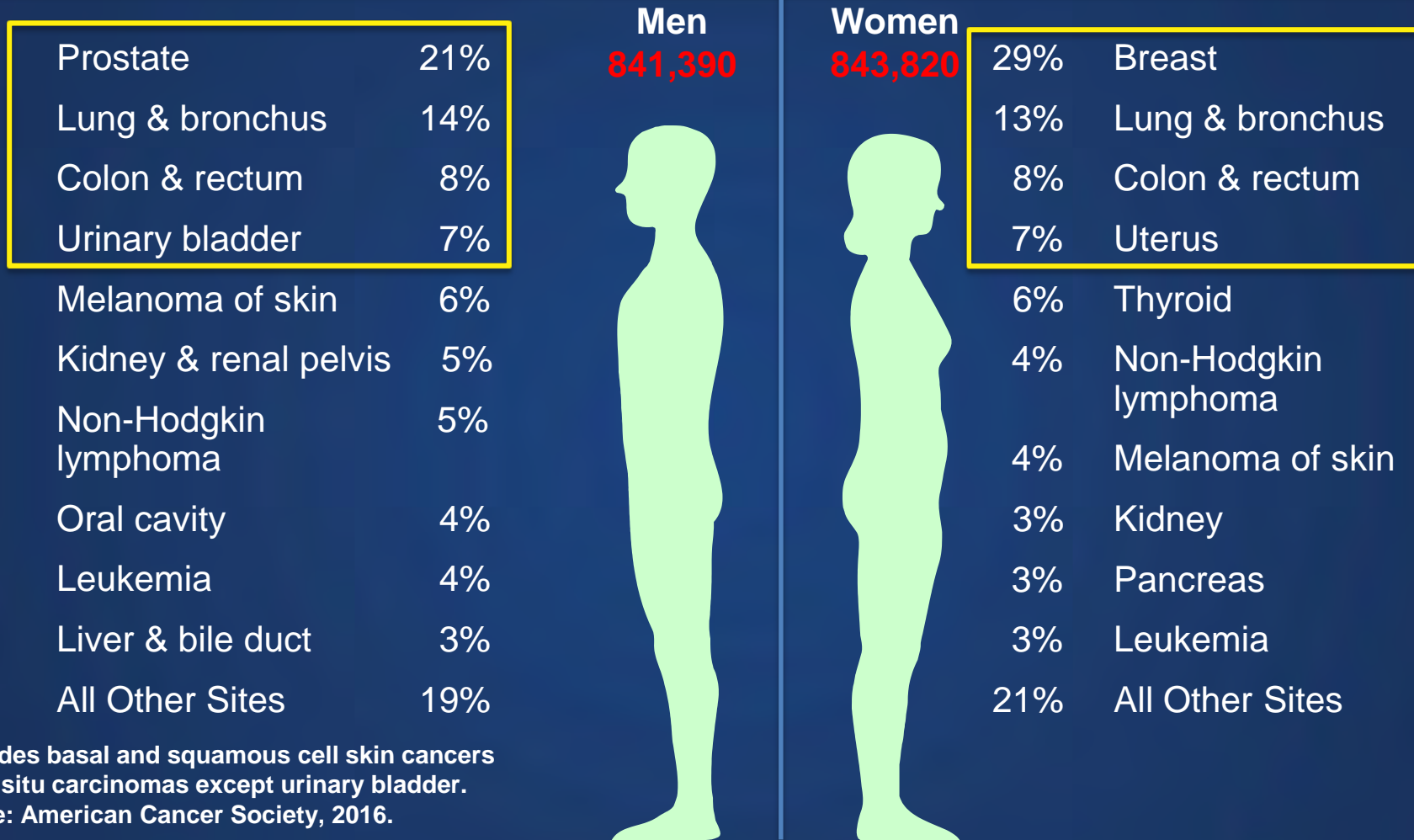
- **590,000**: The number of Americans expected to die of cancer in 2016, about **1,600** people per day.
- **8.2 million**: World cancer deaths in 2012 (**70%** of the world's cancer deaths occur in developing countries)
- **↑80%**: the estimated increase of world cancer deaths by 2030

Do You Know?

What are the most common types of cancer in the United States?

Worldwide?

Most Common Types of Cancer: 2016 Estimated New US Cancer Cases*



*Excludes basal and squamous cell skin cancers and in situ carcinomas except urinary bladder.
Source: American Cancer Society, 2016.

Most Deadly Forms of Cancer: 2015 Estimated US Cancer Deaths



Lung & bronchus	27%
Prostate	8%
Colon & rectum	8%
Pancreas	7%

Liver & intrahepatic
bile duct 6%

Leukemia 4%

Esophagus 4%

Bladder 4%

Non-Hodgkin
lymphoma 4%

Kidney 3%

All other sites 24%

Men
314,290



Women
281,400



26% Lung & bronchus

14% Breast

8% Colon & rectum

7% Pancreas

5% Ovary

4% Leukemia

3% Uterine

3% Non-Hodgkin
lymphoma

3% Liver & intrahepatic
bile duct

2% Brain/nervous system

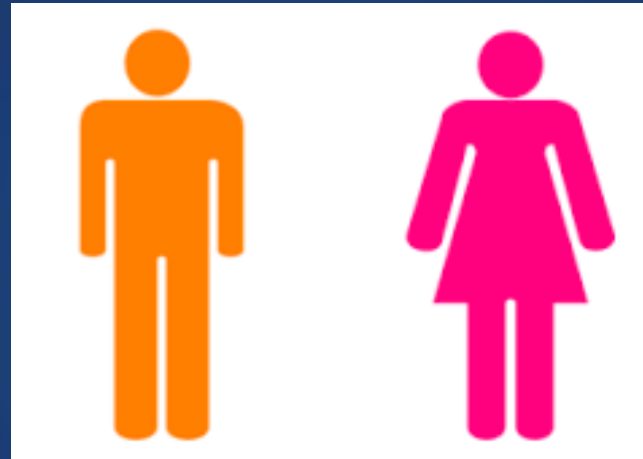
23% All other sites

Source: American Cancer Society, 2016

Most Common Cancers



Lung
Prostate
Colorectal
Stomach
Liver
Urinary Bladder



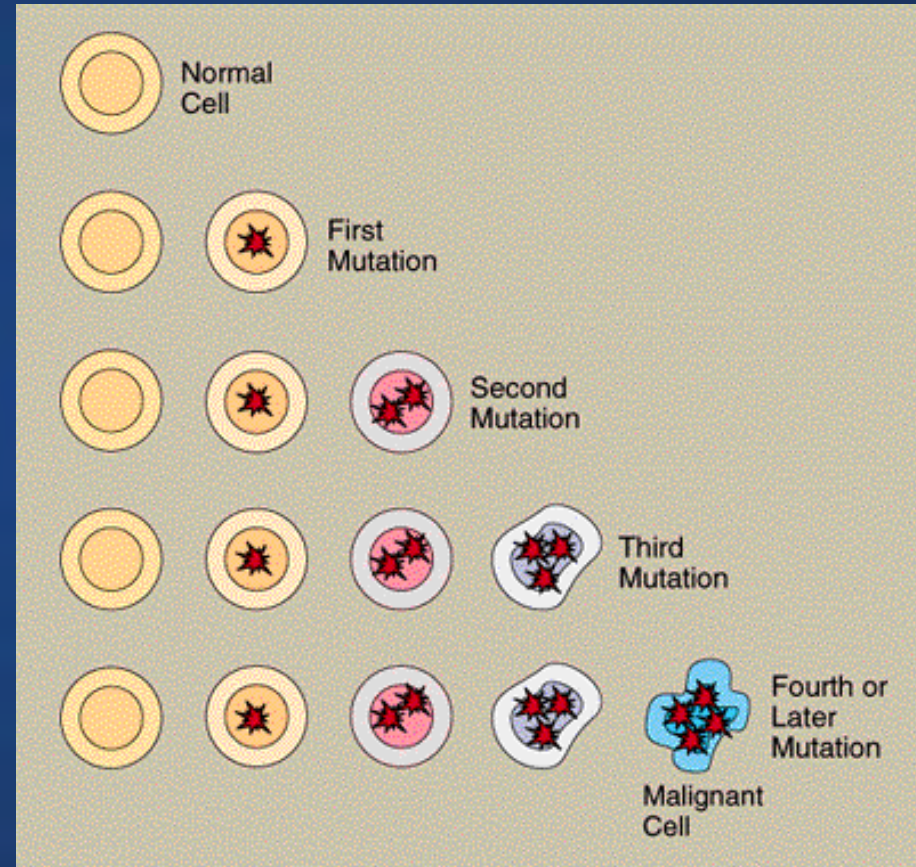
Breast
Colorectal
Lung
Cervical
Stomach
Uterine

Global Cancer Facts & Figures, 2015

What Causes Cancer?

Not Those Mutations Again!

- Recall...cancer is caused by changes—**mutations**—in genes that control the growth and death of cells.
- Accumulating *many* of these bad mutations can lead to cancer. No single event turns a normal cell into a cancer cell.



Risk Factors for Cancer

- Certain environmental and lifestyle factors can cause genetic changes (mutations) that lead to growth of cancer.

Am I at
risk?



- These influences are called *risk factors*: A risk factor is anything that increases your chances of getting a disease.

Age is the biggest cancer risk factor

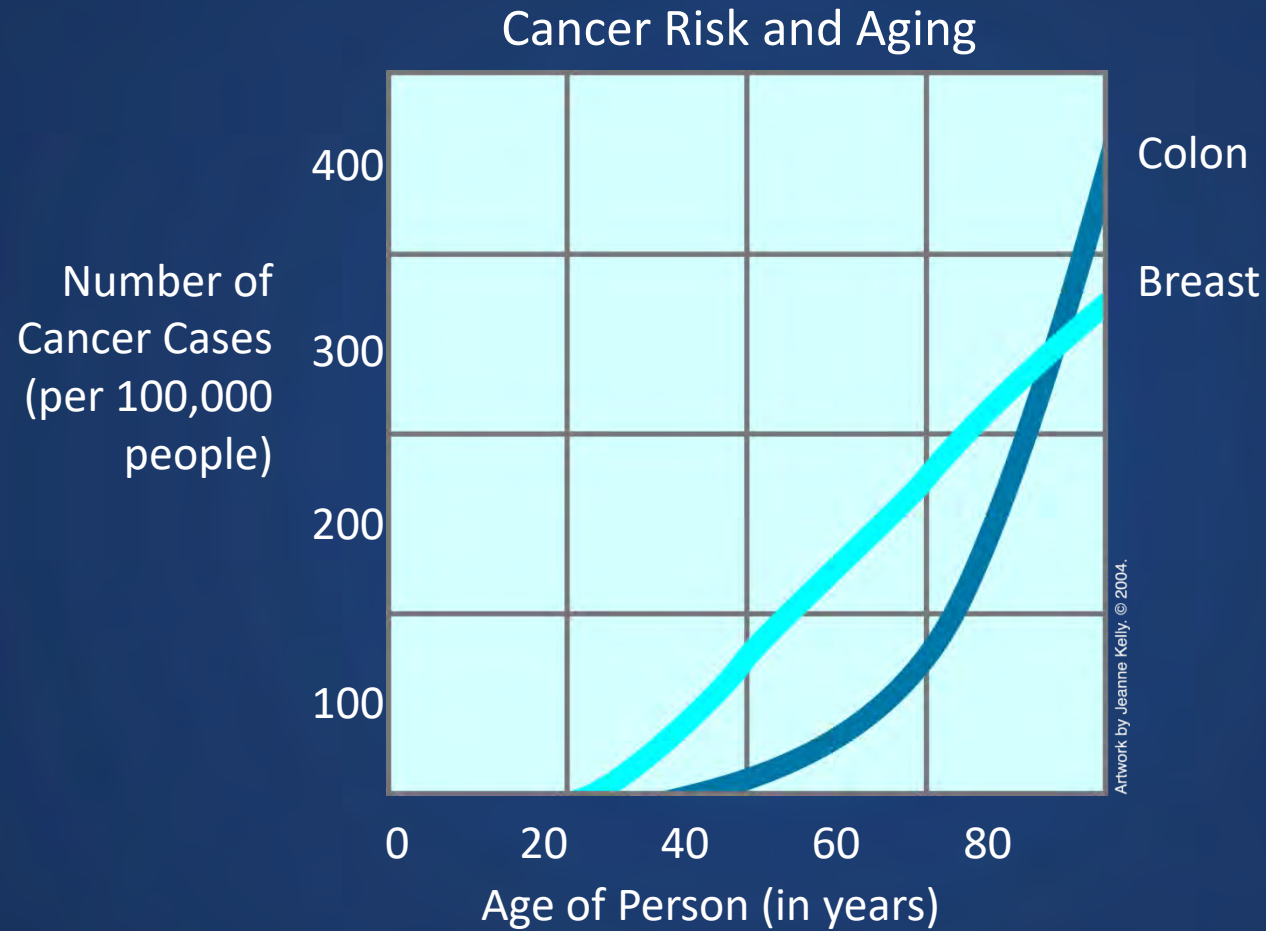
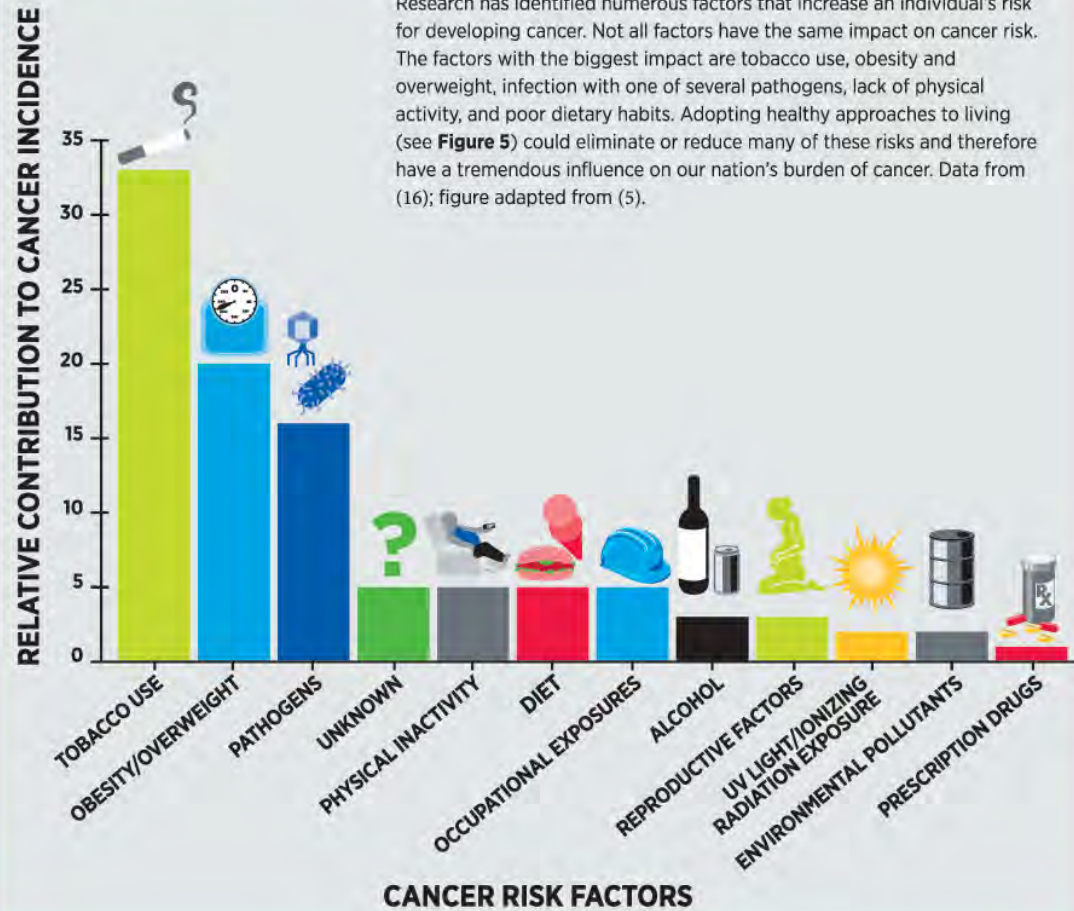


FIGURE 4 | RISKY BUSINESS



AACR Cancer Progress
Report 2014

Tobacco causes 18 types of cancer!



AACR Cancer Progress Report 2013

Healthy Weight and Lifestyle

- **1 in 3**: Cancer deaths due to being overweight, poor diet and/or lack of physical activity



Want to know more about the link between obesity and cancer?

Cancer.net video: <http://www.cancer.net/navigating-cancer-care/videos/after-treatment-and-survivorship/link-between-obesity-and-cancer>

How Can You Reduce Your Risk?

FIGURE 5 | HEALTHY APPROACHES TO LIVING



Research has identified numerous factors that affect a person's risk of developing cancer (see **Figure 4**). Many of the factors with the greatest influence on cancer risk can be eliminated or reduced by adopting a healthy approach to living. For example, ending tobacco use, eating a healthy and balanced diet, undertaking regular physical activity, reducing exposure to the sun, managing pre-existing medical conditions with the appropriate medications, getting vaccinated against certain pathogens, and developing a personalized cancer screening program with a physician (or physicians) are all part of a healthy approach to living.

AACR Cancer Progress Report 2014

Hereditary Cancers

Sporadic Cancers

Most cancers (90%-95%) result from a series of *acquired* genetic mutations caused by tobacco, sunlight, radiation, et cetera.

Hereditary or *Familial* Cancers

A **small proportion (5%-10%)** of cancers-- result from mutations passed from a parent (or both parents) to a child.



Hereditary Cancers

- So, sometimes, you are *born with a* gene mutation and can pass the mutation to offspring
- This means that you are more likely to accumulate the number of mutations (“hits”) needed for development of cancer
- However, even having an inherited gene mutation does not *always* mean you will develop cancer. But your risk is increased. The rest of the mutations are left up to chance (and exposure)



Hereditary cancer predispositions

- BRCA1, BRCA2 gene mutations (breast, ovarian, prostate, pancreatic and other cancers)* [Check out : Understanding Hereditary Breast and Ovarian Cancer Oncology 101 Session](#)
- APC gene mutations (colorectal cancers)
- TP53 gene mutations (breast cancer, sarcoma, leukemia, brain tumors, and other)
- PTEN gene mutations (breast, thyroid, endometrial, other)
- Lynch syndrome (GI and GYN cancers, brain, breast cancer)
- RB1 gene mutation (retinoblastoma, eye cancer)
- Von Hippel-Lindau syndrome (kidney cancer)



Summary: How Does Someone Get Cancer?

- Cancer results from uncontrolled cell growth
- Changes in genes can result in production of abnormal proteins or abnormal amounts of proteins – such proteins “tell” the cell to keep growing and dividing
- Certain environmental and lifestyle factors can cause mutations that allow the growth of cancer
- Multiple mutations are needed (some can be inherited)



Cancer Screening, Diagnosis and Staging Basics

How Do I Find Out If I Have Cancer?

- Signs and symptoms
- Screening tests
- Diagnosis tests
- Incidental (chance) findings

Common Signs and Symptoms

- Nagging cough or hoarseness
- Unplanned weight loss
- Changes in bowel or bladder habits
- New thickening or lump in any part of the body
- Unusual bleeding or discharge
- New mole or obvious change in the appearance of an existing mole or wart

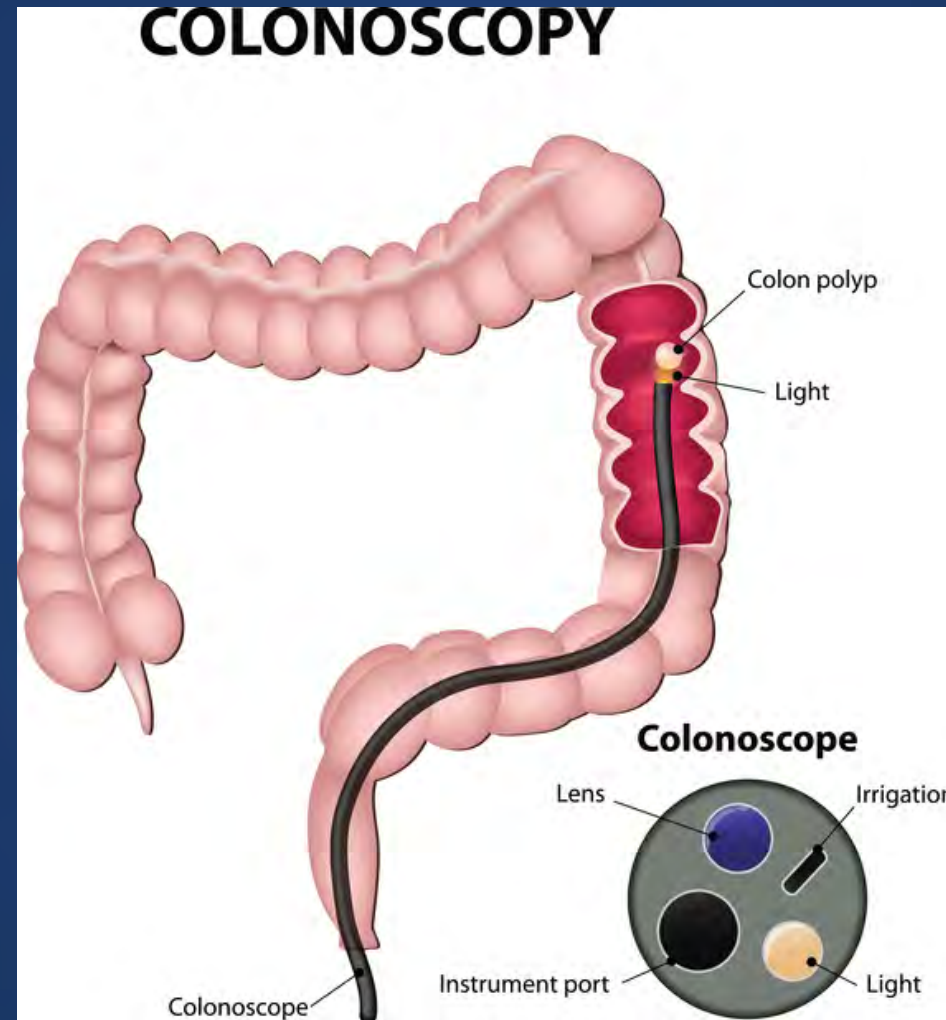




Common Cancer Screening Tests

- Colonoscopy (colorectal cancer)
- Mammography (breast cancer)
- PAP & HPV Tests (cervical cancer)
- PSA (prostate specific antigen; prostate cancer)
- Note that such tests are not widely available in low-resource settings/countries

Uses of Colonoscopy



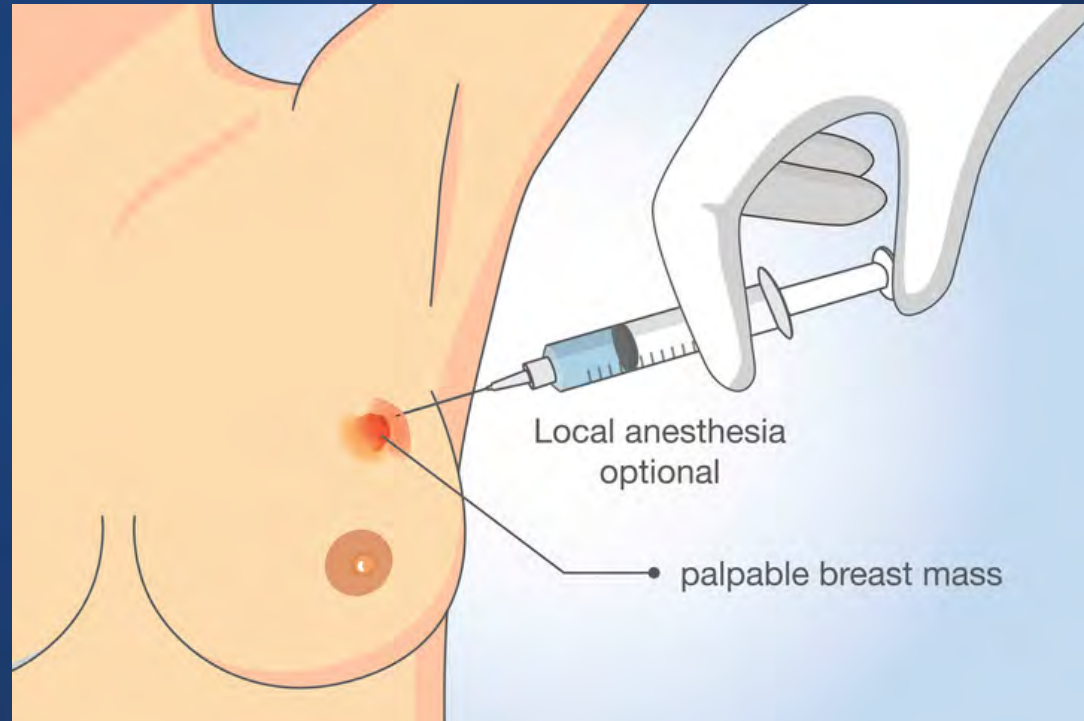
Mammography



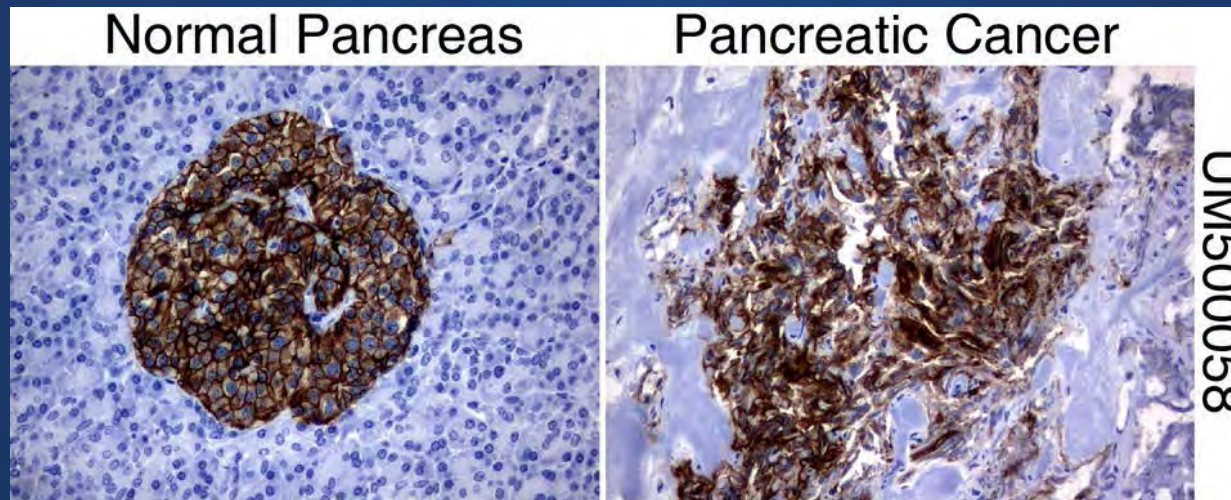
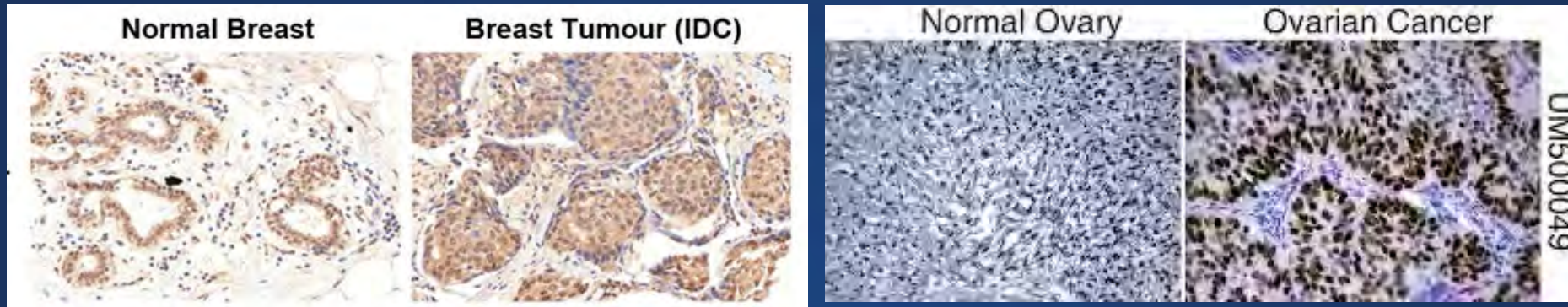
ASCO®

Biopsy, or “Tissue is the Issue”

Biopsy - a very small piece of tissue from the abnormal area (solid tumor) is removed and examined under a microscope by a pathologist. In addition, molecular tests can be performed on the tissue.



Biopsy tissue specimens under a microscope (pathology review)





Summary: Cancer Diagnosis

- There may be signs or symptoms that result in a doctor's visit
- Various types of screening tests can identify possibility of cancer (e.g., suspicious mass on a scan, abnormal blood test)
- Biopsy is the main way to confirm diagnosis of cancer.

Cancer Staging

- Cancer **staging** is a way of describing the severity of a cancer, such as:
 - How large is the tumor?
 - Where is it located?
 - Has it spread?

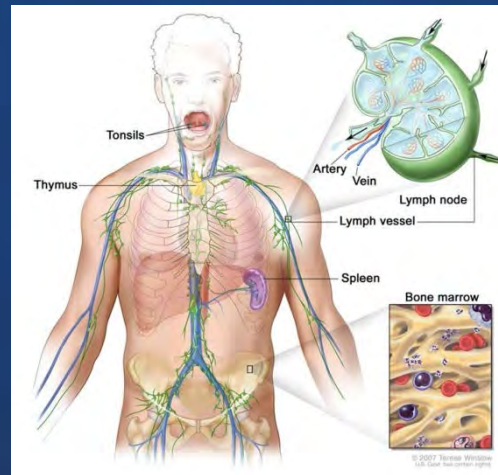
The TNM Cancer Staging System

Doctors look at these three factors to determine the stage of cancer:

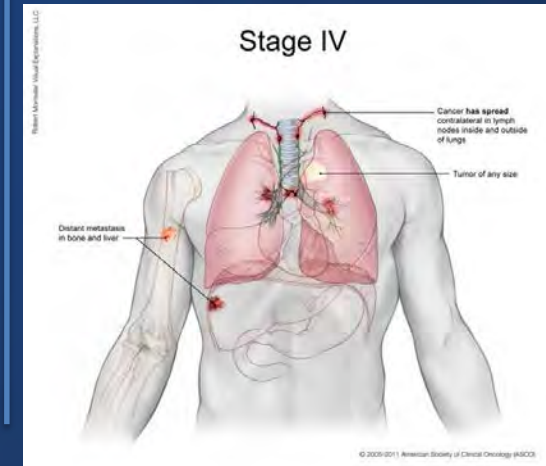
How large is the primary tumor and where is it located? **(Tumor, T)**



Has the tumor spread to the lymph nodes? **(Node, N)**



Has the cancer spread to other parts of the body? **(Metastasis, M)**





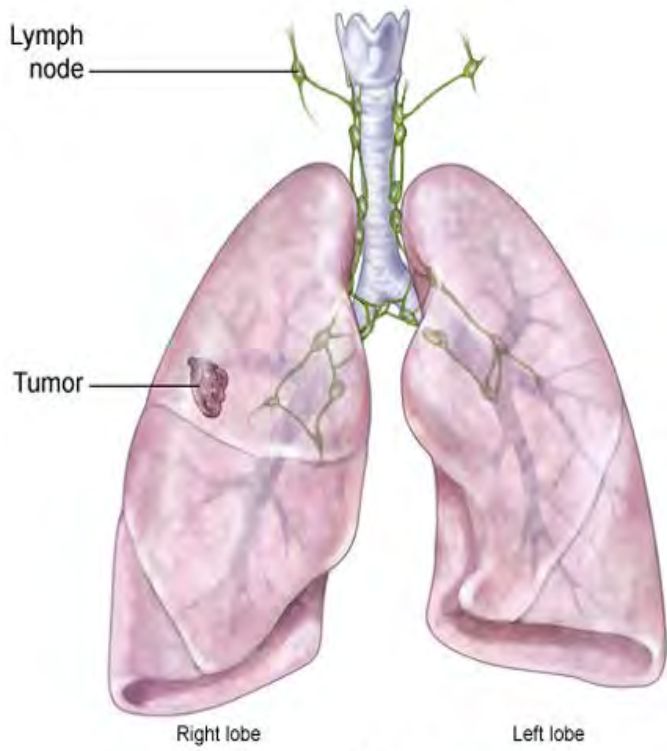
Cancer Stage Groupings I - IV

- stages are written as Roman numerals one through four (I, II, III, IV).
- Staging helps doctors establish a prognosis and prescribe appropriate therapy.
- A cancer with a lower stage is *usually* associated with a better prognosis.



Robert Morreale/Visual Explanations, LLC

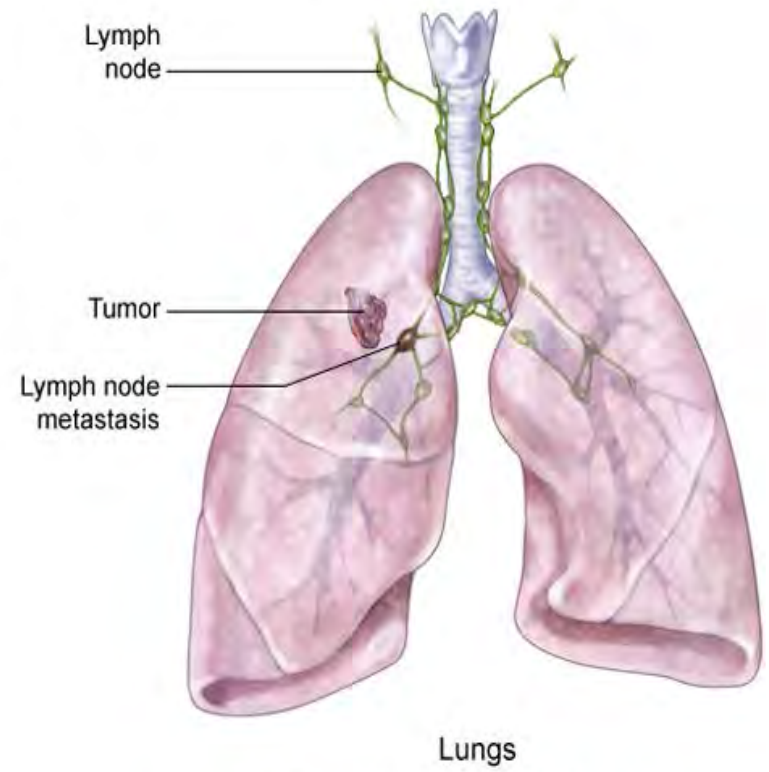
Stage I Cancer



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Stage II Cancer

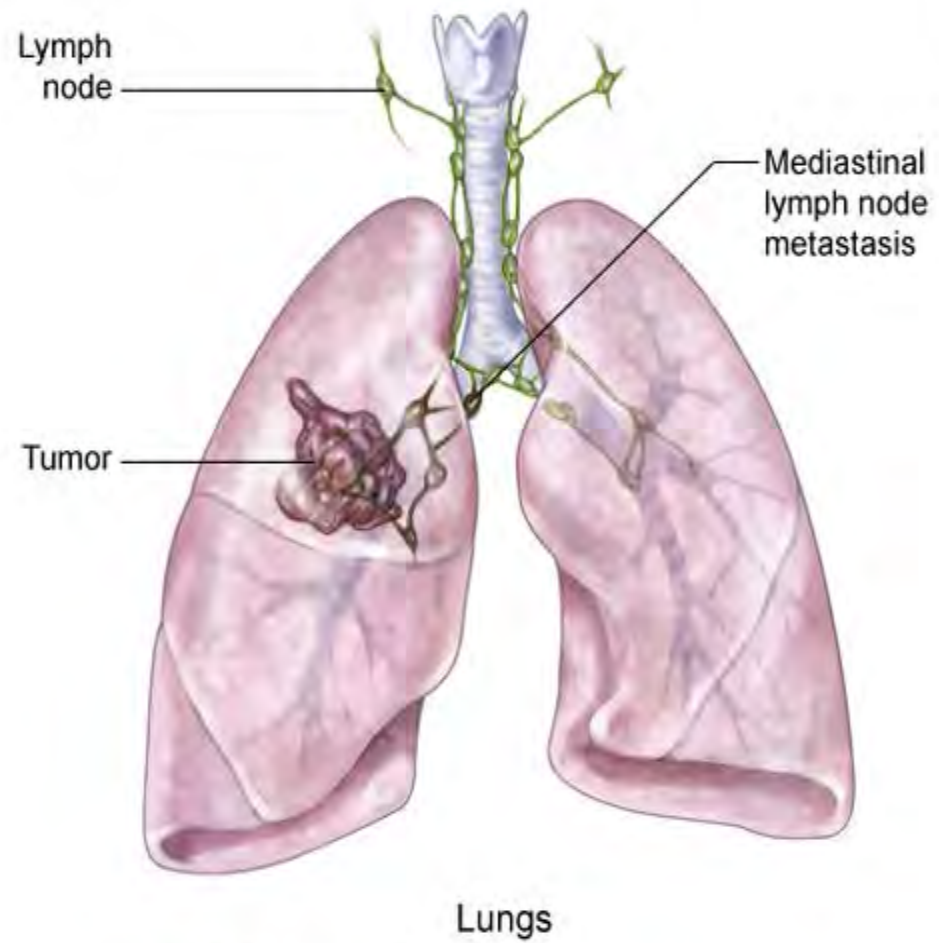


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Stage III Cancer

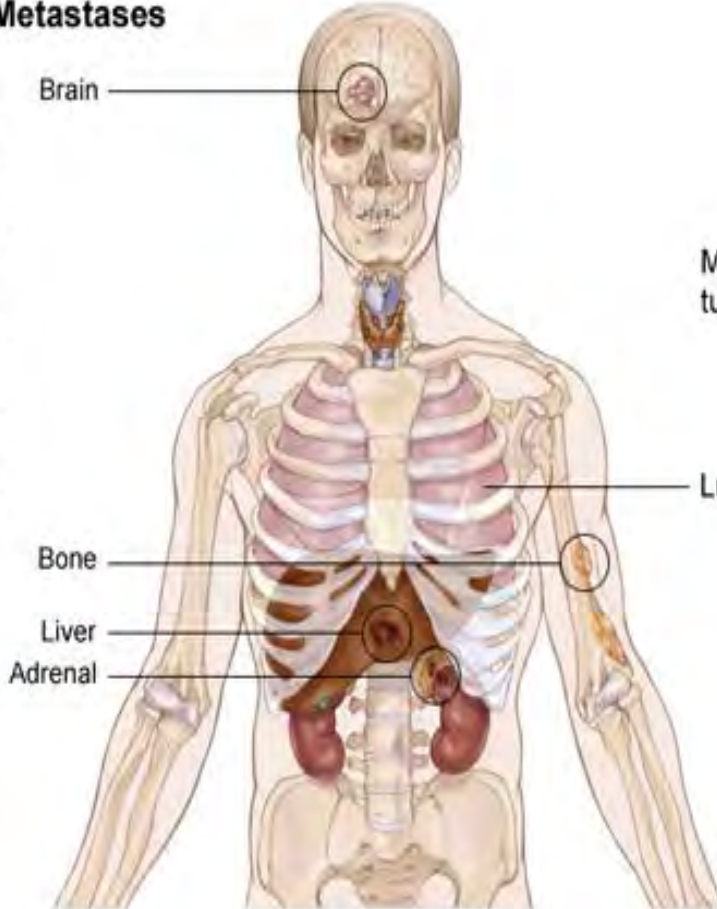


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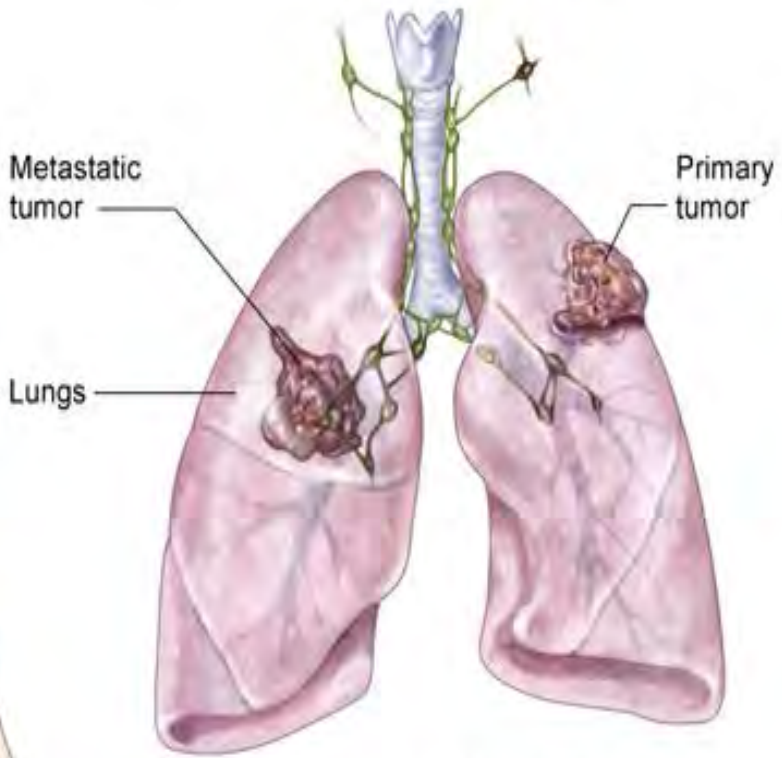


Metastases

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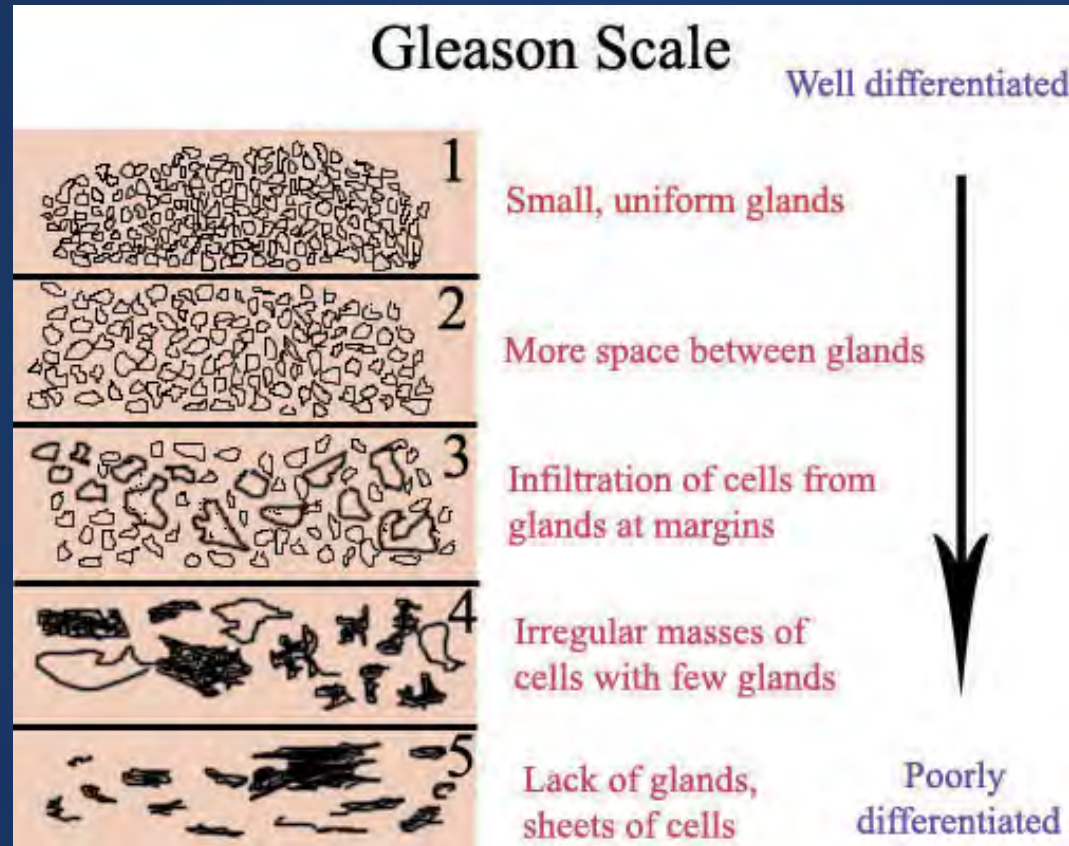


Stage IV Cancer



© 2005 American Society of Clinical Oncology

- **Tumor Grade:** describes how much the tumor tissue looks like healthy tissue when viewed under a microscope.



Higher tumor grade usually means more aggressive cancer and worse prognosis.

Gleason scale (score) designates grade of prostate tumor

What Are the Different Cancer Treatments?

Broad Categories of Treatment I

- *Local therapy* is intended to treat a tumor at the site without affecting the rest of the body. E.g., surgery and radiation therapy.
- *Systemic therapy* refers to drugs which can be given by mouth or directly into the bloodstream (i.v.) to reach cancer cells anywhere in the body (e.g., chemotherapy, hormone therapy, and targeted therapy.)

Broad Categories of Treatment II

- Sometimes *adjuvant* (additional) therapy is given after surgery or other main cancer treatment to kill cancer cells that may have broken away from the primary tumor and begun to spread through the body by way of the bloodstream.
- *Neoadjuvant therapy*, usually chemotherapy, may be given to shrink a tumor before surgery.

Types of Cancer Treatments

- Surgery
- Radiation Therapy
- Chemotherapy
- Hormonal Therapy
- Targeted Therapies
- Immunotherapy
- Palliative Care
- Supportive Care



Cancer Surgery

- Surgery offers the greatest chance for cure for many types of cancer, especially those that have not spread to other parts of the body. Most people with cancer will have some type of surgery.
- Cancer surgery is done by surgical oncologists or general surgeons, 7% of ASCO membership.



Radiation Therapy

- Radiation therapy uses radiation (high-energy x-rays, gamma rays, neutrons, protons) to destroy cancer cells.
- Radiation may come from a machine outside the body (external-beam radiation therapy), or it may come from radioactive material placed in the body near cancer cells (internal radiation therapy). Radiation therapy is usually a *local* therapy.
- Systemic radiotherapy uses a radioactive substance, such as a radiolabeled monoclonal antibody, that travels in the blood to tissues throughout the body.

Use of Radiation

- Radiation can be used either as a primary therapy (prostate cancer) or as an adjuvant therapy (breast cancer)



External-beam radiotherapy



Radiation Therapy

- Side effects of radiation therapy include fatigue, swelling, and skin changes.
- Radiation therapy is given by radiation oncologists, 8% of the ASCO membership.

Chemotherapy

Chemotherapy is the use of drugs to destroy cancer cells.

Chemotherapy is a **systemic therapy**, or a therapy that targets cells throughout the body.



Chemotherapy

- Chemotherapy works by stopping or slowing the growth of cancer cells, which are rapidly growing and dividing.
- **Side Effects:** Because a lot of *normal* cells in the body also grow and divide rapidly, for instance, cells that line the gut and that cause the hair to grow, **a lot of normal cells are also harmed by chemotherapy**. This translates into side effects like nausea and vomiting, and hair loss.

How Is Chemotherapy Used?

- Chemotherapy is the main treatment for many blood cancers.
- Chemotherapy is commonly used to:
 - destroy any cancer cells that remain after surgery or radiation therapy and reduce chance of recurrence. This is **adjuvant** chemotherapy.
 - Also used to shrink tumors before surgery or radiation therapy (**neoadjuvant** chemotherapy).
 - Also used to treat recurrent cancer (cancer that has come back in a person thought to be cancer-free) or metastatic cancer (cancer that has spread from the original location).

Chemotherapy

- Chemotherapy generally does not require a hospital stay (inpatient setting); it is usually given in an outpatient setting, including the medical oncologist's office. Patients can take oral chemotherapy at home.
- Chemotherapy is given by medical oncologists or hematologists, 77% of the ASCO membership.

Hormonal Therapy

Some cancers (e.g., breast , prostate cancers) depend on hormones to grow.

Hormonal therapy blocks these hormones to limit growth of these cancers.

Hormonal therapy is a **systemic therapy**.

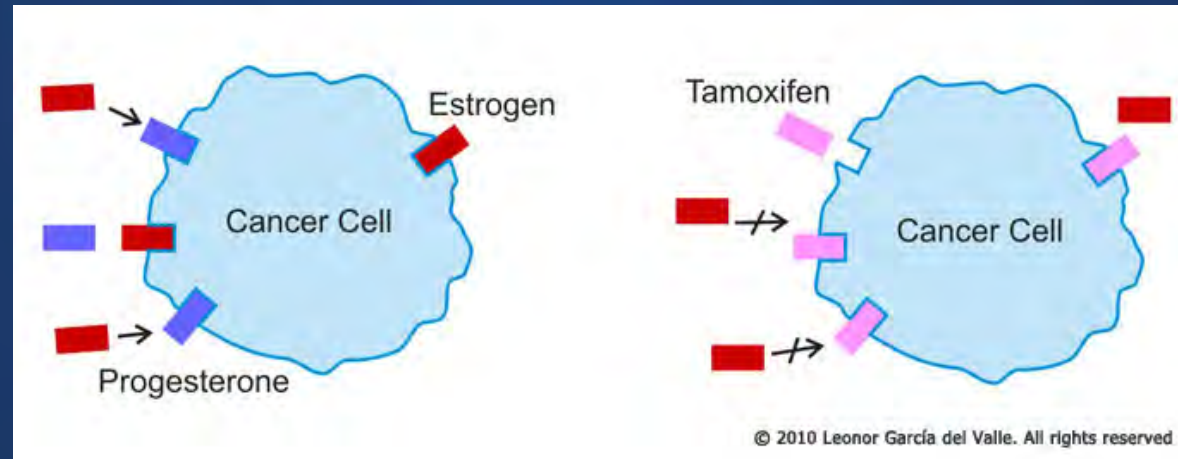
Hormonal Therapy

Hormonal therapy is used to:

- destroy any cancer cells that remain after surgery or radiation therapy to prevent recurrence. This is **adjuvant** hormonal therapy.
- treat **recurrent** cancer (cancer that has come back in a person thought to be cancer-free) or **metastatic** cancer (cancer that has spread from the original location).
- lower the risk of breast cancer in women at high risk for the disease.

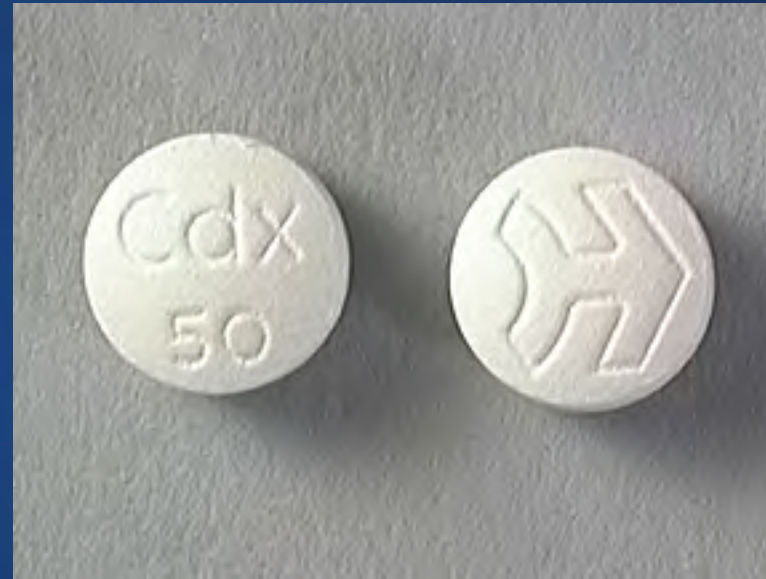
Hormonal Therapy for Breast Cancer

Tamoxifen works by blocking estrogen from attaching to breast cancer cells and fueling their growth.



Hormonal Therapy for Prostate Cancer

Common hormonal therapies include **anti-androgens** that reduce the body's production of testosterone, which fuels prostate cancer growth.



Side Effects of Hormonal Therapy

- Tamoxifen
 - hot flashes
 - increased risk of uterine cancers
 - increased risk of blood clots
- Anti-androgens
 - hot flashes
 - impaired sexual function
 - loss of sex drive
 - weakened bones

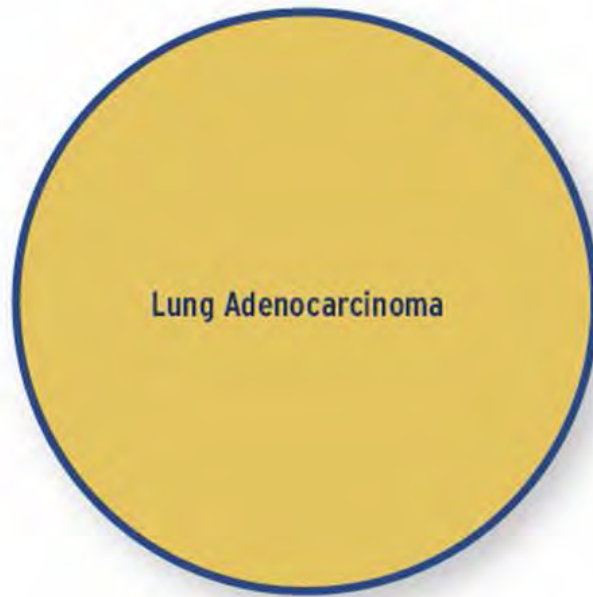


Precision or Personalized Medicine

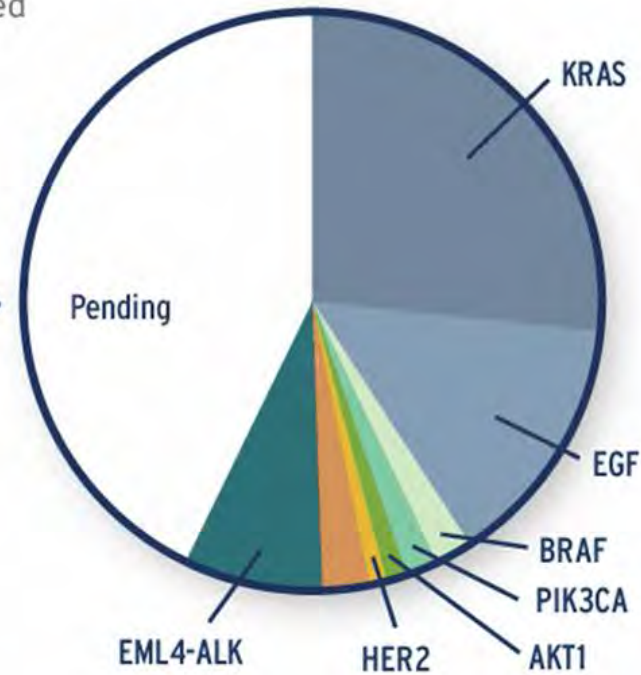
- Targeted treatments are matched to genetic changes in the tumor.
- Such changes result in abnormal molecules (usually proteins) that cause cells to grow out of control.
- Such abnormal molecules are the “targets,” that can be blocked by targeted therapy.

Different Targets in Lung Cancers

BEFORE: One Disease



TODAY: Many different forms of lung cancer driven by different molecular defects – with more yet to be identified

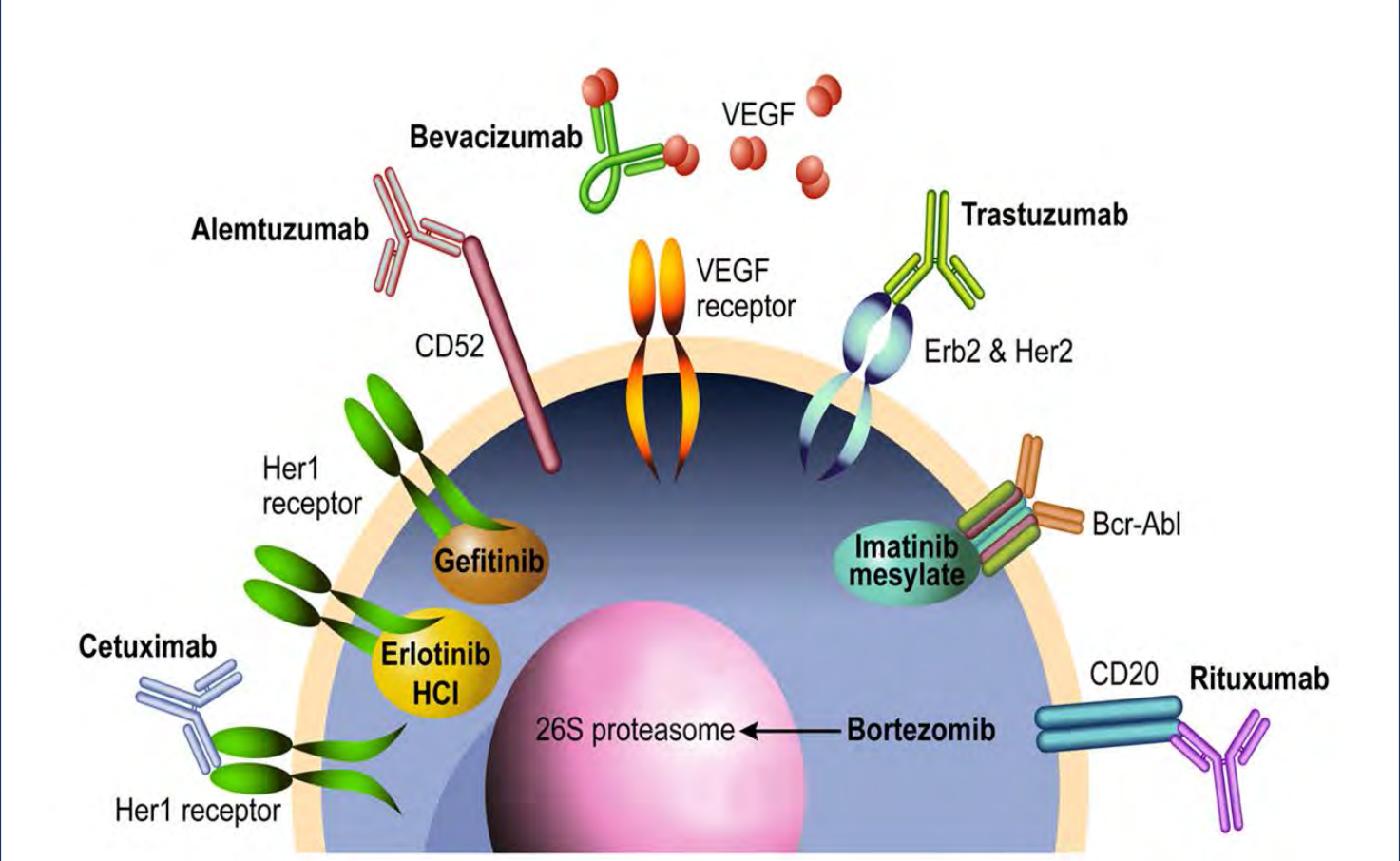


What do **targeted cancer therapies** do?



Targeted cancer drugs have been in use for less than 20 years.

“Targets” can be near the cancer cell, on its surface or inside



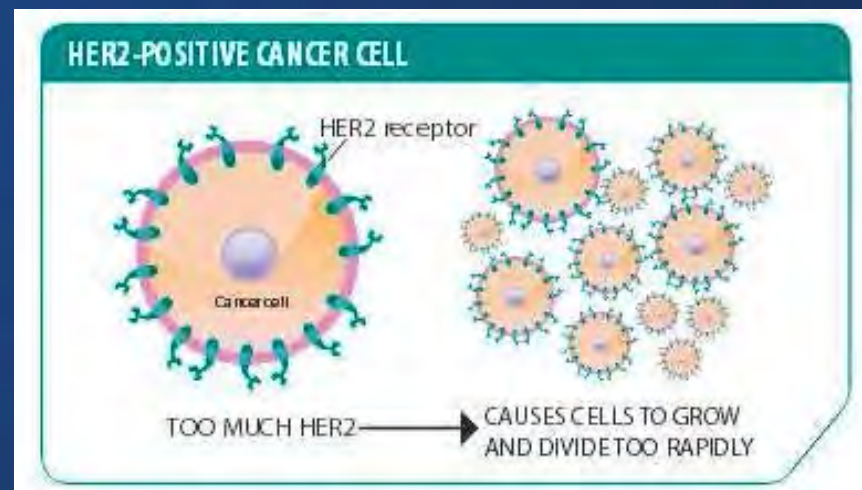
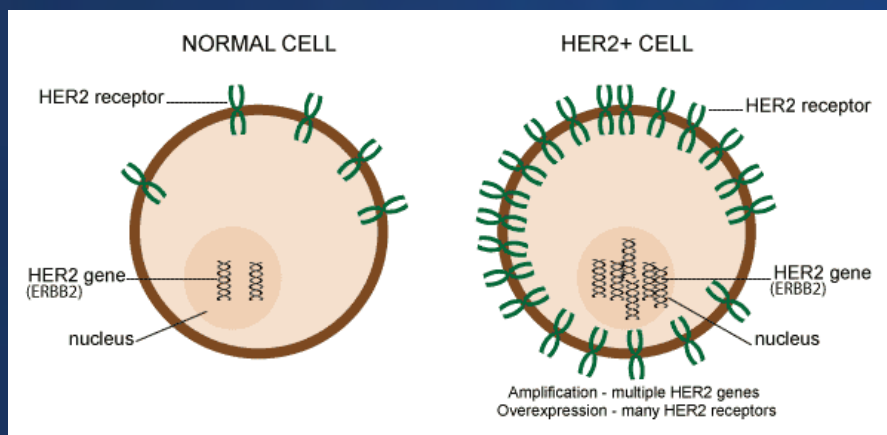


Targeted Cancer Therapies

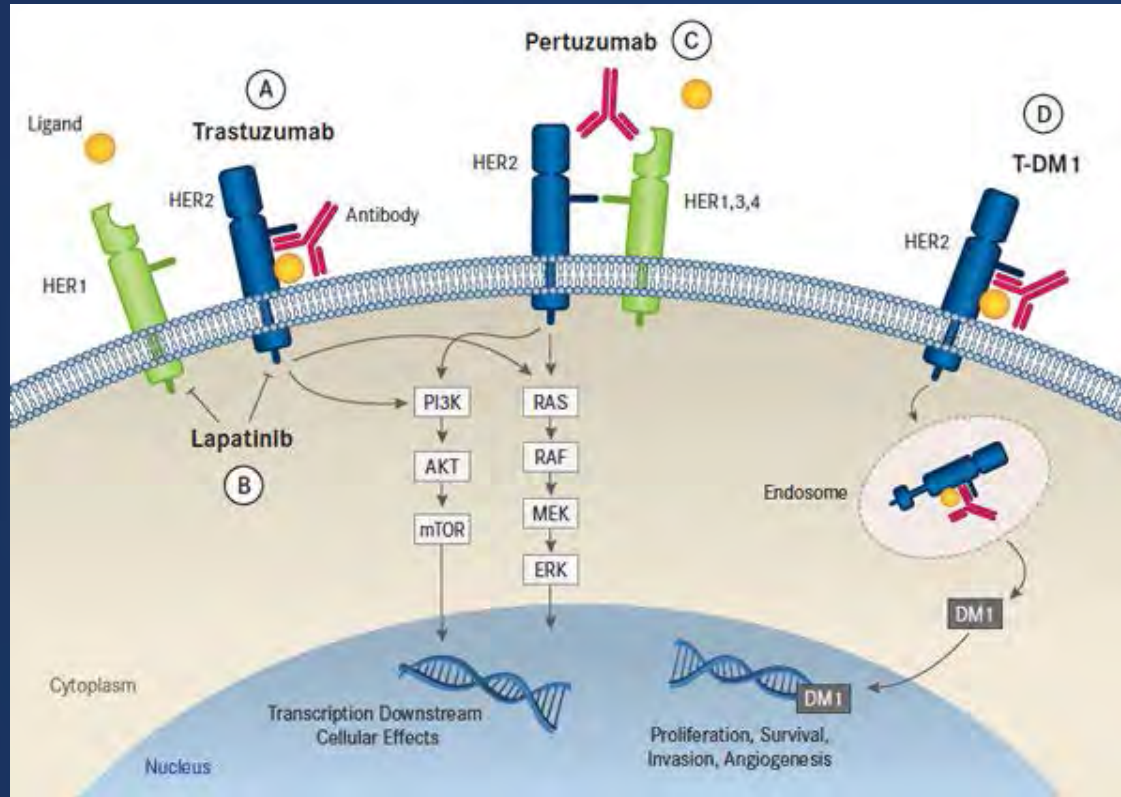
- Targeted therapies are given by medical oncologists and often in combination with other cancer therapies.
- Generally, these therapies do not have the same side effects as traditional chemotherapy. Side effects are varied and depend on the particular drug.
- See [Oncology 101 Molecular Pathways](#) slides for more info

Targeted Cancer Therapies: An Example

- About one in five patients with breast cancer have too much of a protein called **human epidermal growth factor receptor 2 (HER2)** on the surface of tumor cells.



HER2 Targeted Cancer Therapies



Four different drugs that block HER2 are currently approved by the FDA for use in breast cancer treatment.

Targeted Therapy – Keep in Mind

- Targeted cancer therapies only work if the person's tumor *has the molecular target*.
- Not all tumors have a target with an available drug.
- Not all patients with tumors that have a target are successfully treated with the targeted drug that matches that abnormality.
- All patients eventually develop resistance to targeted therapy.



What is Cancer Immunotherapy?

- Immunotherapy harnesses the power of the immune system to fight against cancer.
- Drugs help the immune system find and destroy cancer cells.
- In 2016, the FDA approved immunotherapy treatments for **kidney cancer, bladder cancer, head and neck cancer and Hodgkin lymphoma** (previous approvals for melanoma and lung cancers)
- See [Oncology 101 Molecular Pathways and Understanding Immunotherapy Sessions](#) slides for more info on how immunotherapy works
- Also view ASCO's Clinical Cancer Advances report.

Conclusion and Summary

- Cancer – genes and environment
- A small % hereditary
- How cancers are named
- Screening, Diagnosis, Staging
- Types of treatment