But I'm Too Young!
A Case Study of Ovarian Cancer

by

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Abby is Sick:
Review of the Story So Far…

- Abby has been having abdominal pain.
- She has gone to see Dr. Allen.
- An ultrasound has indicated a mass on her right ovary.
- She is preparing to have the mass and ovary removed surgically.

Group Discussion

- If you were Abby, what questions would you have?

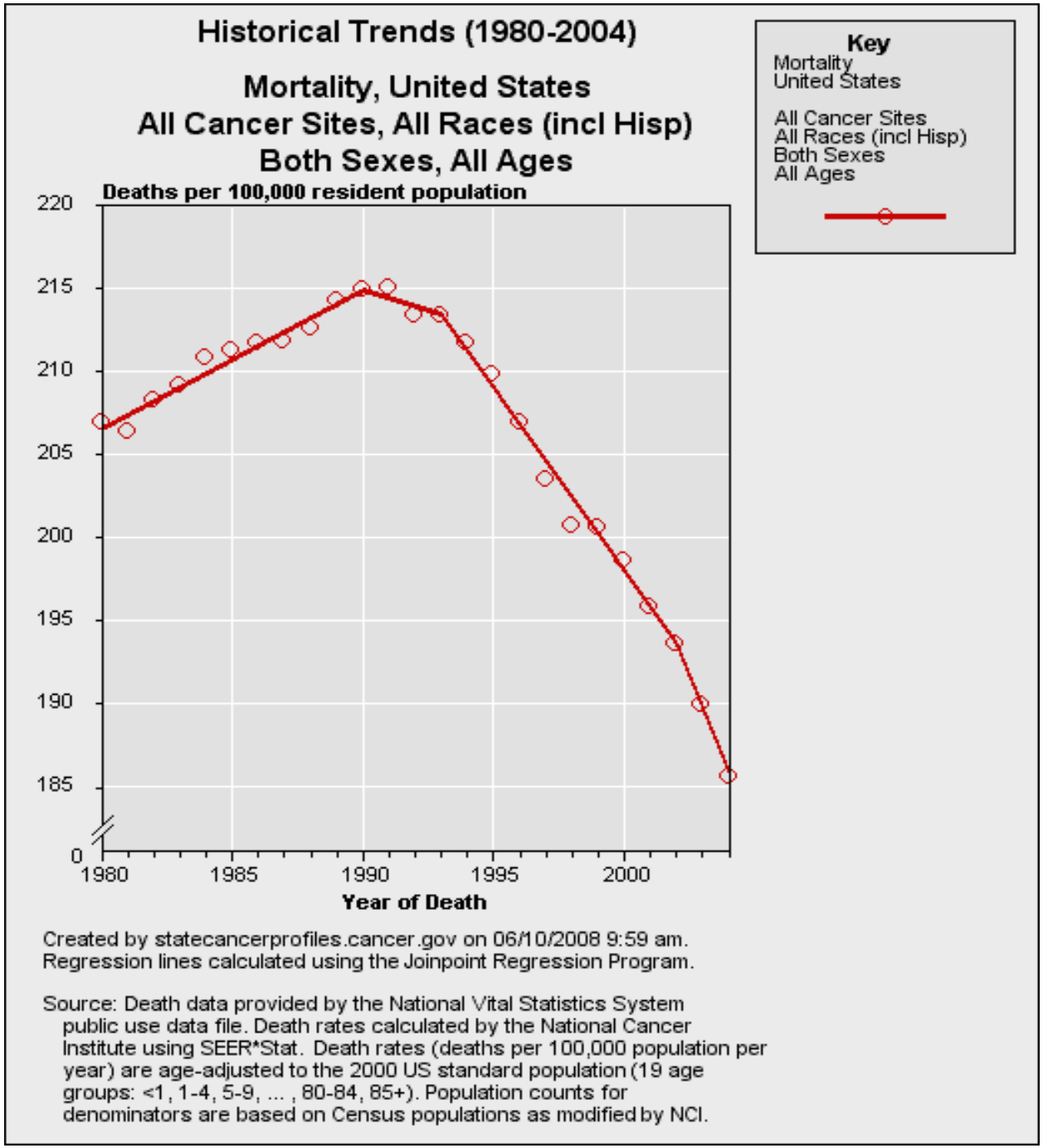
- Should Abby be worried about cancer? The doctor said it was a cyst!

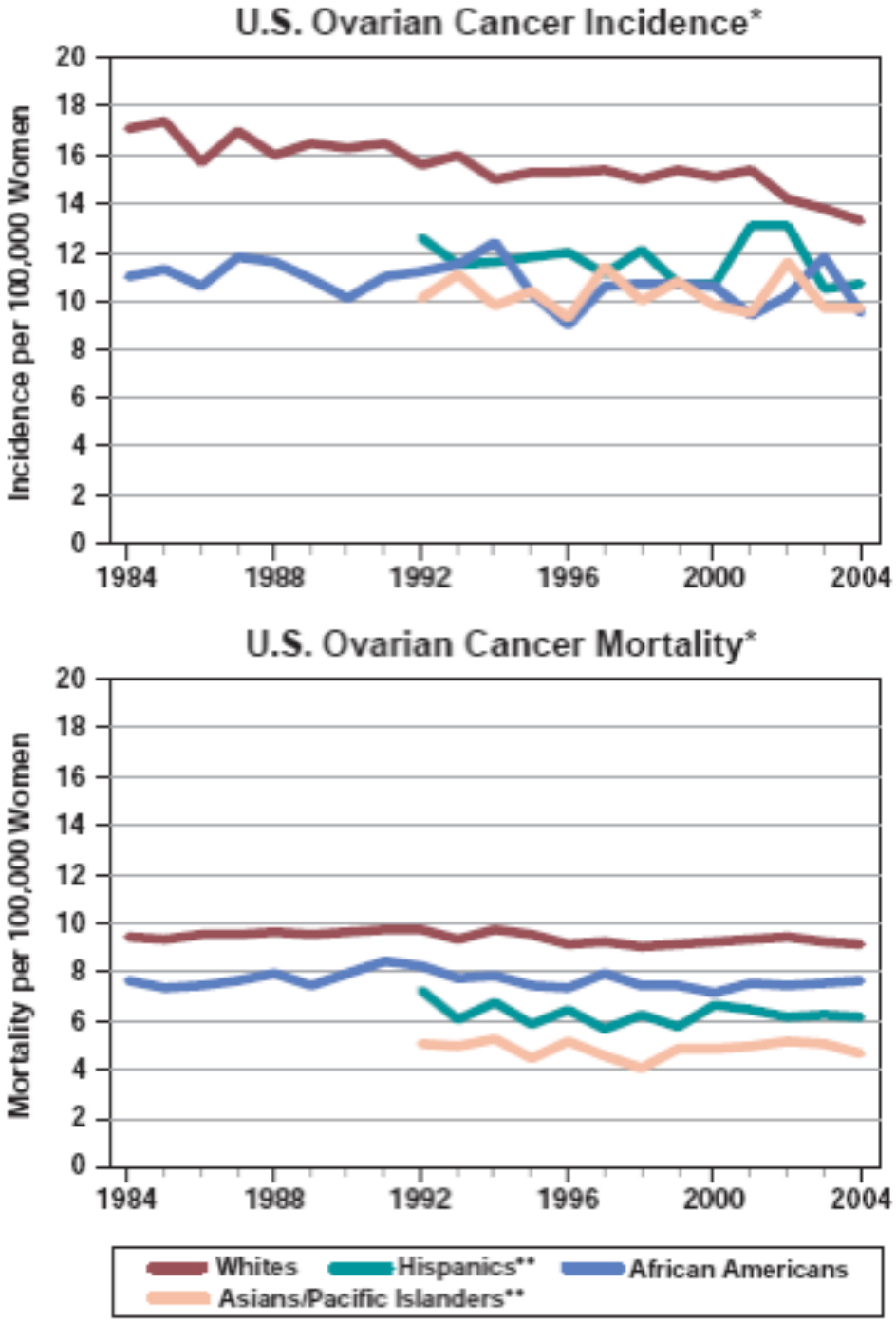
CQ1: Do you know someone personally that has had cancer?

A: Yes

B: No

Overall Cancer Incidence and Mortality Trends in U.S.





A snapshot of ovarian cancer

From: *A Snapshot of Ovarian Cancer*, National Cancer Institute, updated 2007.

CQ2: Abby wondered: what is the difference between *cancer* and *tumor*? What do you think?

A: The two terms can be used interchangeably as they are synonymous.

B: Cancer is a disease that eventually disrupts body functions whereas a tumor is a mass of cells with no apparent function in the body.

C: Cancer is a disease which affects men whereas a tumor may affect both men and women.

E: Cancer is a disease of the digestive tract whereas a tumor may develop anywhere in the body.

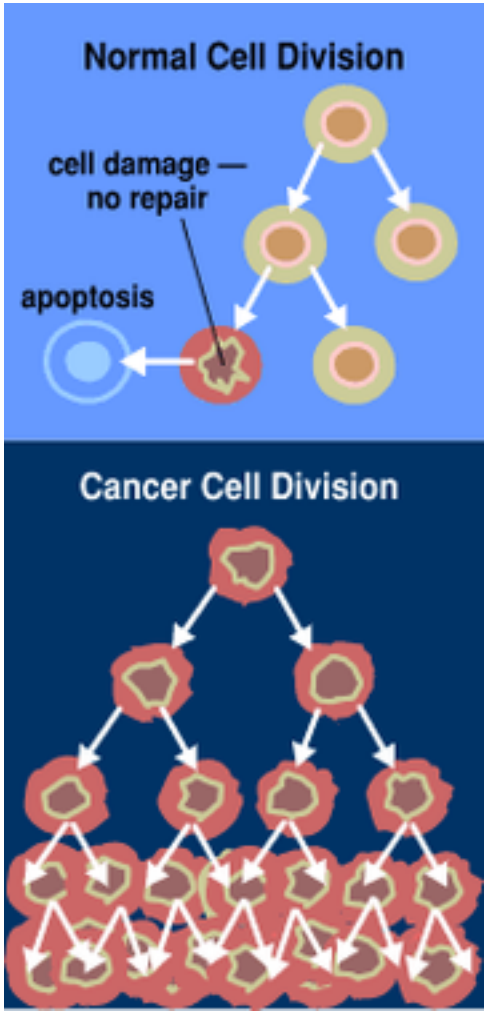
What is Cancer?

- Simplest definition
  From the American Cancer Society
  " cancer is a group of diseases characterized by uncontrolled growth and spread of abnormal cells. If the spread is not controlled, it can result in death."
- Tumor
  – Two types:
    - ***Benign*** (non-cancerous) – this is *not* cancer!
      – Does not spread; it can eventually become malignant in some cases.
    - ***Malignant*** (cancerous) – this is cancer!
      – Has the potential to spread to other parts of body.

Role of Cell Division in Cancer

Top = normal cell division

Bottom = unregulated cell division and tumor formation



Malignant
If tumor invades surrounding tissue (cancerous)

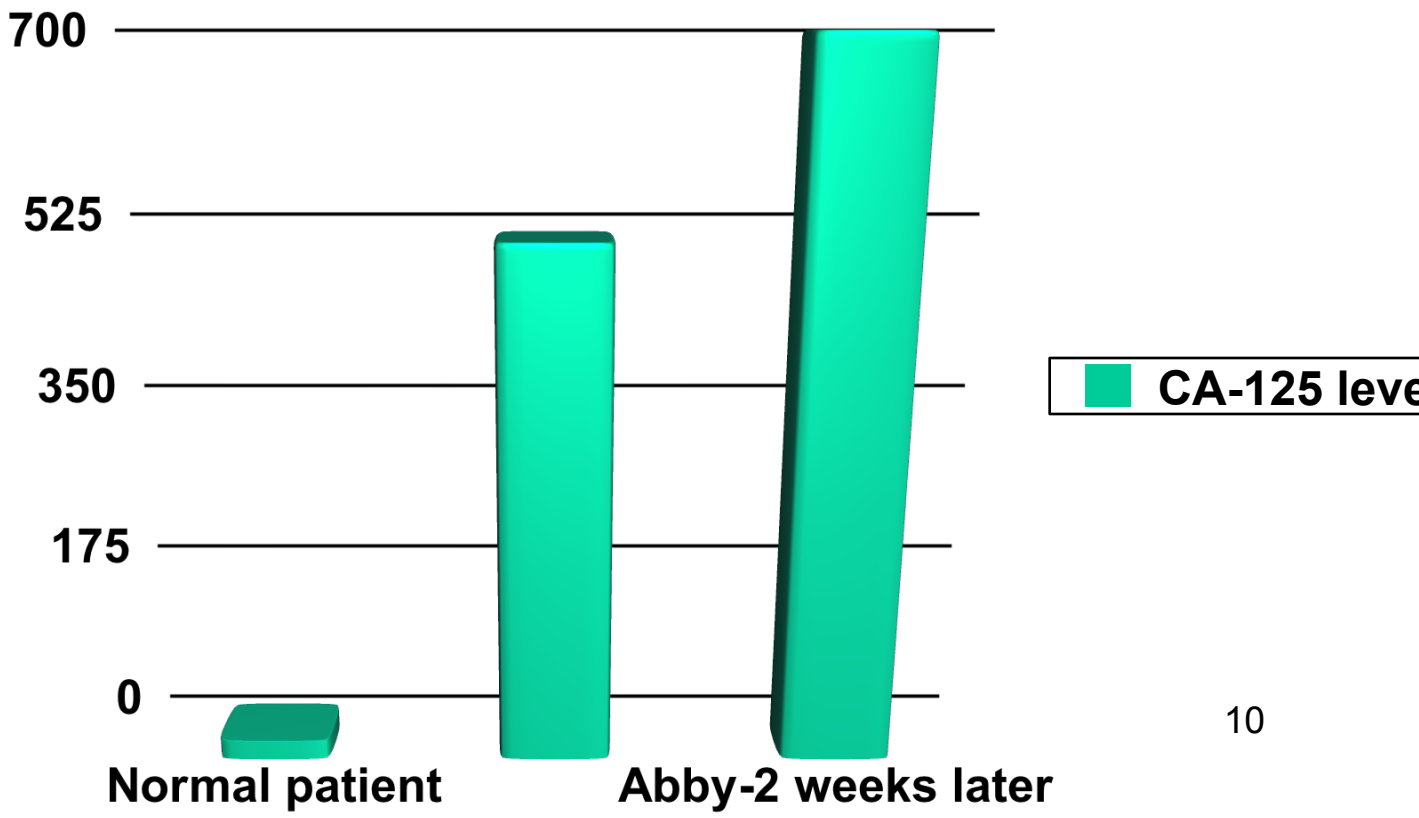
Benign
If tumor has no effect on surrounding tissue (non-cancerous)

Metastatic
If individual cells break away and start a new tumor elsewhere (cancerous)

Image from the National Cancer Institute

CQ3: Normal CA-125 levels are indicated by values of 35 U/ml or less. Abby's CA-125 levels taken at two different times are indicated below. Is Abby likely to have a cyst or cancer?

A. Cyst
B. Cancer

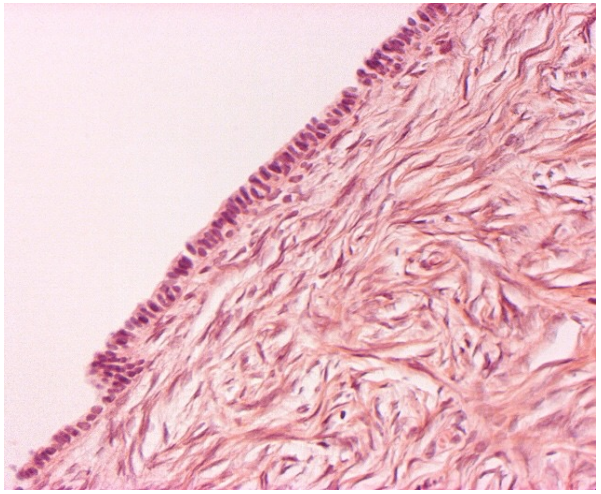


Preparing for Surgery

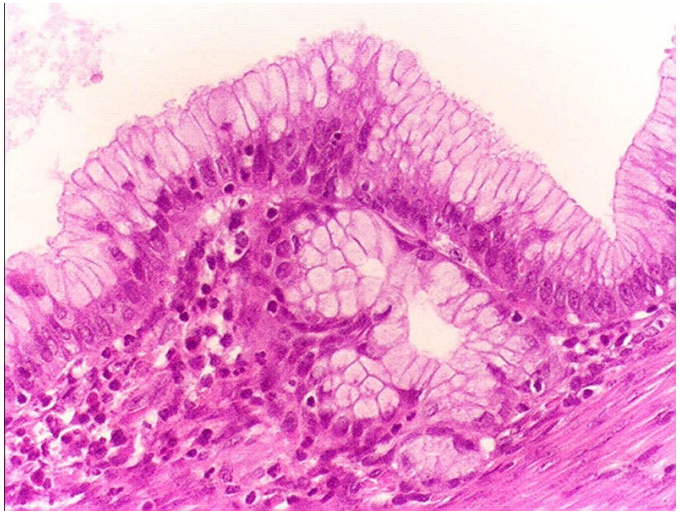
Before the surgery, Dr. Allen came in to talk to Abby about her test results.

“I am really sorry, but your CA125 level is high and it looks like your ovary actually does not have a cyst, but instead has a tumor. It is best now to go ahead and remove both of your ovaries.”

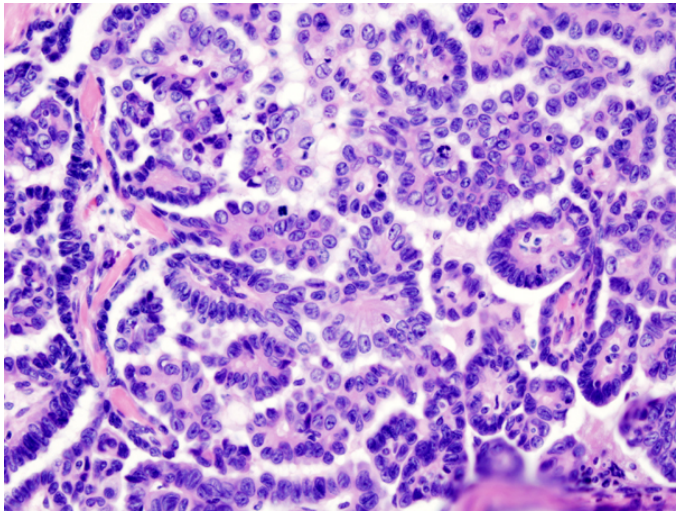
Dr. Allen explained she had consulted with a pathologist to verify the diagnosis. She pulled out a brochure titled *Ovarian Cancer* and opened it to show Abby three photographs. One showed normal ovarian tissue; the other two showed benign and malignant ovarian tissue.



Normal ovarian epithelium



Ovary cystoadenoma (benign)



Ovarian adenocarcinoma (malignant)

The genetics of ovarian cancer

Abby had already learned a lot about ovarian cancer so she followed Dr. Allen's explanation.

"I'm only 20 years old. How did I get ovarian cancer? Isn't this a disease of older women?

"Typically ovarian cancer does affect older women. However, you may have a genetic predisposition for it. Cancer cells have mutations in specific genes that regulate cell division. When they are mutated, cell division becomes uncontrollable," the doctor explained.

"I learned about those genes on the Internet! Is it true that some ovarian cancers are associated with mutated copies of genes called ***BRCA1*** or ***BRCA2***?" asked Abby.

"Yes," said Dr. Allen. "You likely were born with one a mutated copy of these genes already. A mutation of the second copy could have occurred more recently, triggering the development of your tumor."

CQ4: Why does cancer primarily affect older people rather than young people?

A: Because the immune system of older people is not as effective in distinguishing normal cells from cancer cells.

B: Because older people have been exposed to more carcinogens.

C: Because cancer develops after multiple mutations have occurred which takes years to happen.

D: None of the above.

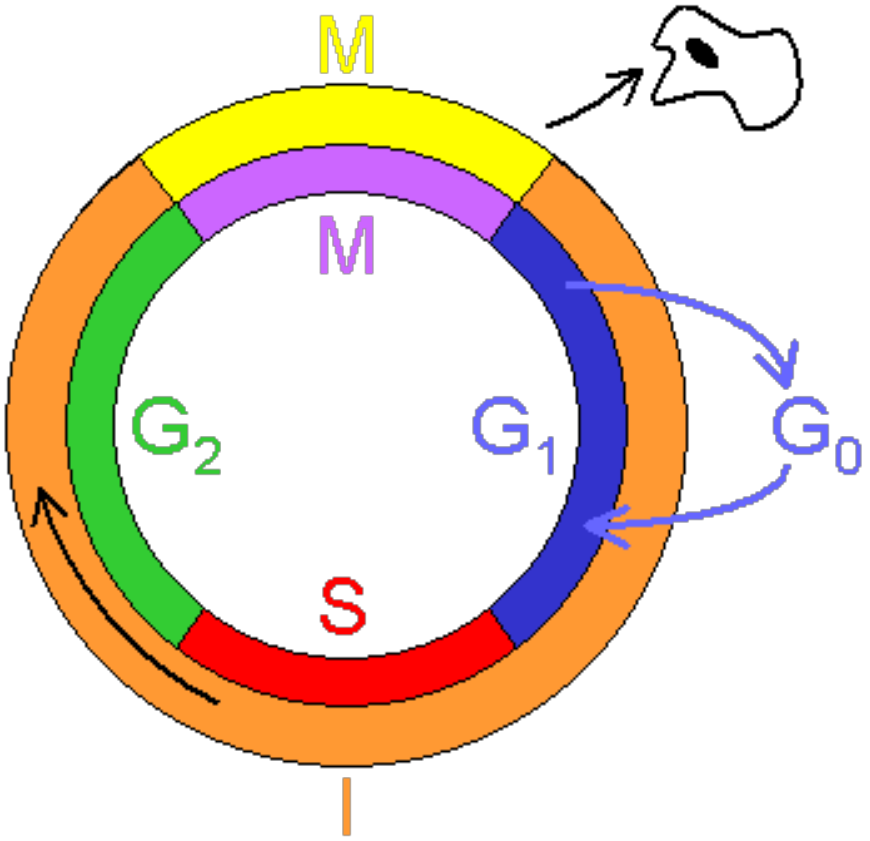
Cancer is a genetic disease

- Cancer arises from the *accumulation* of genetic changes (mutations).
- Most cancers have a minimum of 6-9 different genes mutated.
- Not a hereditary disease – we do not pass on cancer to offspring.
- We can inherit dispositions (susceptibility) to cancer.
- Many genes that are mutated in cancer are involved in *regulating the cell cycle.*

Review: The cell cycle has four phases and controls cell division

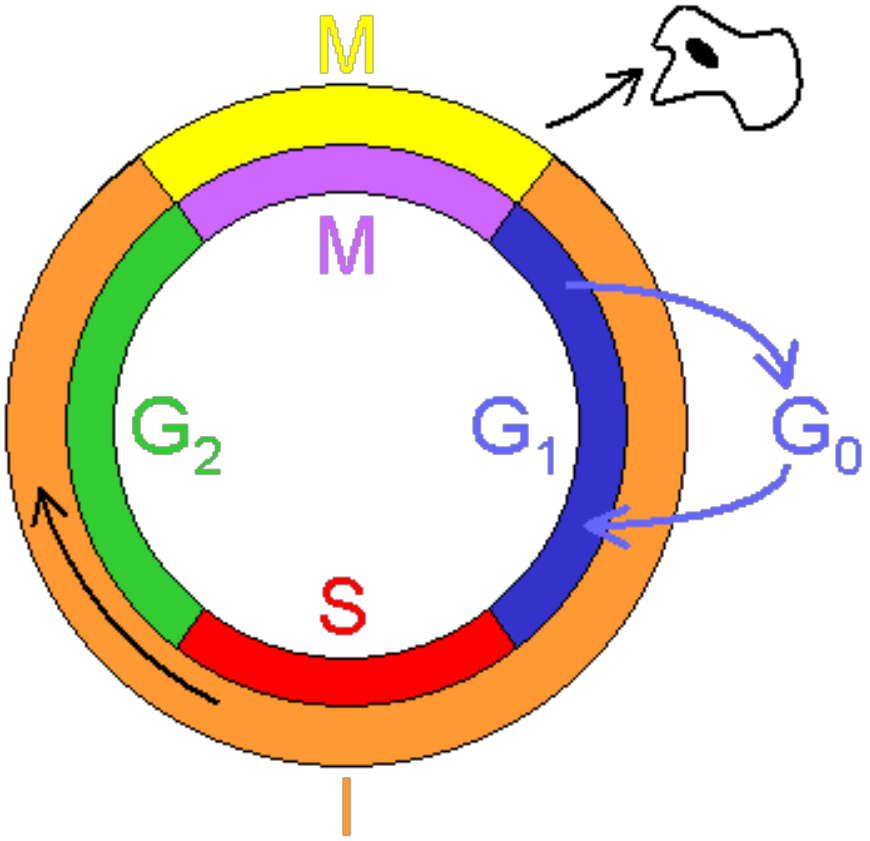
- Two gap or growth phases (G1 and G2)
- S phase - DNA synthesis
- M phase - Mitosis

Interphase



Cell Cycle Checkpoints

- Three checkpoints in cell cycle
  - **G1-S transition**
  - **G2-M transition**
  - **Exit M phase transition**
- Checkpoints are where the cell assesses whether conditions are favorable for cell division.
- When the environment is not favorable (for example, when the cell's DNA is damaged), a protein called **p53** can stop the cell cycle and cause the cell to die.
- When the proteins that regulate the cell cycle are mutated or absent, cells can divide uncontrollably, leading to cancer.



CQ5: What would you expect cells to be like if they did not have properly functioning p53?

A: The absence of p53 inside cells would cause them to divide more rapidly.

B: The absence of p53 could cause cells to replicate with damaged DNA that could ultimately lead to cancer.

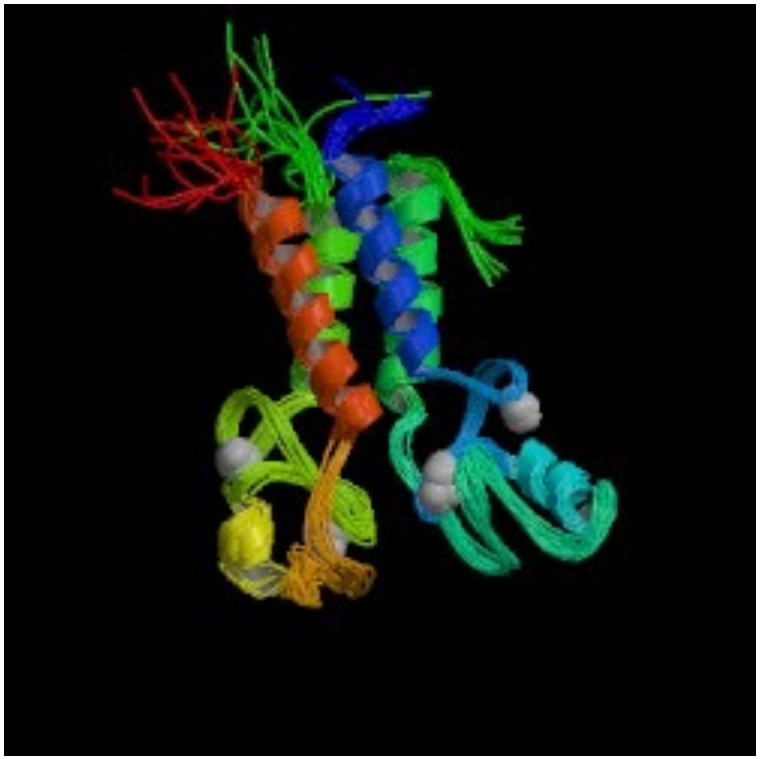
C: The absence of p53 could cause cells to skip mitosis (M phase) and stay in S phase of the cell cycle.

D: The absence of p53 would have no effect on the cells.

CQ6: The BRCA1 and BRAC2 genes that may be mutated in Abby's cells would be considered?

A: An oncogene

B: A tumor suppressor gene



From Benign to Malignant

- Cancer cells divide too quickly and can leave the original site and enter the blood, lymph, or tissues.
- Most cells divide a set number (60-70) of times, then they stop dividing.
- This usually limits benign tumors to small sizes.
- Cancer cells can divide indefinitely.

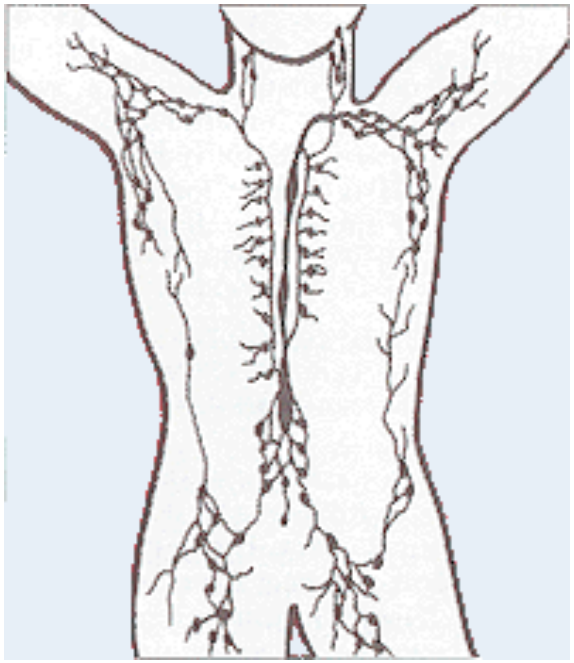
CQ7: How do cancer cells travel through the human body?

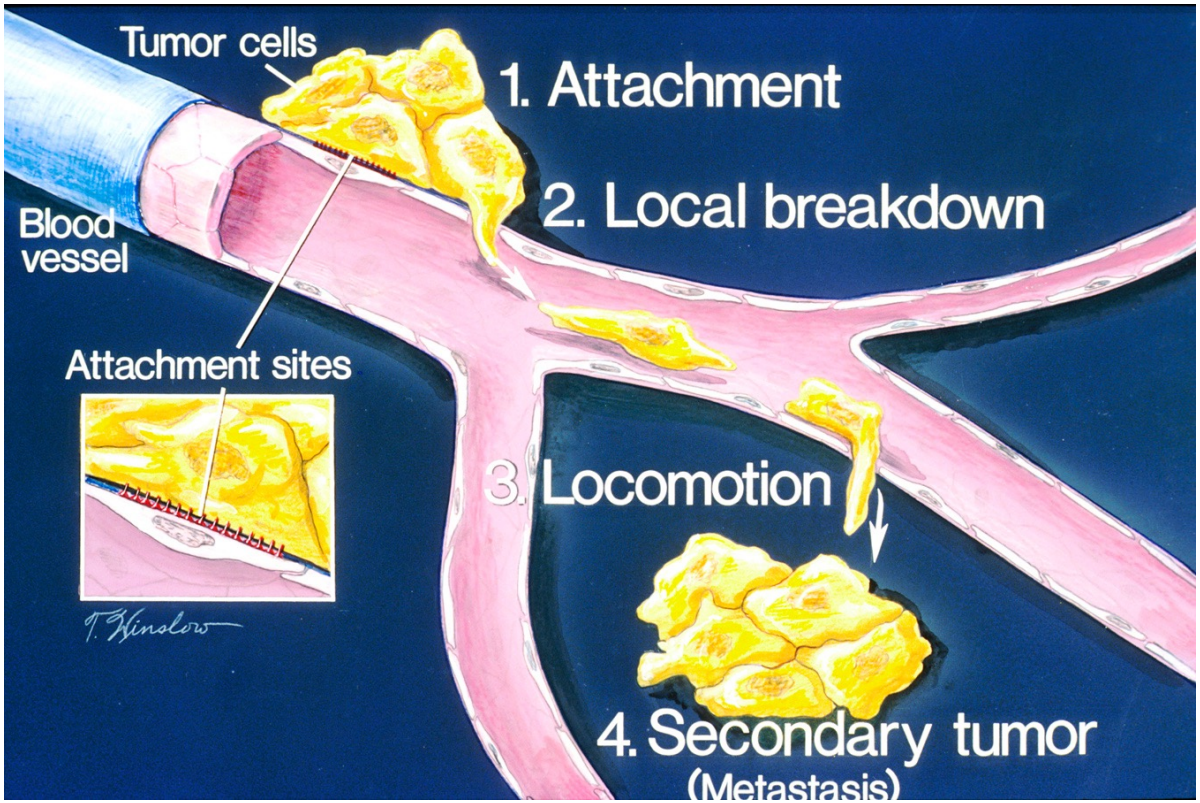
A: Cancer travels through the body by way of sexual intercourse between a healthy person and one affected by the disease.

B: The circulatory system only is responsible for relocating cancer cells.

C: The lymphatic system collects fluids from capillaries and with it cancer cells, which are then delivered by the circulatory system.

D: They are moved around on neurons throughout the body.





The vessels of the circulatory and lymphatic systems provide a pipeline for cancer cells to move to other locations in the body through a process called *metastasis*.

Abby's treatment options

Dr. Allen came to see Abby after her surgery.

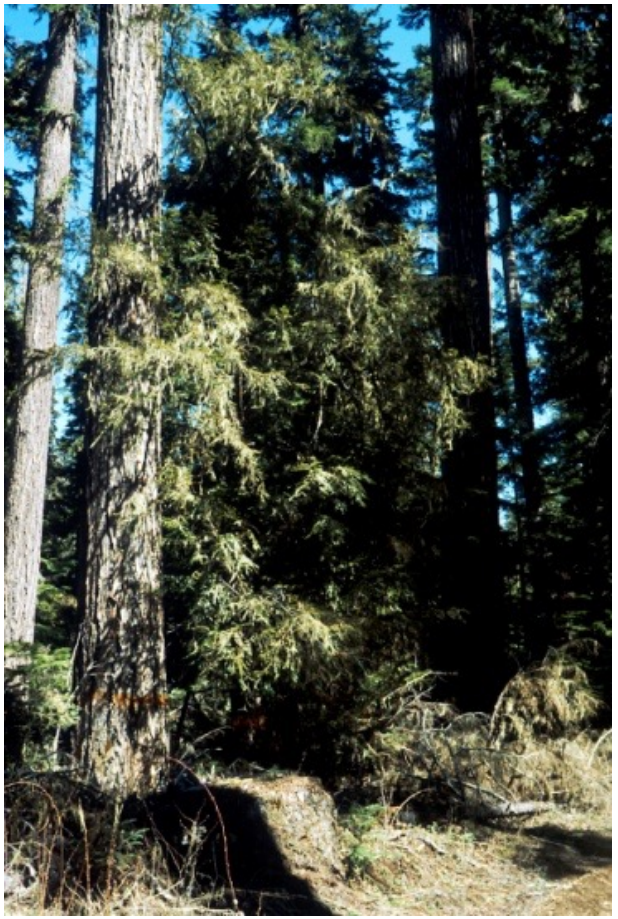
"Everything went really well. Now we need to think about preventing this from ever coming back. Typically we use a combination of various types of therapy, which includes radiation and chemotherapy."

- *Radiation* - Uses high-energy rays to kill cancer cells. A large machine directs radiation at the body.
- *Chemotherapy* - Uses anticancer drugs to kill cancer cells.

Typical Ovarian Cancer Treatments

One common chemotherapy for ovarian cancer is Taxol, which was first isolated from Yew bark in 1962 by the National Cancer Institutes (NCI).

Taxol blocks a cell's ability to break down the mitotic spindle during mitosis. With the spindle still in place, the cell can't divide into daughter cells and therefore the cancer can’t grow.



Taxus Brevifolia

Cancer Detection and Treatment

- Earlier detection and treatment of cancer greatly increase the odds of survival.
- Therefore, knowing the warning signs of cancer is important to health.

C hange in bowel or bladder habits

A sore that does not heal

A nusual bleeding or discharge

T thickening or lump

U ndigestion or difficulty swallowing

O bvious change in wart or mole

T agging cough or hoarseness

I

O

N

CQ8: Can surgery successfully cure a cancer that has metastasized?

A. No, all body cells are dividing uncontrollably
B. Yes, it could remove all cells with defective cell-cycle regulation
C. No, cancer cells are no longer localized in one spot
D. Yes, if the tumor is benign

Abby's ovarian cancer has been in remission for 10 years. She graduated from college with a BA in Anthropology. Three years later she married, and today she is living happily with her husband Charles and their four-year-old adopted daughter.