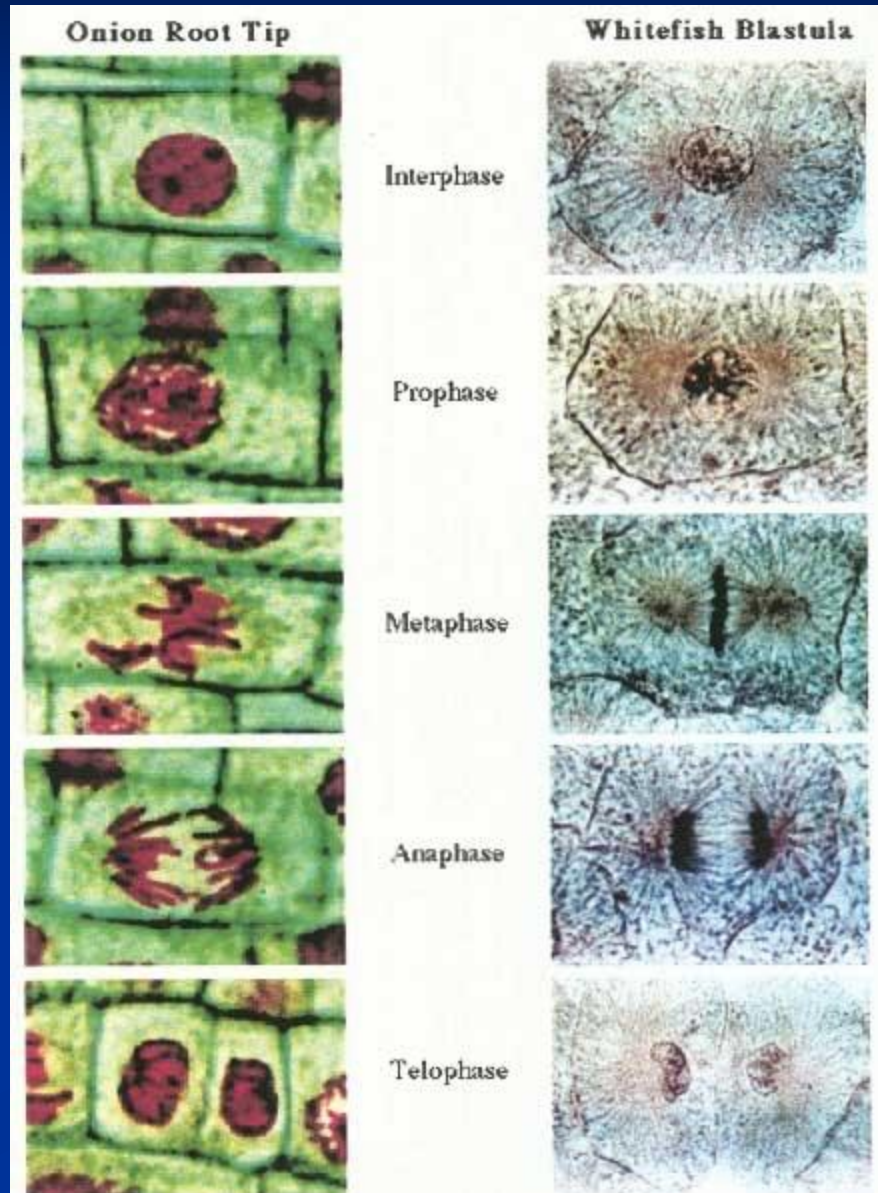


The Cell Cycle and Cell Death

SNC2D

Cell Reproduction

Mitosis in animal cells looks very like mitosis in plant cells:



Interphase

- The cell prepares for cell division by growing (producing new proteins and organelles) and by synthesizing copies of its DNA (the chromatin).



Prophase

- During the first phase of mitosis, the chromatin condenses into chromosomes and the nuclear structure disintegrates. A framework called the mitotic spindle forms.



Metaphase

- Next the chromosomes line up in the middle of the cell.

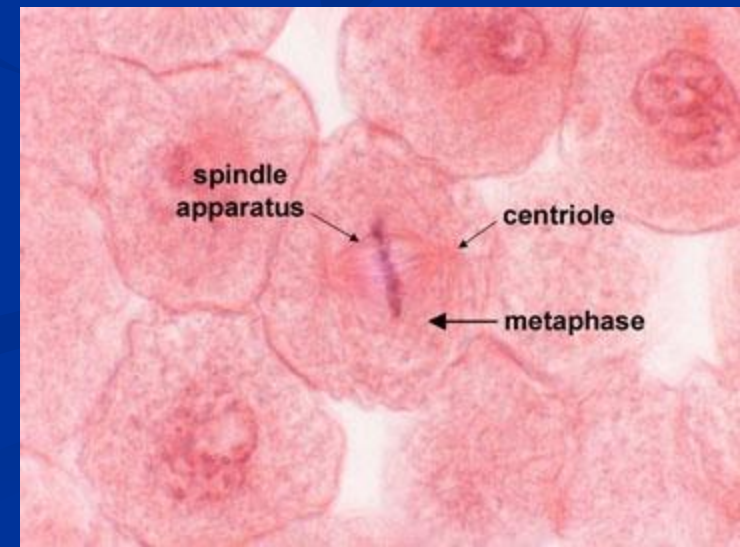


Metaphase

- Next the chromosomes line up in the middle of the cell.

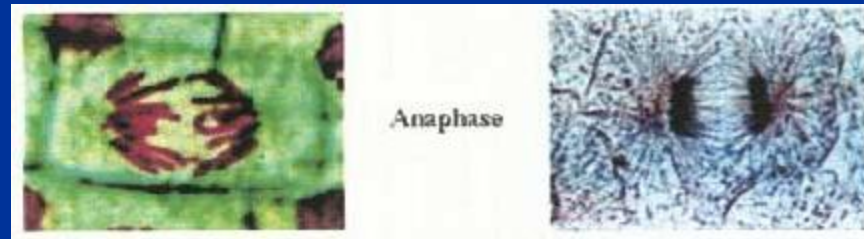


In an animal cell, at the end of the spindle fibres at the poles are the centrioles.



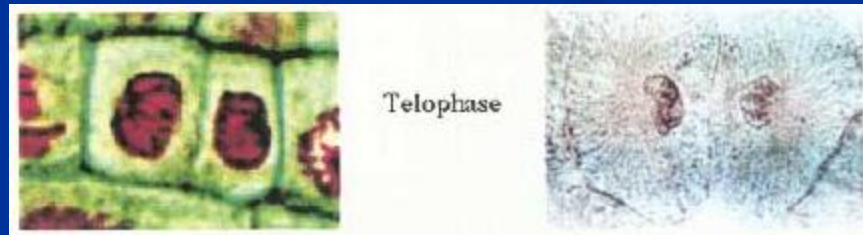
Anaphase

- The chromosomes separate and are pulled to opposite ends of the cell.



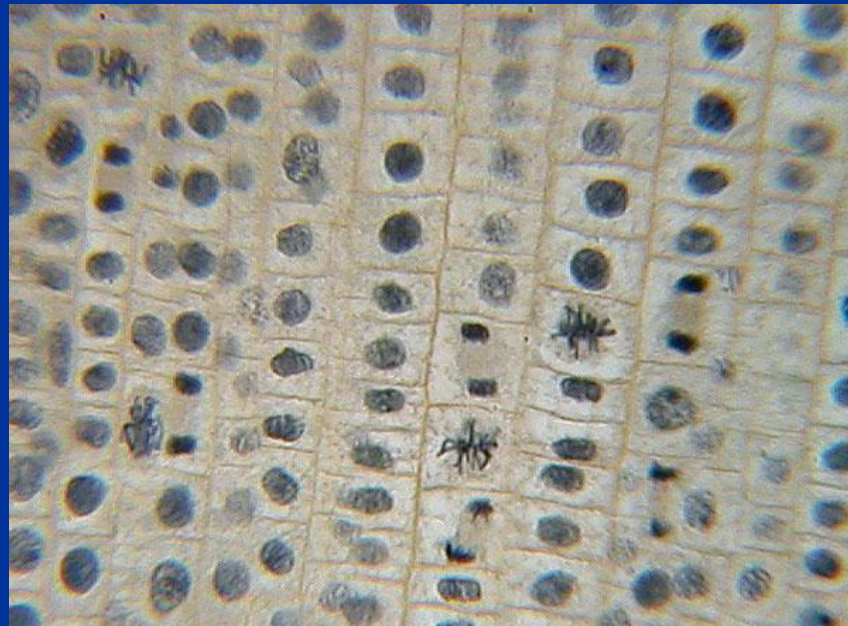
Telophase and Cytokinesis

- In the last stage of mitosis, the cell divides the cytoplasm into two portions. The final separation of the cytoplasm into two distinct cells is called cytokinesis.



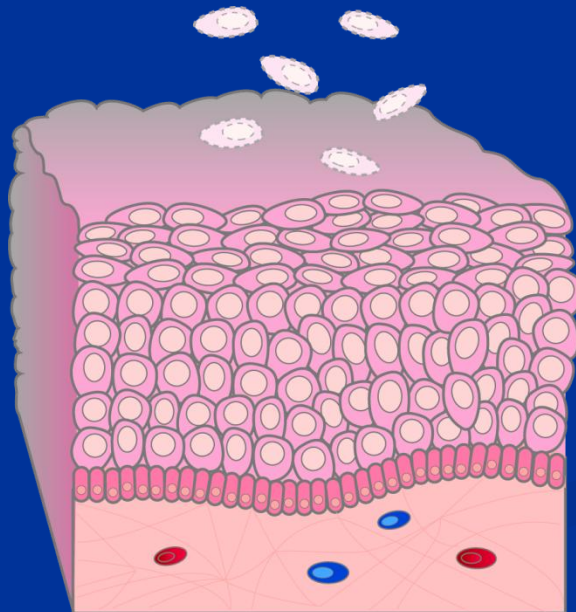
Rate of Mitosis

Different parts of an organism experience different rates of mitosis (e.g. an onion root tip is where growth occurs and therefore the cells divide frequently, every 12 – 36 hours).



Rate of Mitosis

In humans, skin cells (that brush off) or intestinal cells (that are broken down by the digestive process) have high rates of mitosis, whereas red blood cells may last for months.

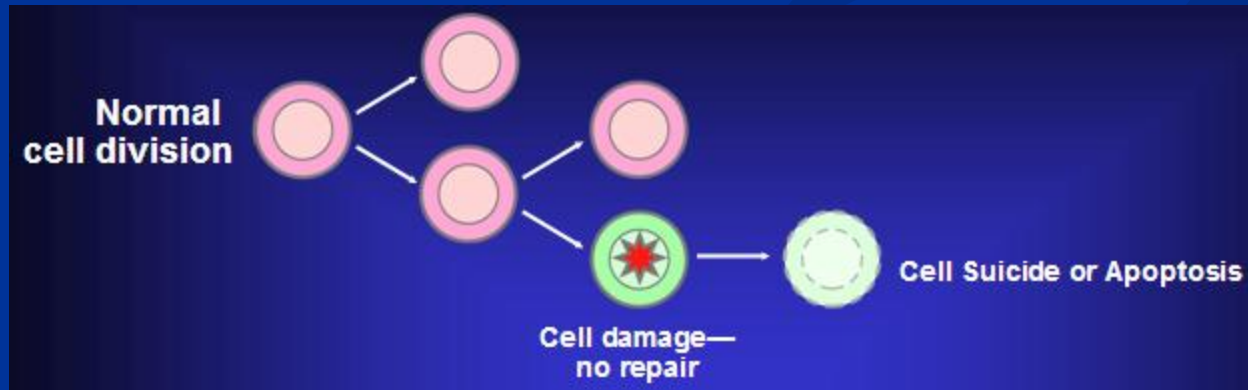


human skin cells

Artwork by Jeanne Kelly. © 2004.

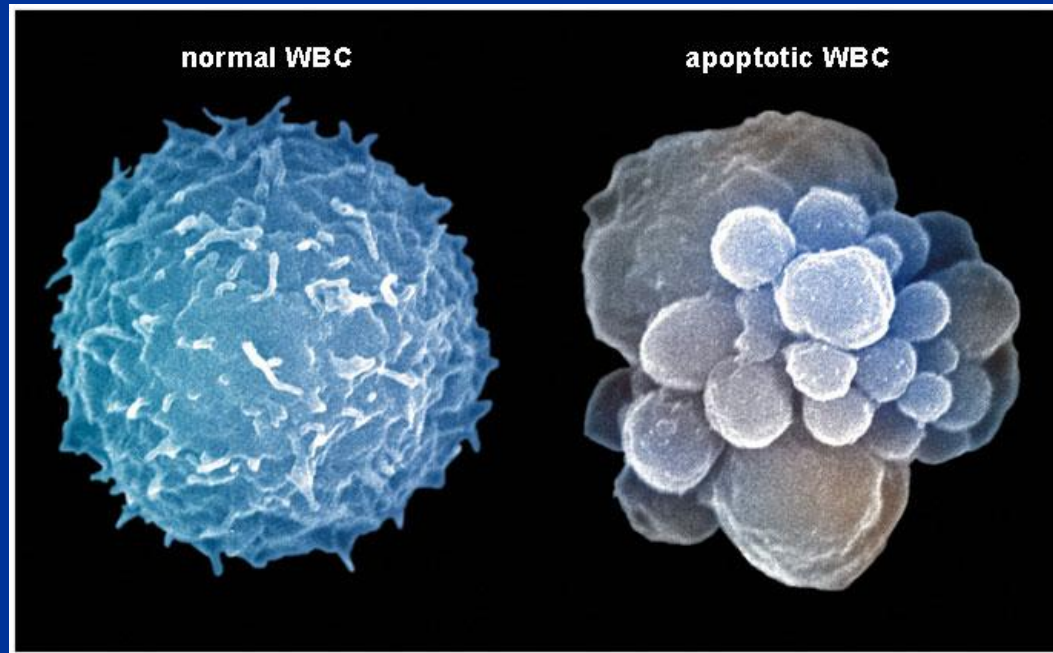
Apoptosis

The regulated death of a cell that is no longer useful (e.g. white blood cells post-infection) or has lost its ability to function efficiently is called **apoptosis**.



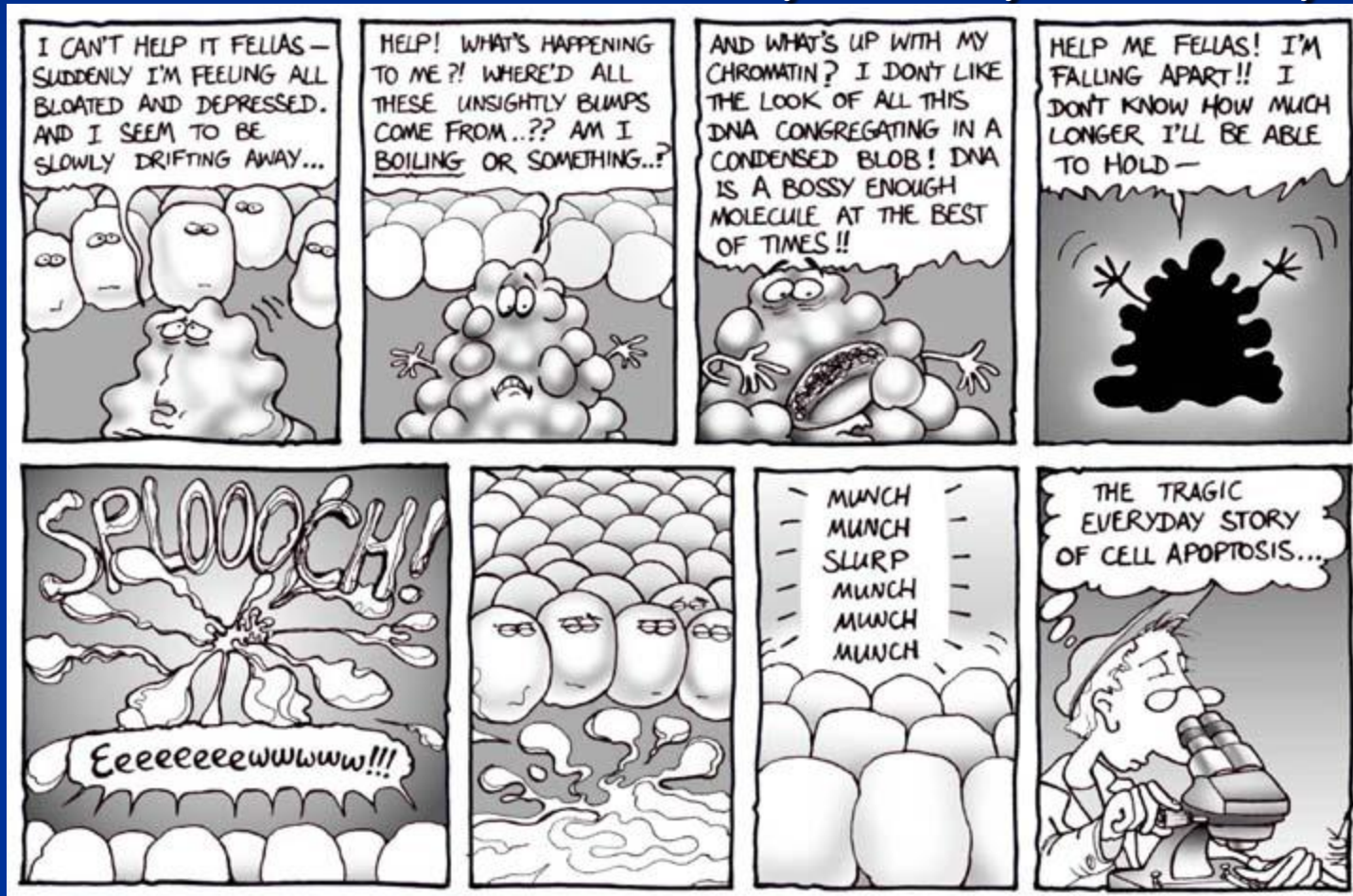
Apoptosis

The regulated death of a cell that is no longer useful (e.g. white blood cells post-infection) or has lost its ability to function efficiently is called **apoptosis**.



Apoptosis

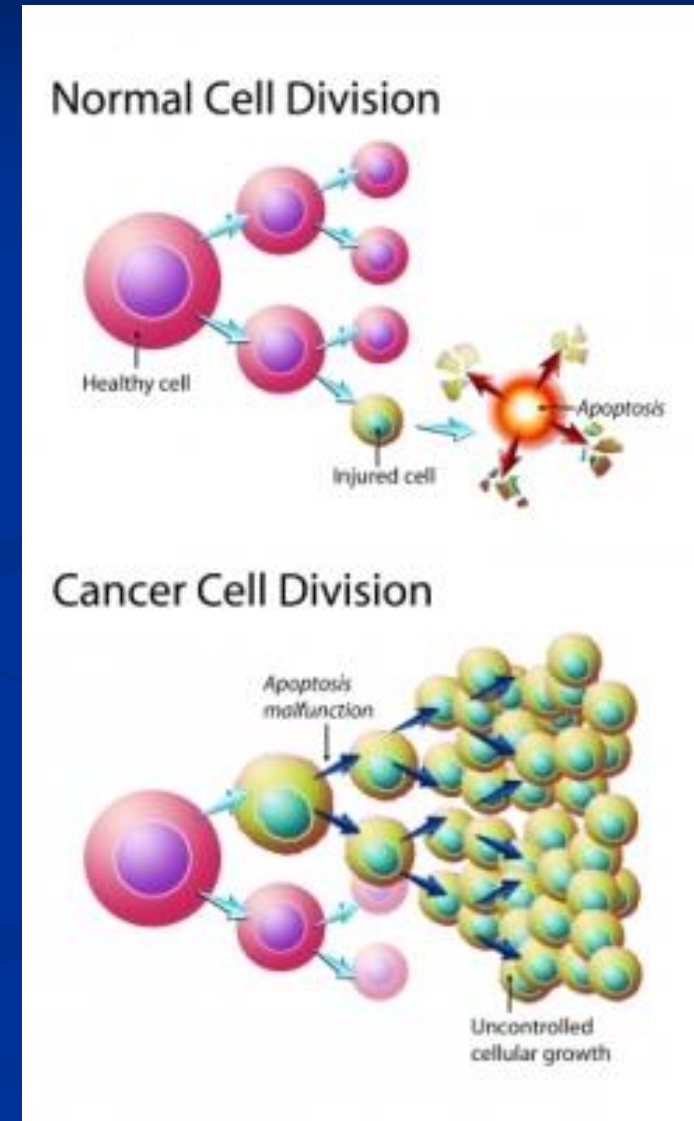
The material of the cell is recycled by the body.



Cancer

What happens when damage to a cell impairs its ability to commit apoptosis and it divides and divides and divides?

Cancer



Exponential Growth

Consider what happens if 1 cell out of 1 000 starts dividing uncontrollably.

The remaining 999 will die as often as they are replaced.

That 1 cell . . .

Exponential Growth

# of divisions	normal cells	cancer cells
0	999	1
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Exponential Growth

# of divisions	normal cells	cancer cells
0	999	1
1	999	2
2		
3		
4		
5		
6		
7		
8		
9		
10		

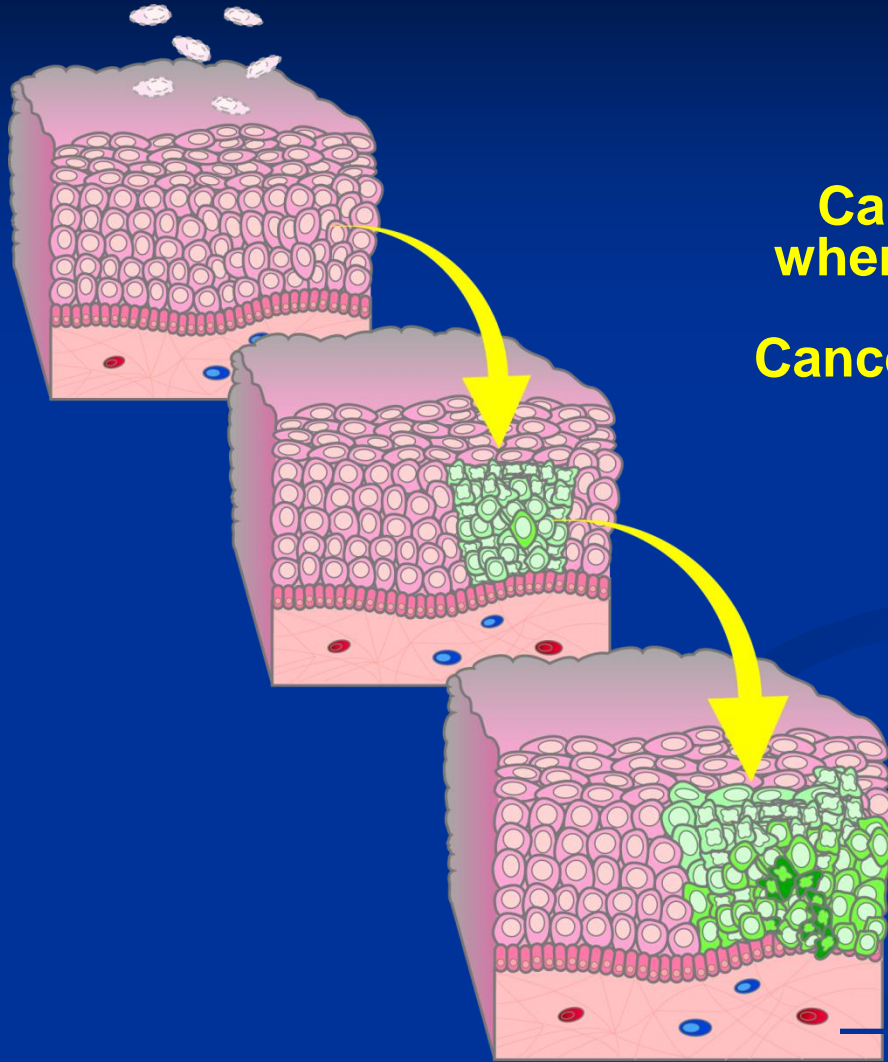
Exponential Growth

# of divisions	normal cells	cancer cells
0	999	1
1	999	2
2	999	4
3	Keep going. . . .	
4		
5		
6		
7		
8		
9		
10		

Exponential Growth

# of divisions	normal cells	cancer cells
0	999	1
1	999	2
2	999	4
3	999	8
4	999	16
5	999	32
6	999	64
7	999	128
8	999	256
9	999	512
10	999	1024

The Beginning of Cancerous Growth

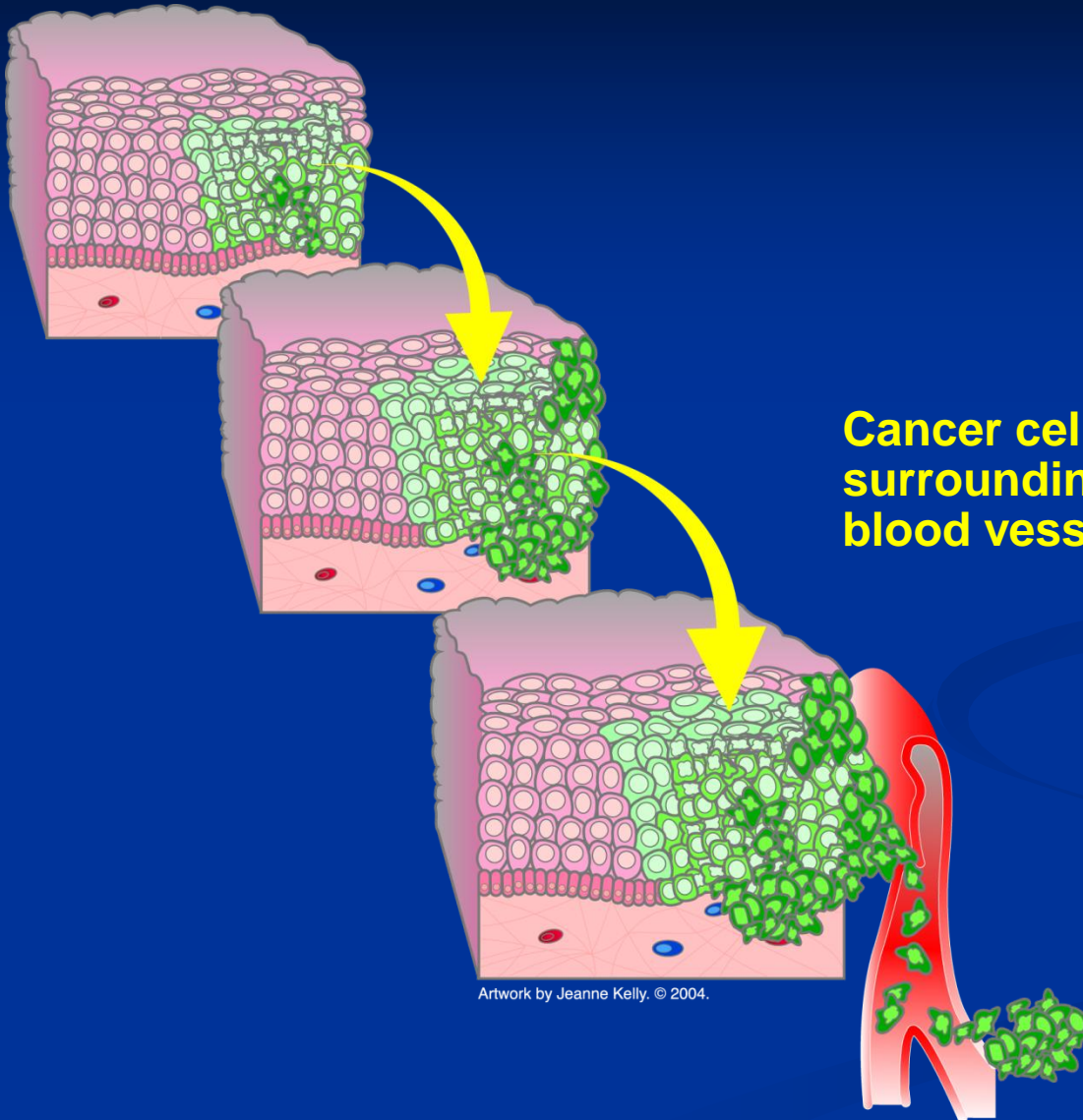


Cancers grow more quickly where cells divide frequently.

Cancerous growths are called tumours.

Artwork by Jeanne Kelly. © 2004.

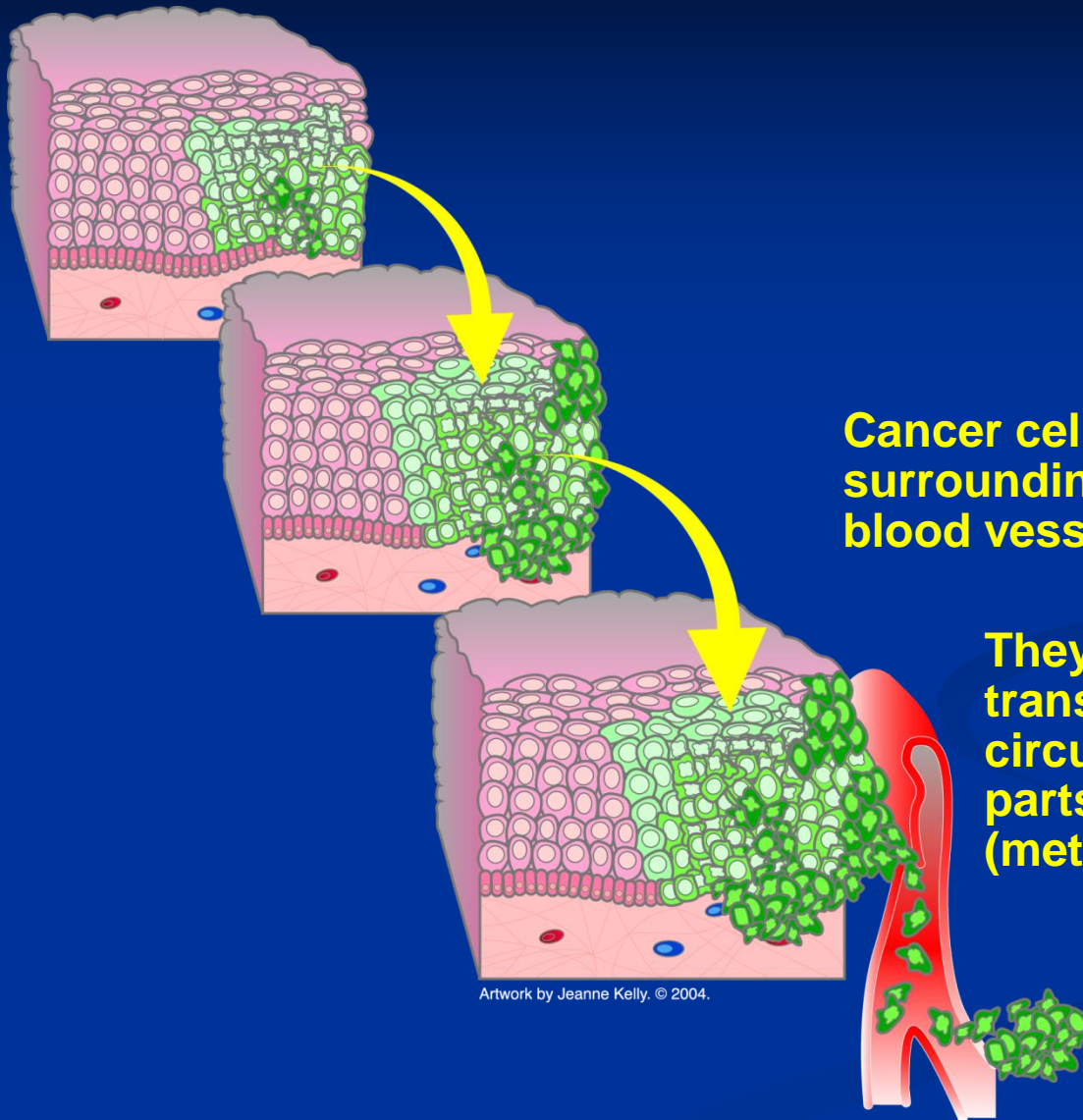
Invasion and Metastasis



Cancer cells can invade surrounding tissues and blood vessels.

Artwork by Jeanne Kelly. © 2004.

Invasion and Metastasis



Cancer cells can invade surrounding tissues and blood vessels.

They can also be transported by the circulatory system to other parts of the body (metastasis).

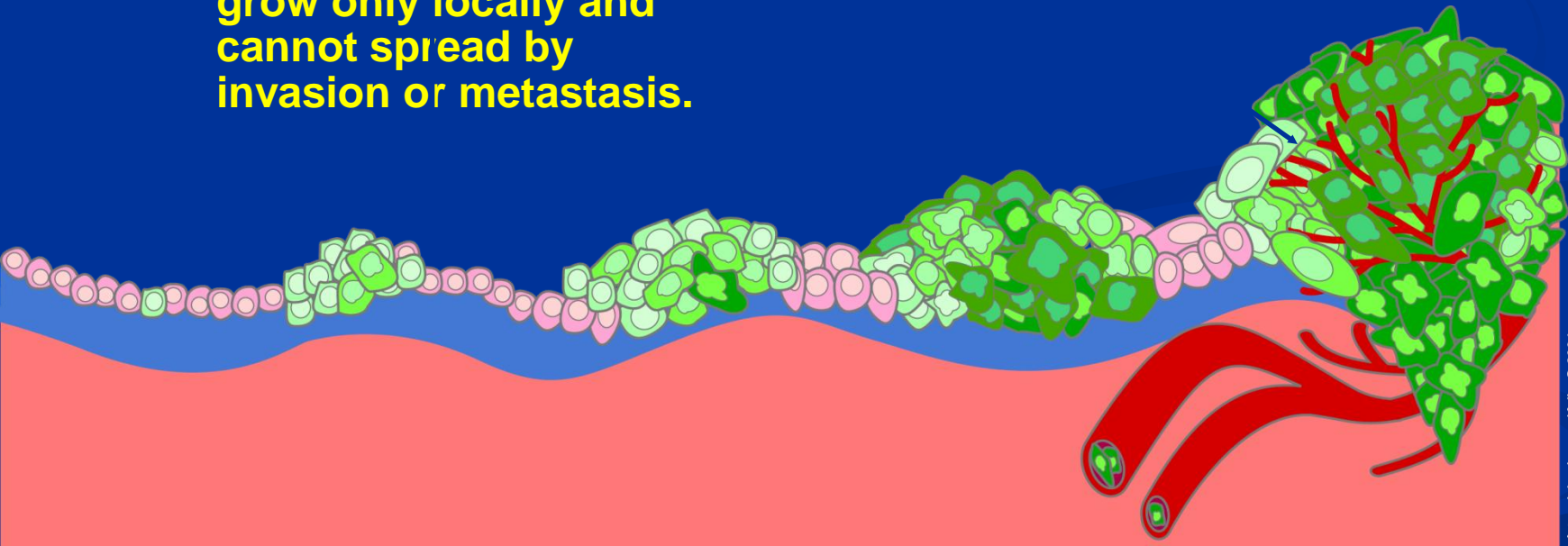
Cancer cells then grow at the new locations.

Artwork by Jeanne Kelly. © 2004.

Malignant versus Benign Tumors

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

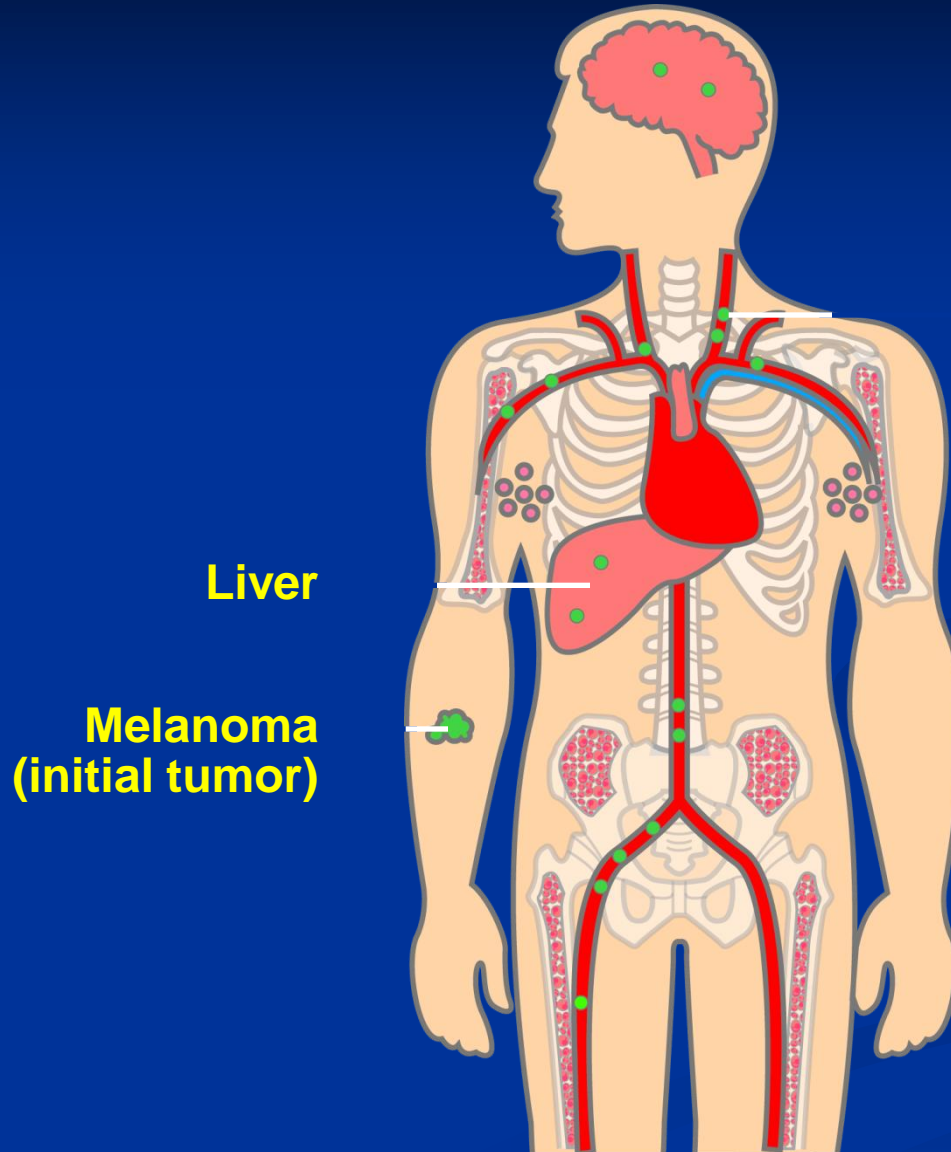
Malignant cells invade neighboring tissues, enter blood vessels, and metastasize to different sites.



Artwork by Jeanne Kelly. © 2004.

Time 

Why Cancer Is Dangerous



Liver

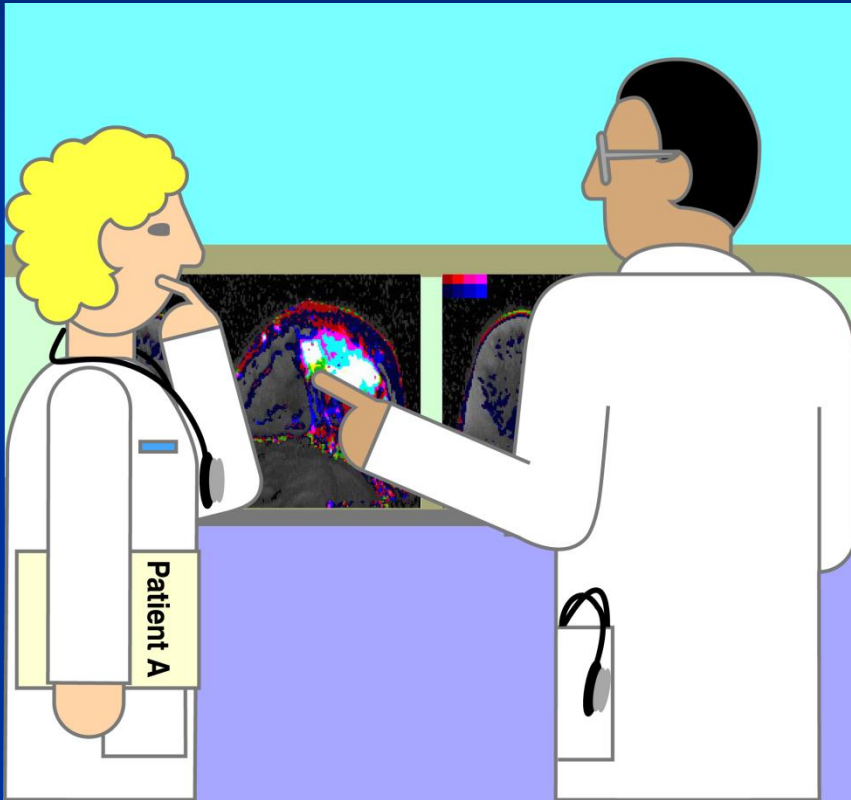
Melanoma
(initial tumor)

Melanoma (skin cancer) cells can travel through the circulatory system.

The cancer that spreads to the liver would be called metastatic melanoma, not liver cancer.

Artwork by Jeanne Kelly. © 2004.

Cancer Detection and Diagnosis

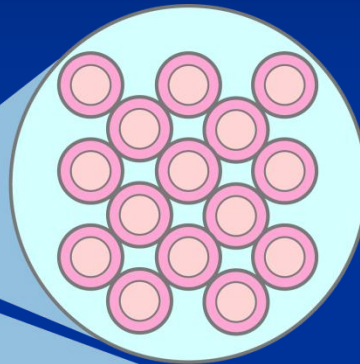


Artwork by Jeanne Kelly, © 2004.

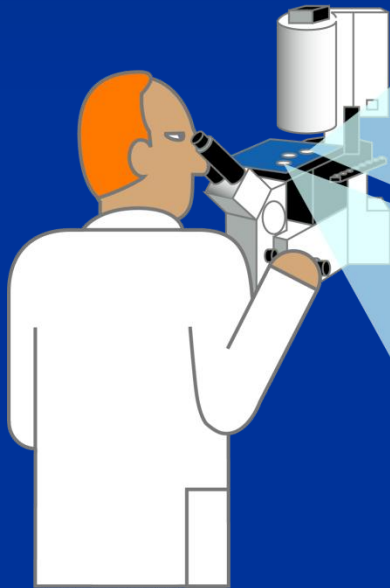
Cancerous tumours can be detected by medical imaging (x-ray, ultrasound, and MRI scans).

Cervical Cancer Screening

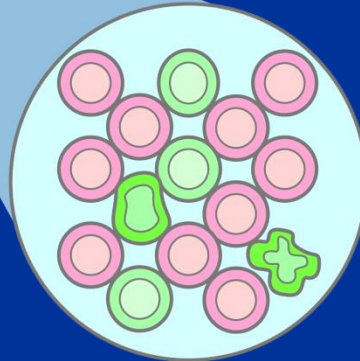
**Normal
Pap smear**



But even earlier stages
of cancer can be
detected by
screening cells.



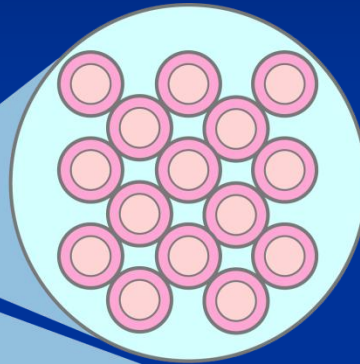
Artwork by Jeanne Kelly. © 2004.



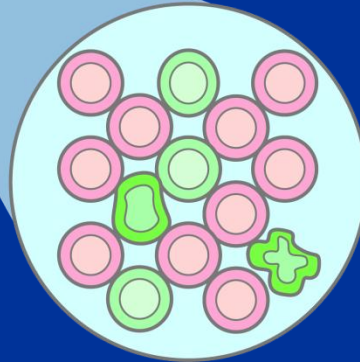
**Abnormal
Pap smear**

Cervical Cancer Screening

**Normal
Pap smear**



But even earlier stages of cancer can be detected by screening cells.



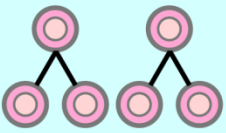
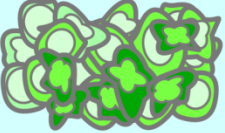




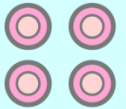



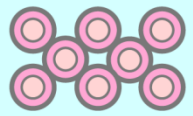
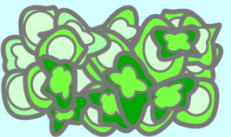
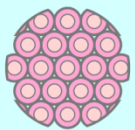
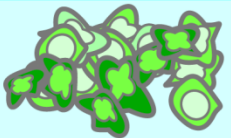
**Abnormal
Pap smear**

Biopsies similarly look at cells inside suspected tumours.



Artwork by Jeanne Kelly. © 2004.

Cancer Cells Look Different

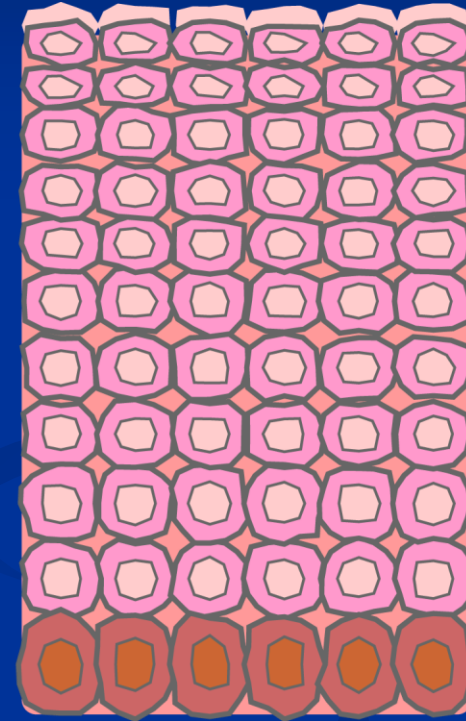
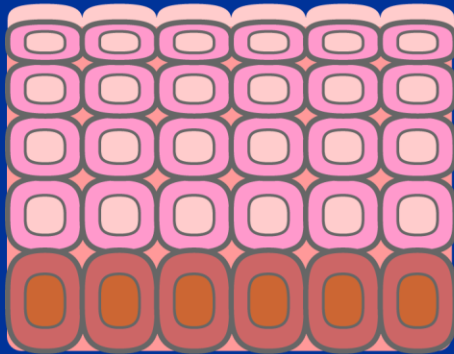
Normal	Cancer	
		Large number of irregularly shaped dividing cells
		Large, variably shaped nuclei
		Small cytoplasmic volume relative to nuclei
		Variation in cell size and shape
		Loss of normal specialized cell features
		Disorganized arrangement of cells
		Poorly defined tumor boundary

Artwork by Jeanne Kelly. © 2004.

Hyperplasia

Sometimes screening detects an excessive rate of cell division called hyperplasia – the cells are still normal and the process is reversible.

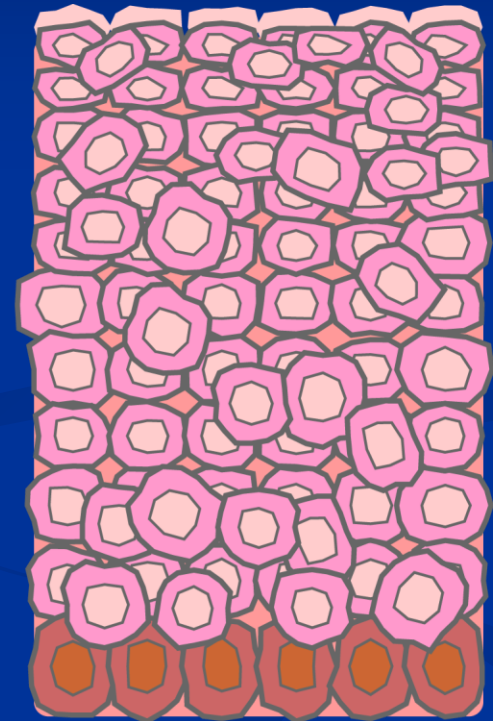
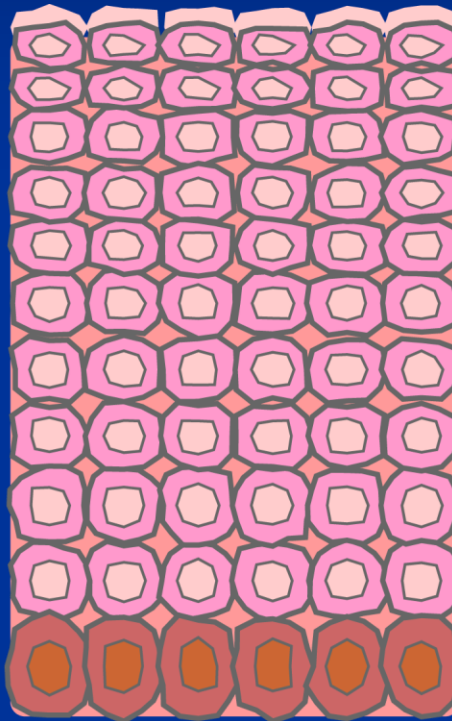
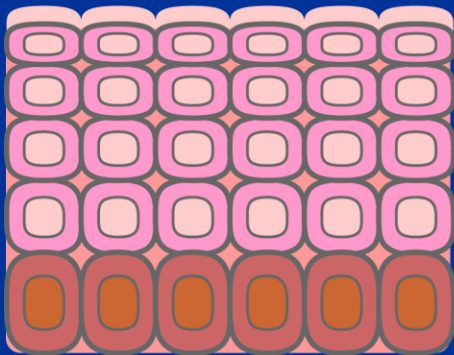
An example of hyperplasia would be a callus on your hand.



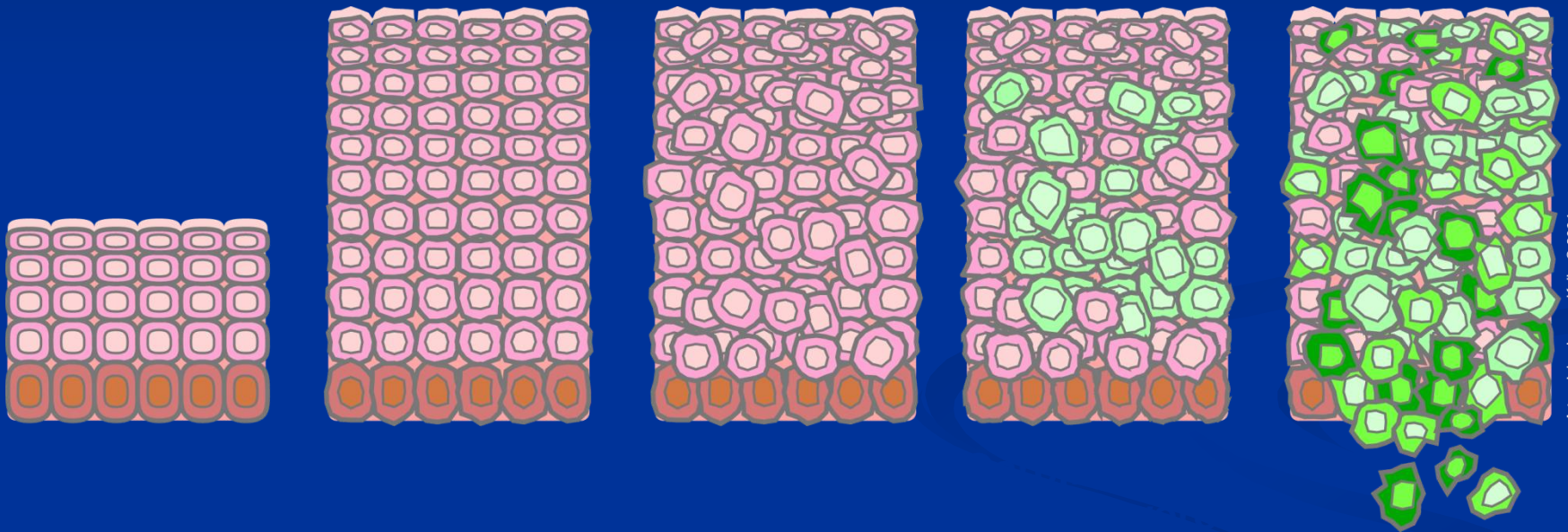
Artwork by Jeanne Kelly, © 2004.

Dysplasia

Also detectable is dysplasia: excessive growth and abnormal tissue arrangement.



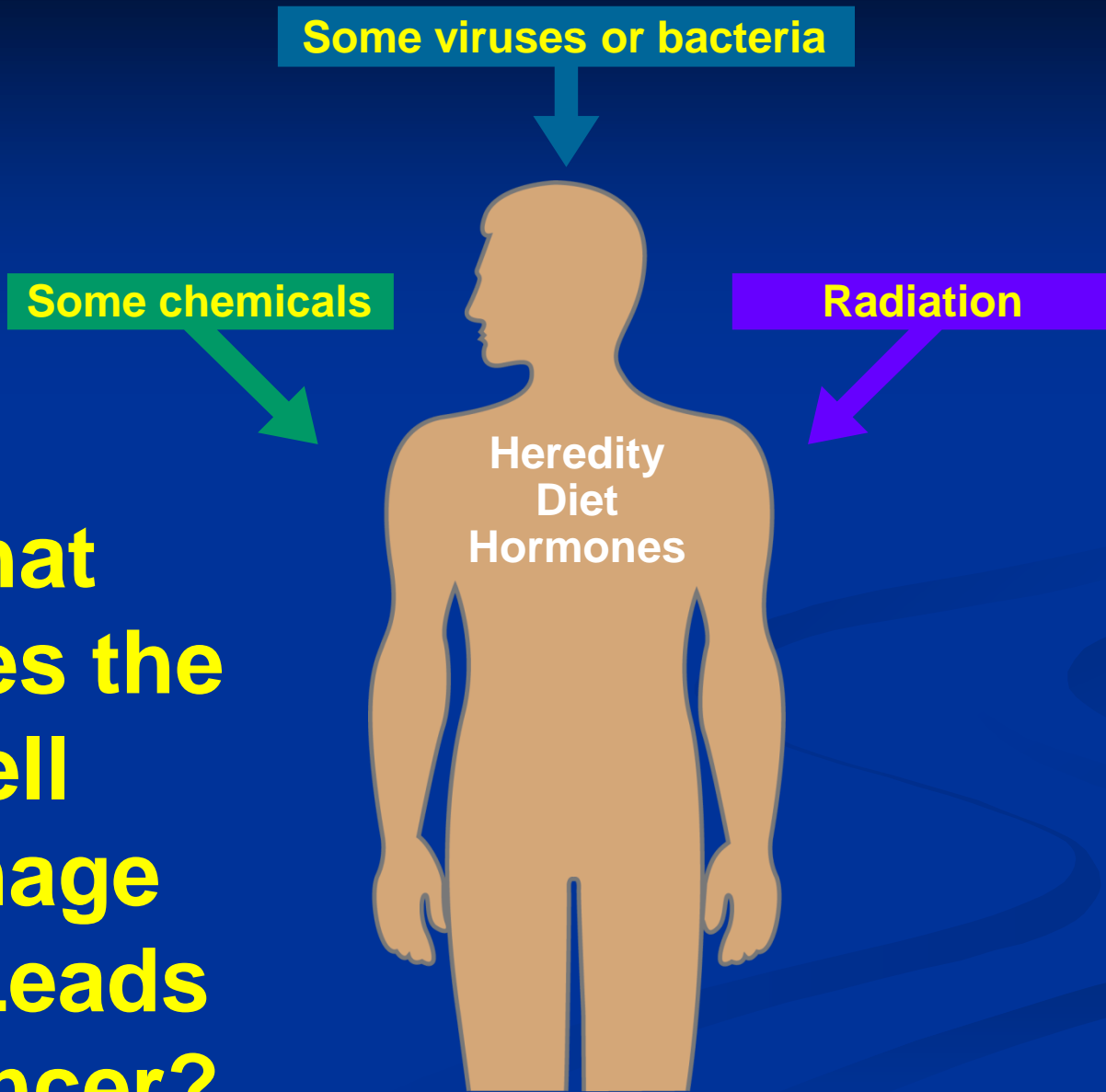
Artwork by Jeanne Kelly. © 2004.



Artwork by Jeanne Kelly. © 2004.

Dysplasia is often monitored to make sure it doesn't develop into a metastatic cancer.

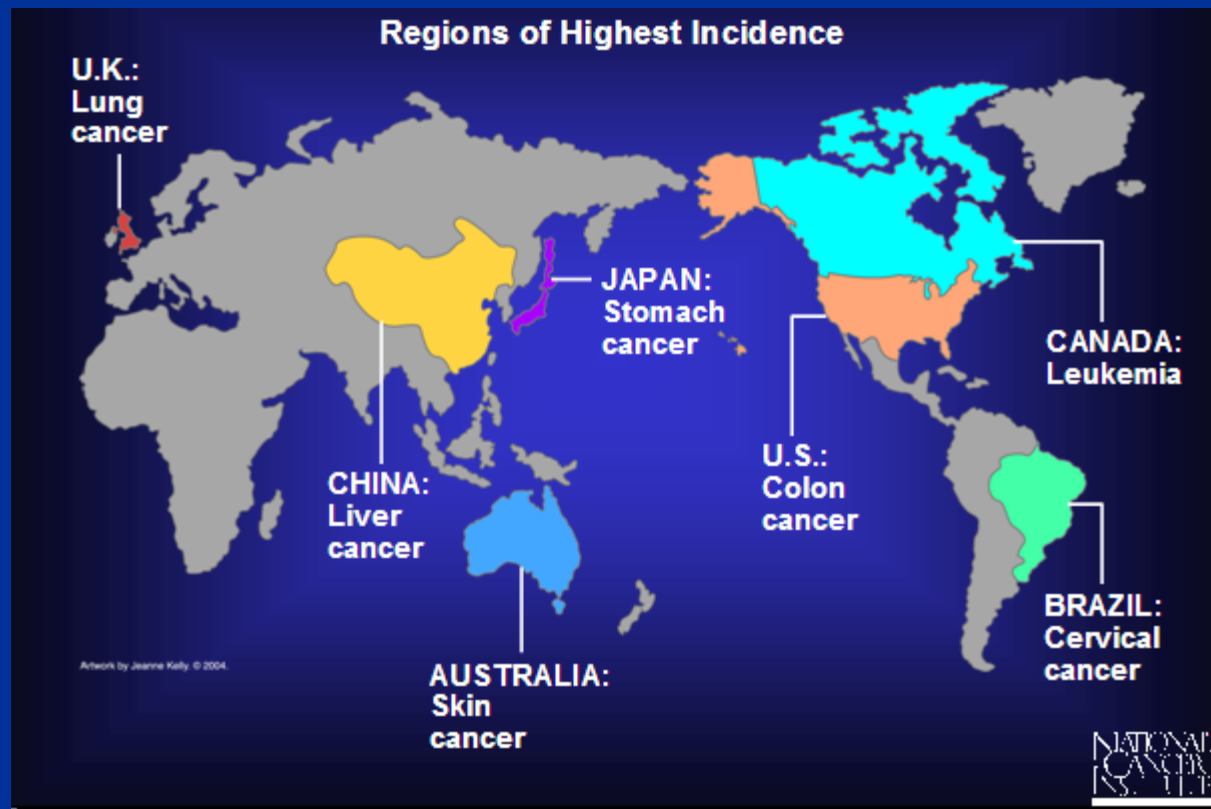
What Causes the Cell Damage that Leads to Cancer?



Artwork by Jeanne Kelly. © 2004.

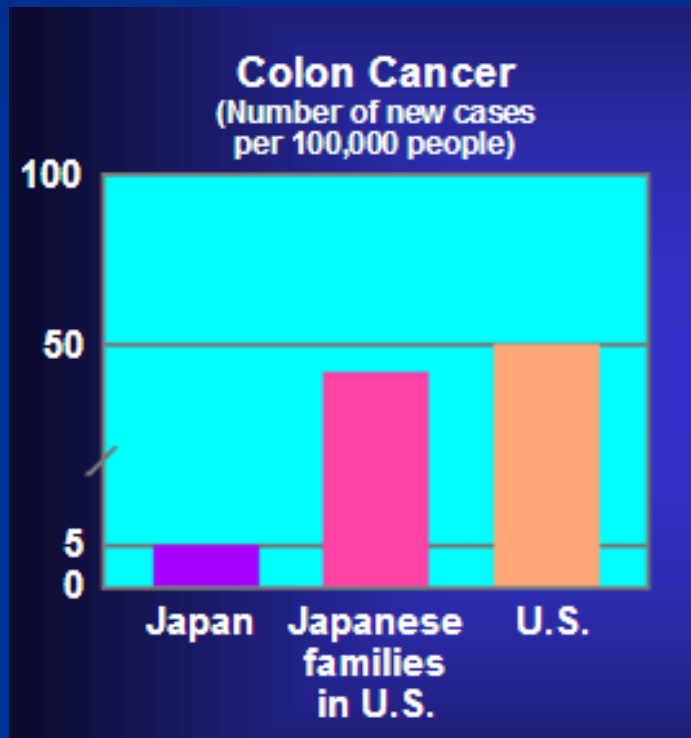
Population-Based Studies

We can determine possible causes of cancer by looking at the incidence in different populations:



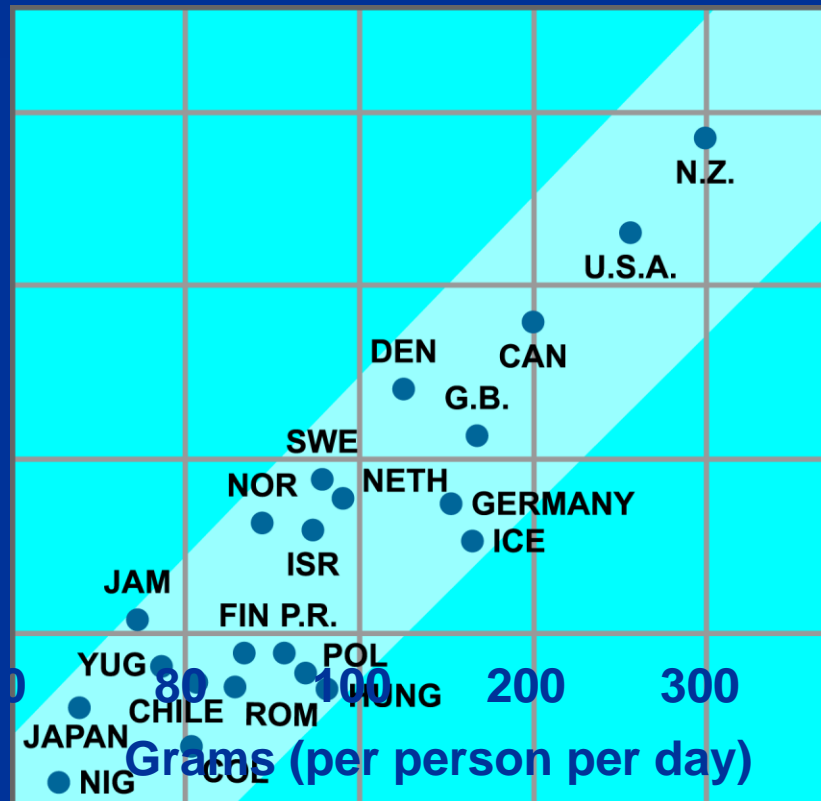
Incidence in Populations

The higher incidence of colon cancer in Japanese families that have moved to the U.S. suggests that it's behavioural and/or environmental factors are what is changing the risk.



Look For Correlations

Correlation Between Meat Consumption and Colon Cancer Rates in Different Countries



Artwork by Jeanne Kelly, © 2004.

Some Cancer-Causing Chemicals in Tobacco Smoke

aminostilbene
arsenic
benz[a]anthracene
benz[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-dibutyl nitrosamine
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-nitrosornicotine
N-nitrosoanabasine
N-nitropiperidine
polonium-210

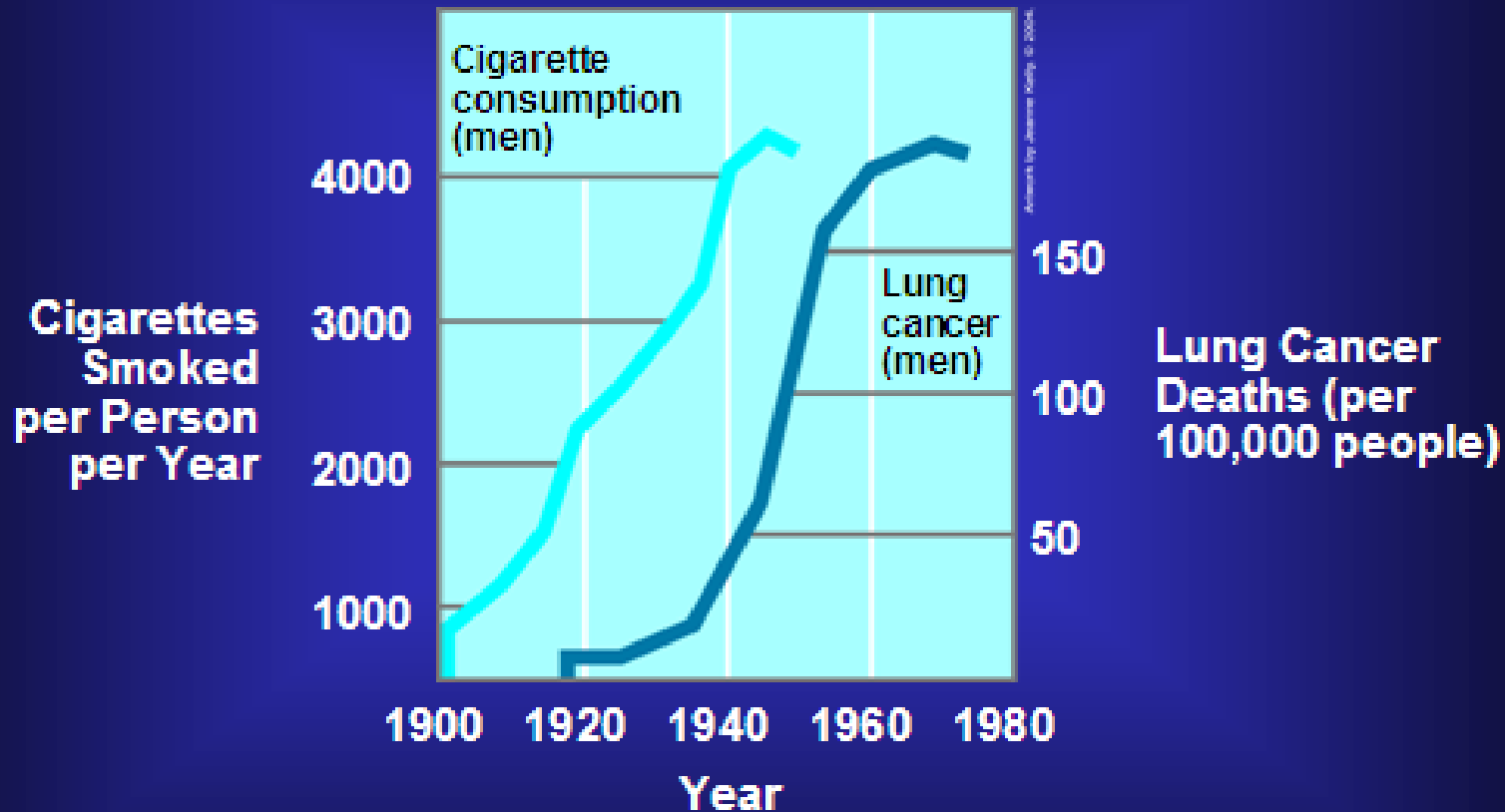


Some chemicals
can damage cells

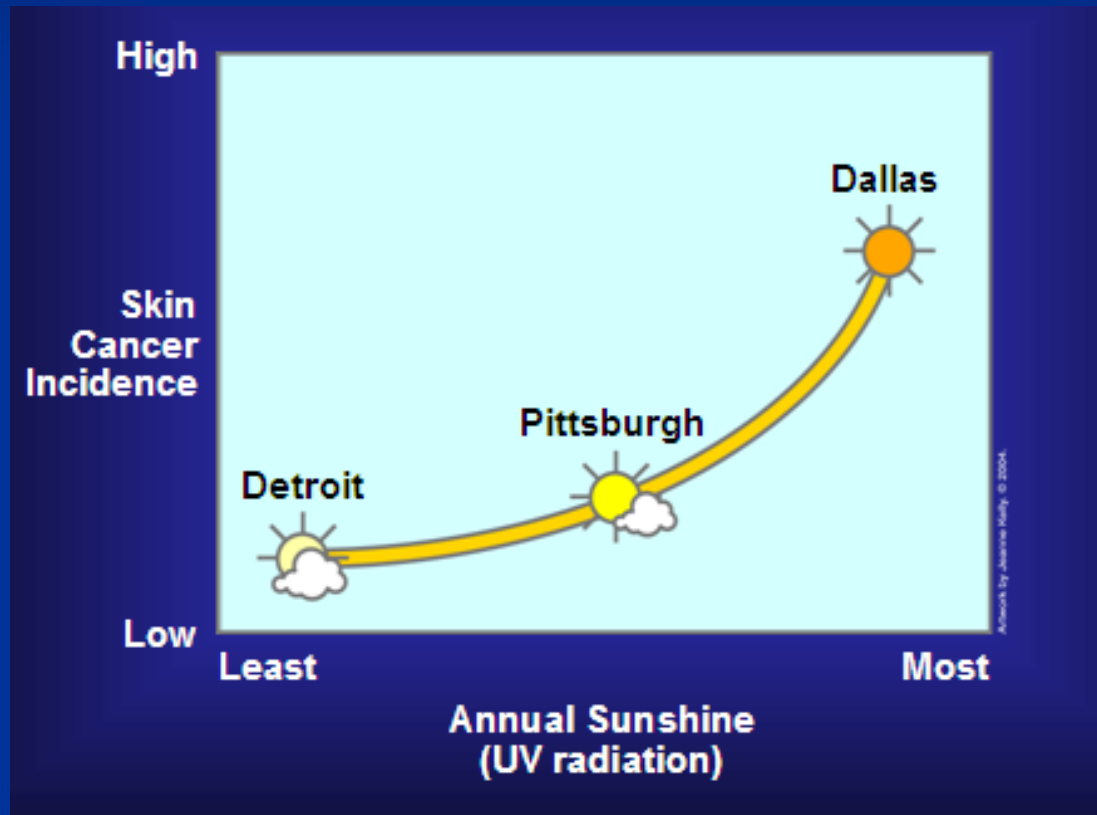
Artwork by Jeanne Kelly, © 2004.

How Can We Show the Risk?

20-Year Lag Time Between Smoking and Lung Cancer

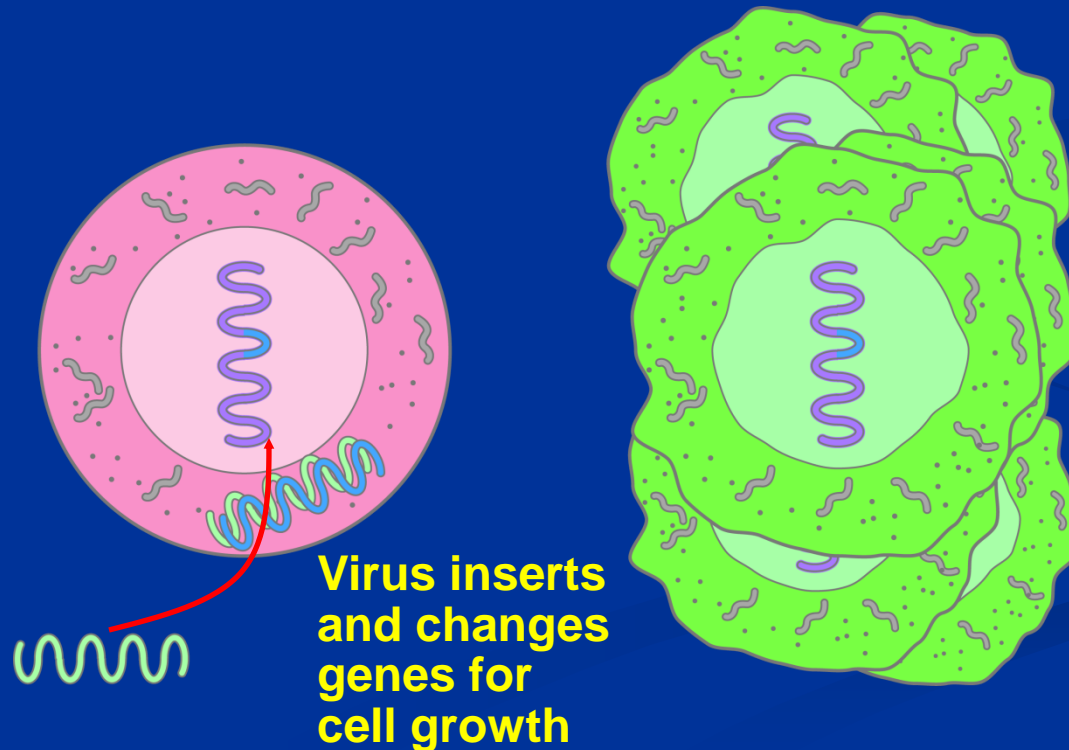


And Skin Cancer is Correlated with UV Exposure



Viruses

Some viruses are also linked to certain cancers (e.g. human papillomavirus to cervical cancer).

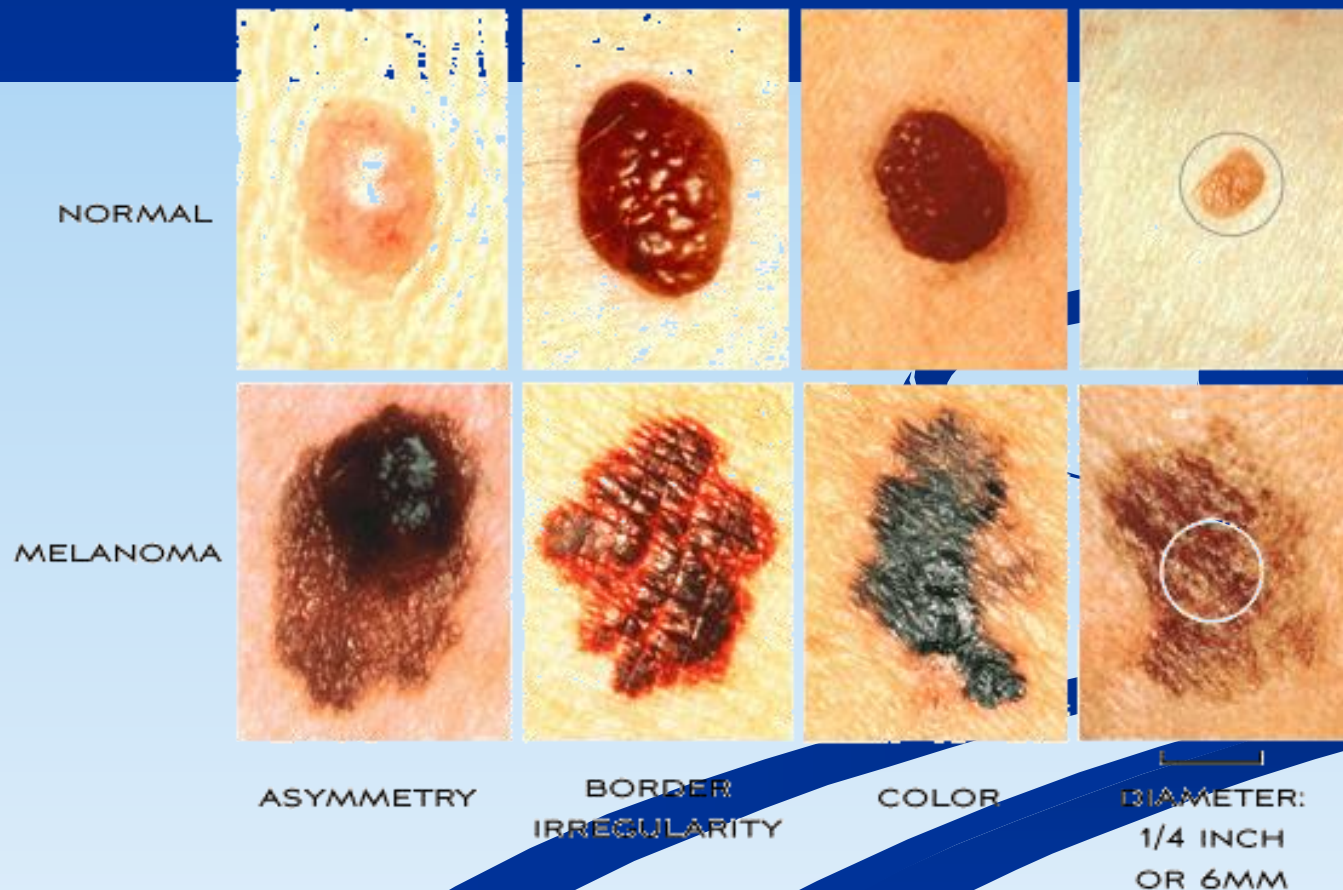


Reducing Your Cancer Risk!

- Cancer is NOT contagious!
- Cancer screening is checking for cancer in absence of cancer symptoms
- Can be done at home (breast self-exams, testicular self-exams)
- Routine check-ups (pap test, PSA test)
- Special appointments (mammograms)
- Genetic screening is recommended in cases of family history of cancer

Reducing Your Cancer Risk

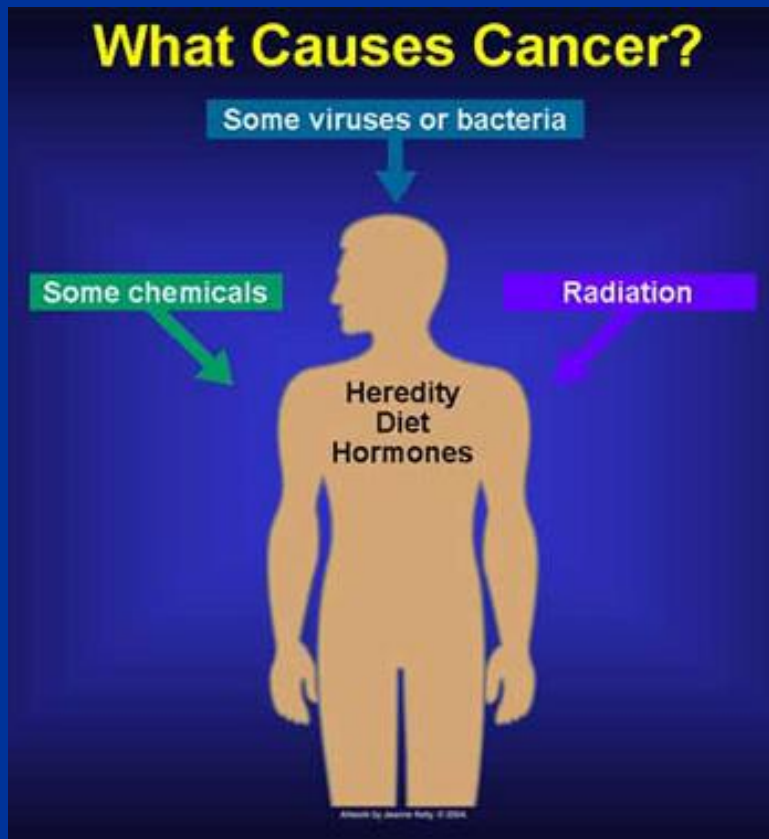
- Check your skin regularly for moles following the ABCD test



Source: Skin Cancer Foundation

Reducing Your Cancer Risk

- Educate yourself about the risks in your family history, your environment and your lifestyle choices



Lifestyle Choices:
No smoking
Exercise
Healthy Diet
Healthy Body weight

Textbook Questions

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