- SPI 3210.1.6 Determine the relationship between cell growth and cell reproduction.

- EQ-How do you determine SA/V of a cell?

EXIT

Click on a lesson name to select.

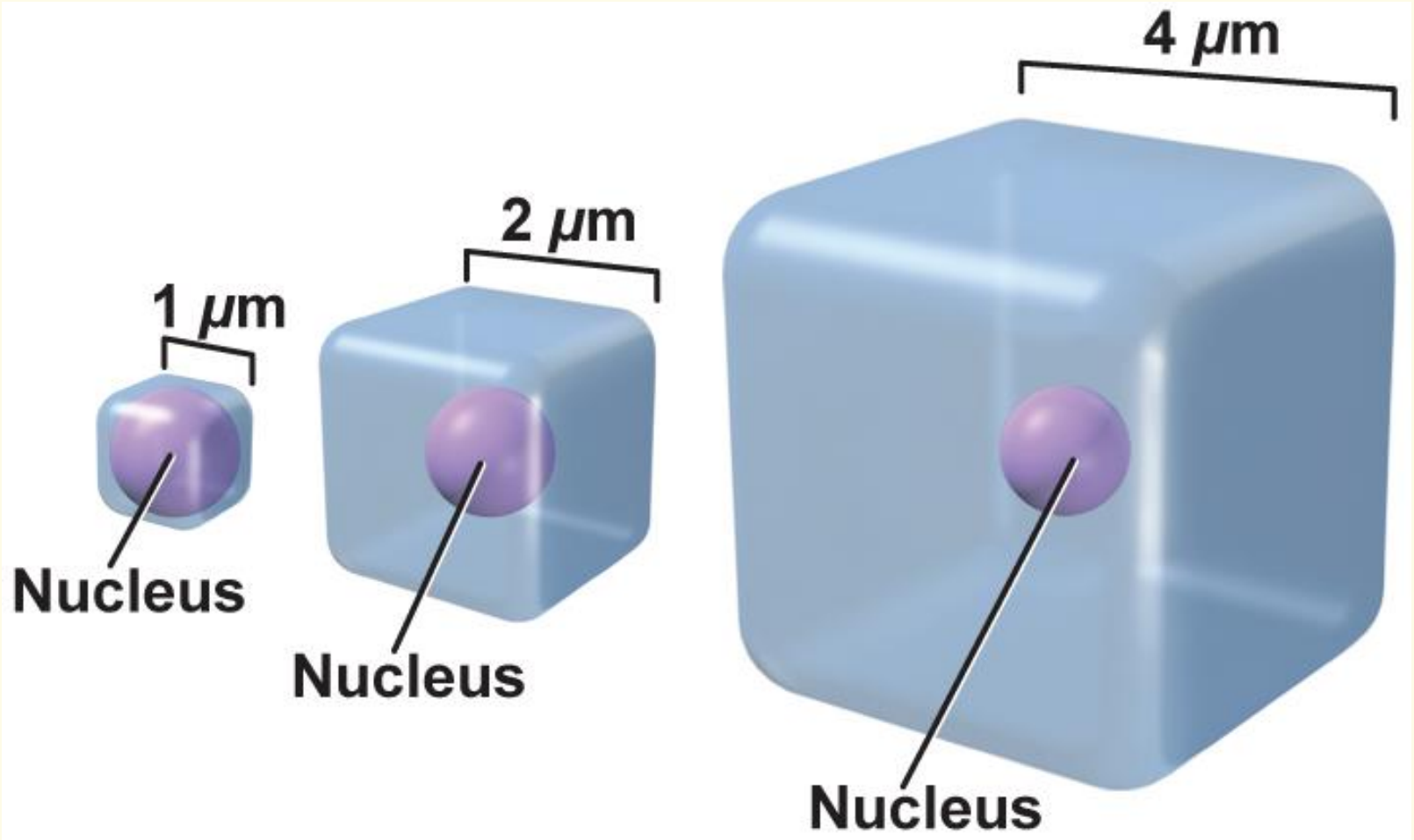
Chapter 9 Cellular Reproduction

EXIT

Click on a lesson name to select.

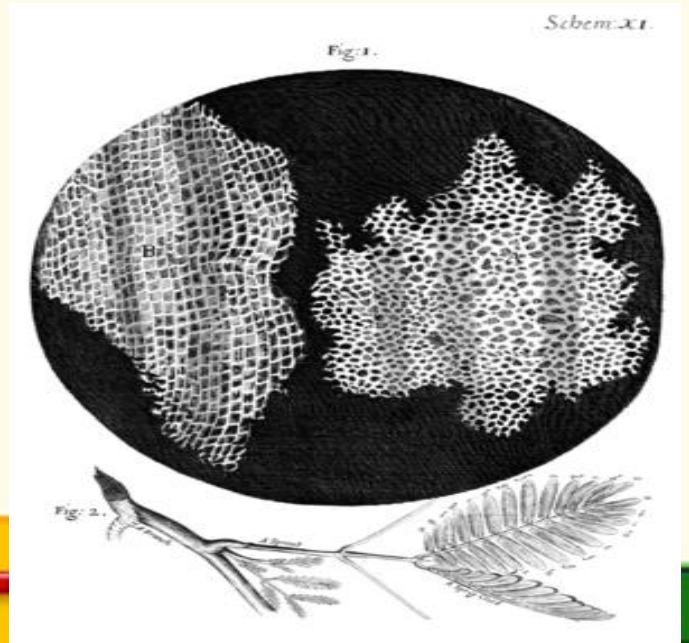
9.1 Cellular Growth

Ratio of Surface Area to Volume-what cell is best?



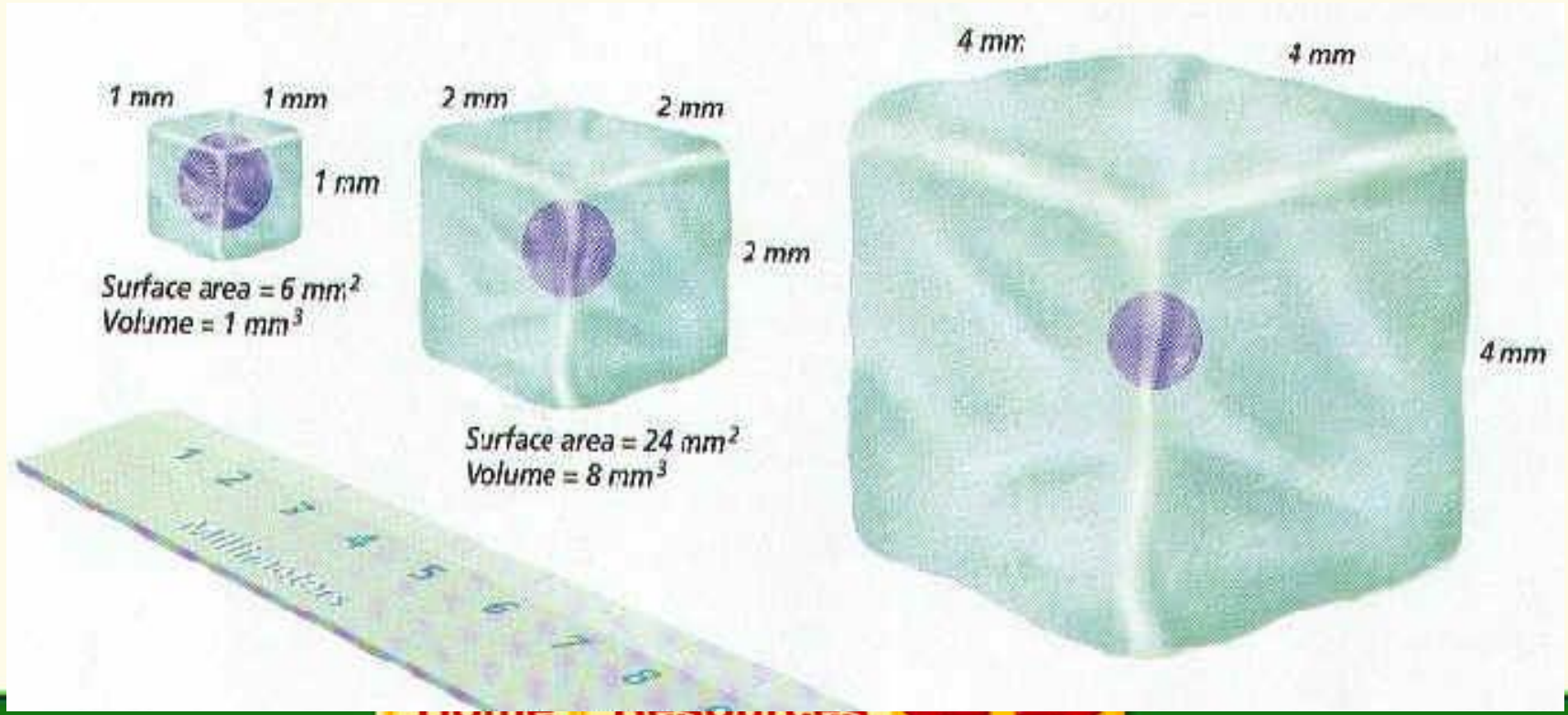
•Surface area in the cell is the area covered by the plasma membrane. The volume refers to the space taken by the inner contents.

- The cell might have difficulty supplying nutrients and expelling enough waste products.
- Living things grow by producing more cells, not larger ones.



Cell Size Limitations

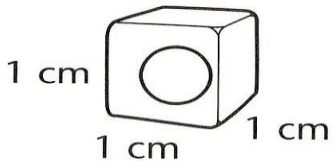
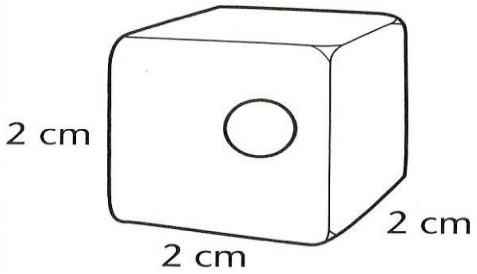
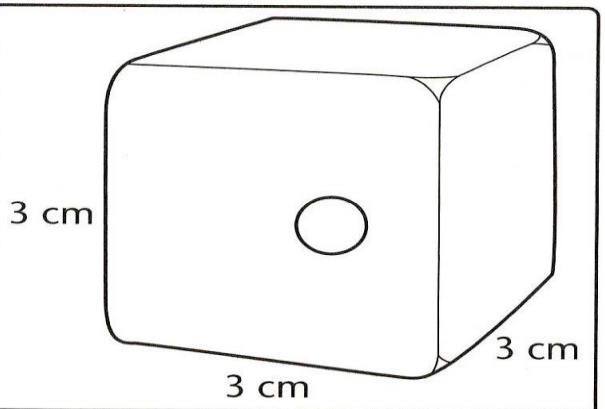
- The smaller the cell, the higher ratio of surface area to volume
  - This allows cells to sustain themselves more efficiently.



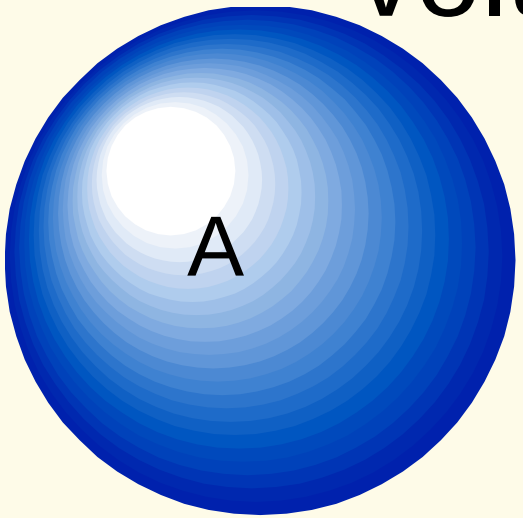
Transport of Substances

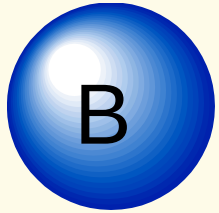
- Substances move by diffusion (high to low) or by proteins.
- Diffusion over large distances is slow and inefficient.
- Small cells maintain more efficient transport systems.

- Surface area= l x w x # sides, unit is cm^2.
- Volume= l x w x h, unit is cm^3.
- Ratio of surface area to volume: $\frac{SA}{V}$

Cell Size			
Surface Area (length x width x 6)	1 cm x 1 cm x 6 = 6 cm^2	2 cm x 2 cm x 6 = 24 cm^2	3 cm x 3 cm x 6 = 54 cm^2
Volume (length x width x height)	1 cm x 1 cm x 1 cm = 1 cm^3	2 cm x 2 cm x 2 cm = 8 cm^3	3 cm x 3 cm x 3 cm = 27 cm^3
Ratio of Surface Area to Volume	6 / 1 = 6 : 1	24 / 8 = 3 : 1	54 / 27 = 2 : 1

Which cell has a smaller surface-to-volume ratio?



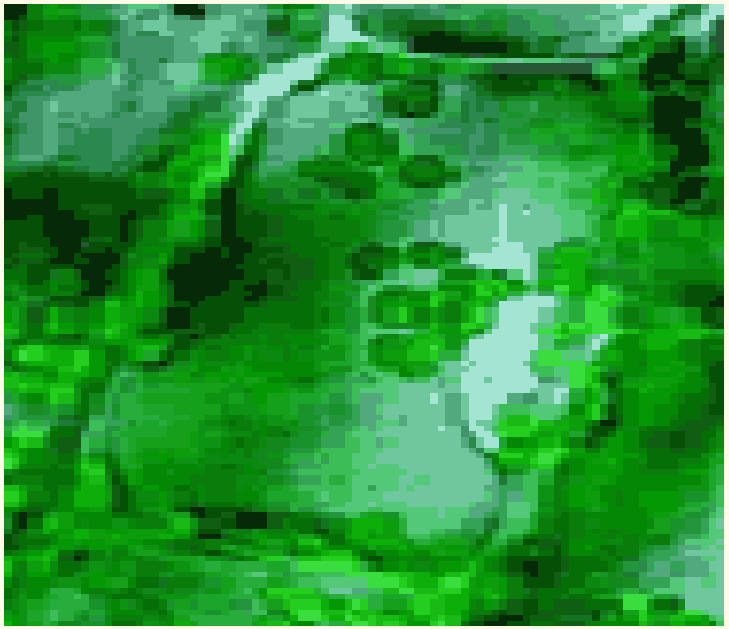


So, what happens when the cell reaches its size limit?

- When a cell reaches its size limit it will either stop growing or divide—most will divide.
  - Red and white blood cells, nerve cells, heart muscle, and skeletal muscle cells do not divide.
- Eukaryotic cells reproduce by a cycle of growing and dividing called the **cell cycle**.
- Prokaryotic cells reproduce by **binary fission**.

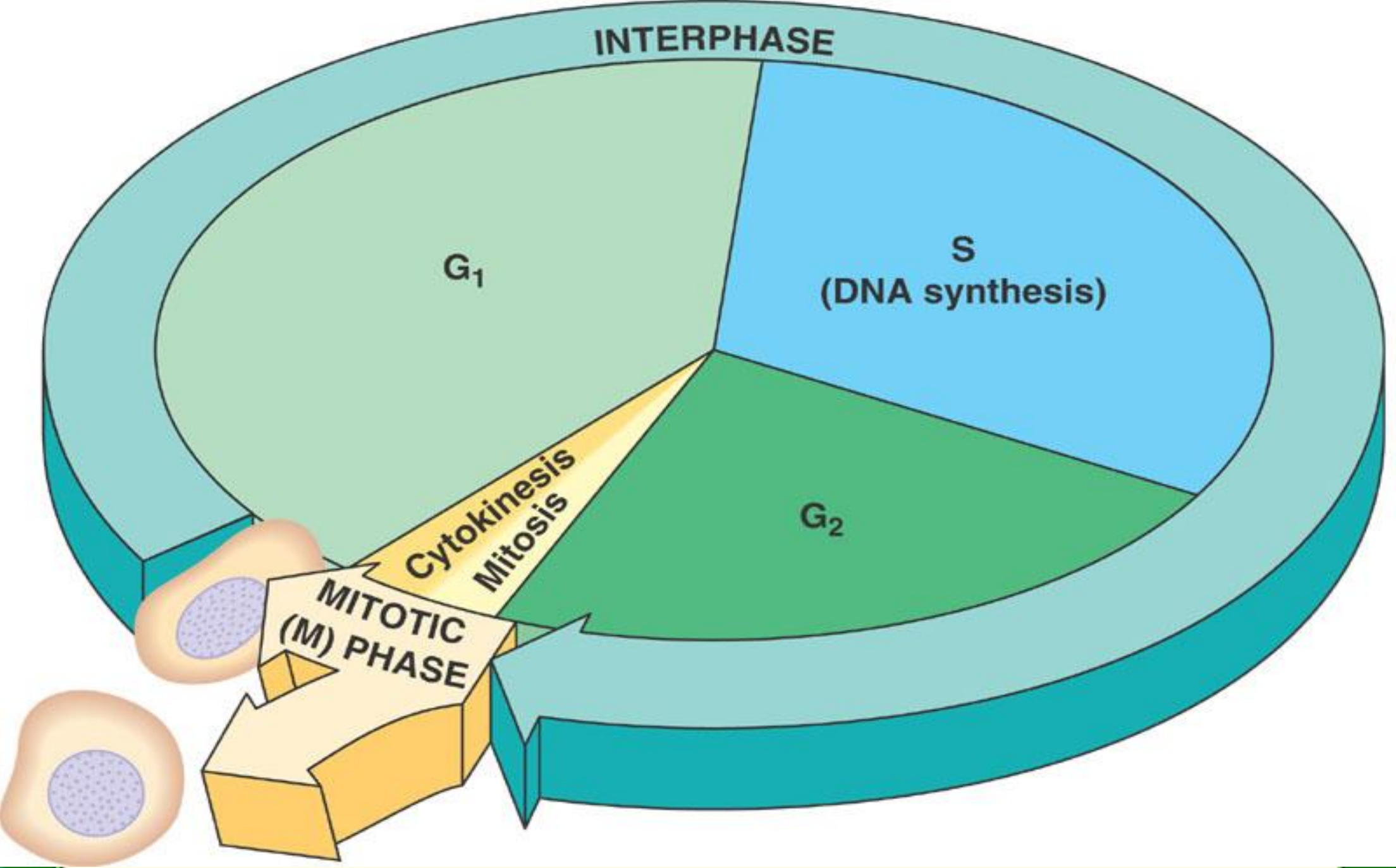
The Cell Cycle

- It is the way the cell reproduces so that you grow and heal certain injuries.



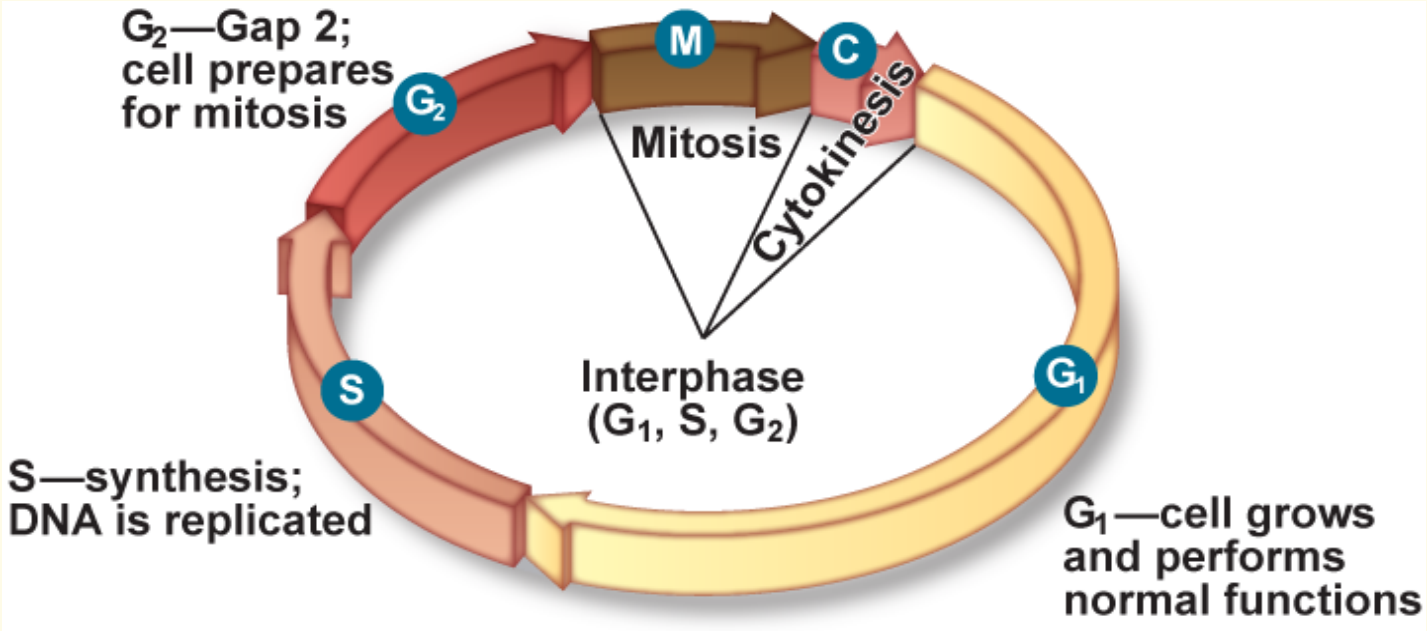
The Cell Cycle-3 parts

1. **Interphase**
   - Longest part of the cell cycle
   - Occurs in three stages: G1, S, G2
2. **Mitosis**
   - Division of cell nucleus
   - Occurs in four stages: Prophase, Metaphase, Anaphase, Telophase
3. **Cytokinesis**
   - Division of the cytoplasm which results in two new cells


INTERPHASE
G1
S
(DNA synthesis)
G2
Cytokinesis
Mitosis
MITOTIC
(M) PHASE

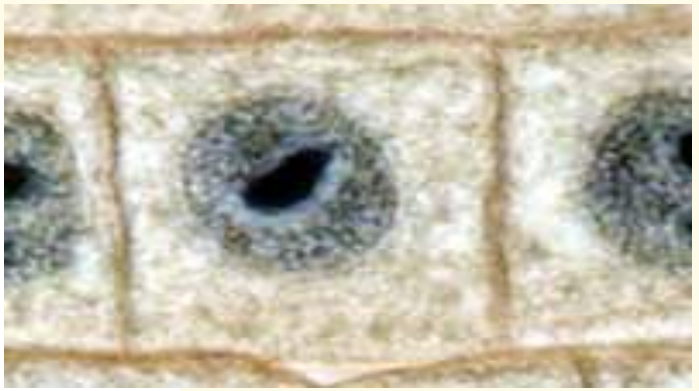
The Stages of Interphase

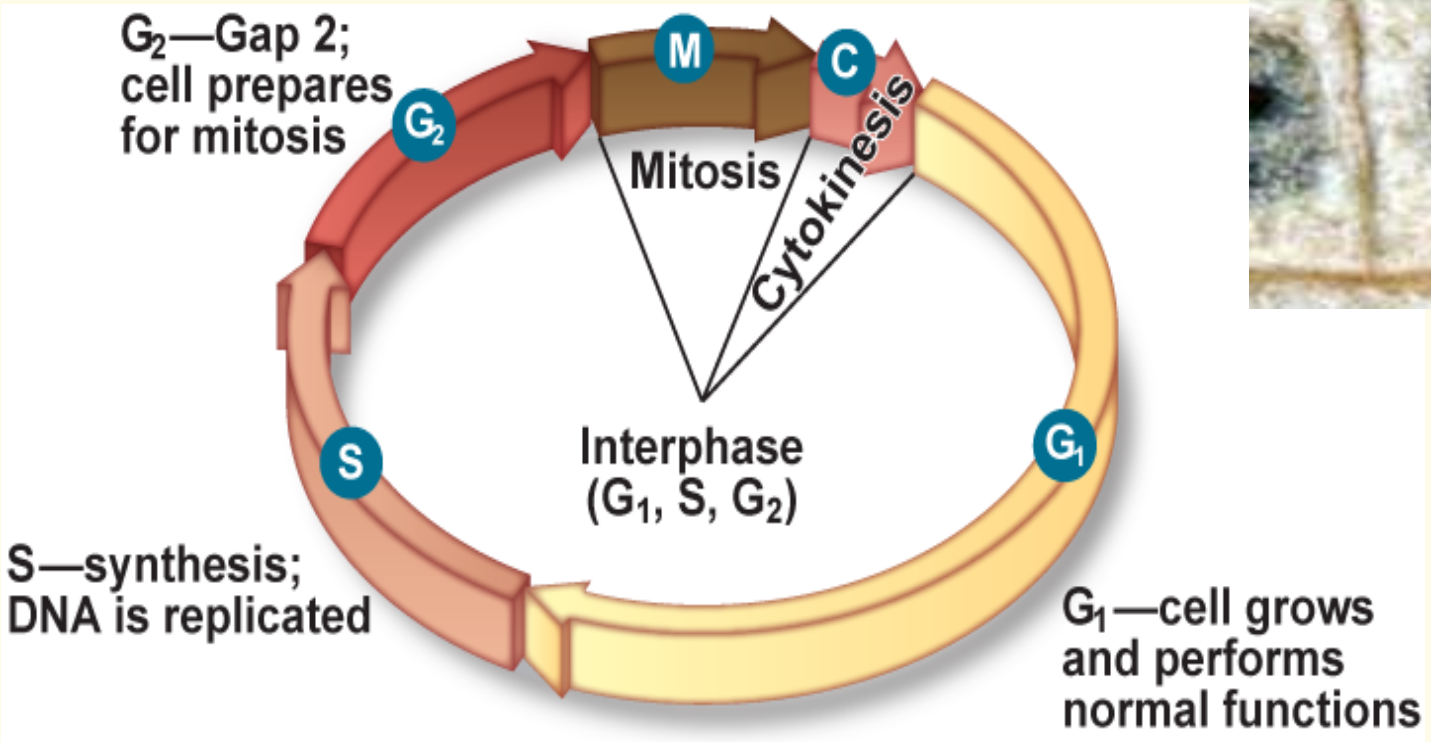
- The first and longest stage of interphase, Gap or Growth 1= G_1
  - The cell is growing, carrying out normal cell functions, and preparing to replicate DNA.
  - p.246



The Second Stage of Interphase, S=Synthesis

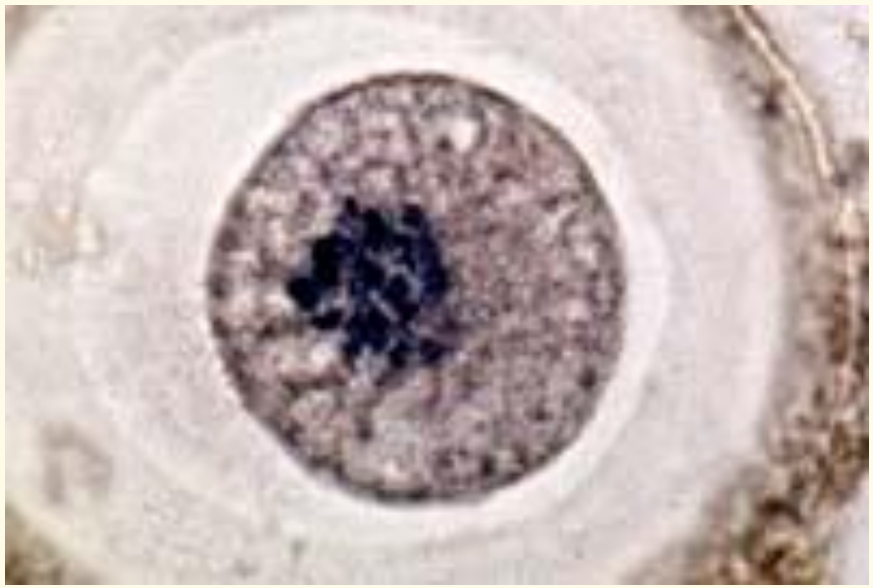
- The cell copies its DNA in preparation for cell division.

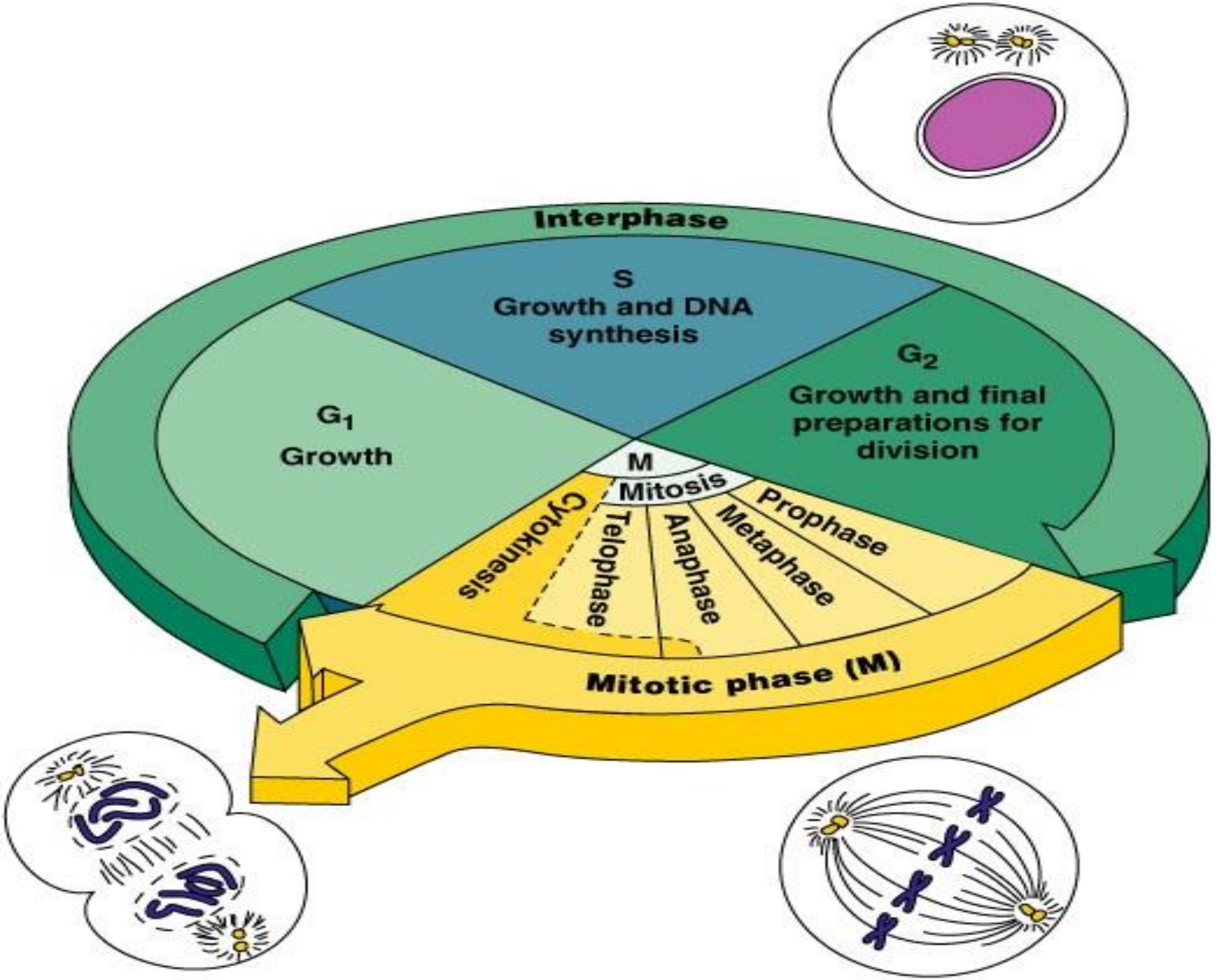




The Third Stage of Interphase, Gap or Growth 2=G_2

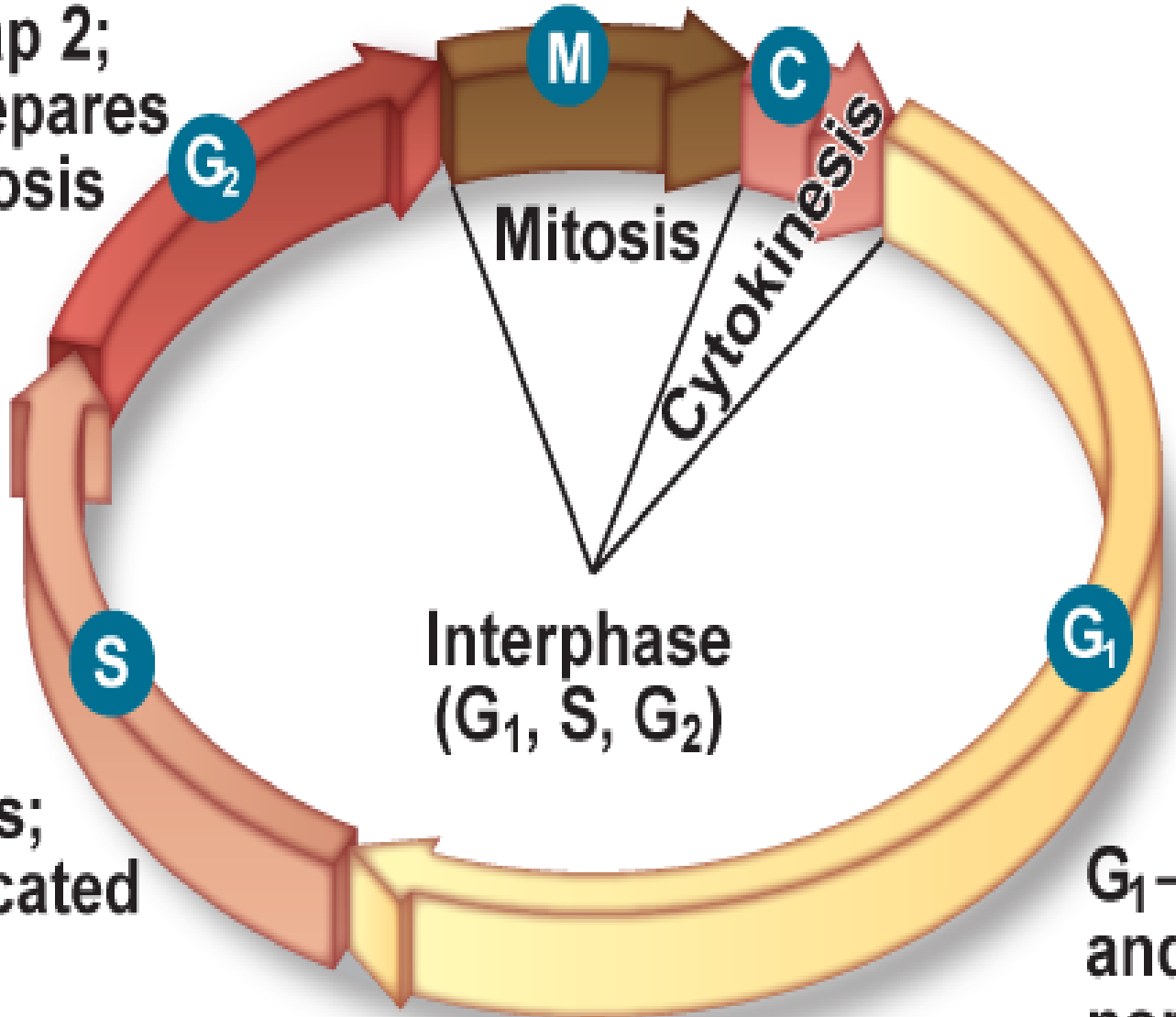
- The cell prepares for mitosis
- Replication of organelles.
- Chromatin is present here.





- **In the time that it takes you to read this sentence, your body will have produced millions of new cells!**

G_2—Gap 2; cell prepares for mitosis



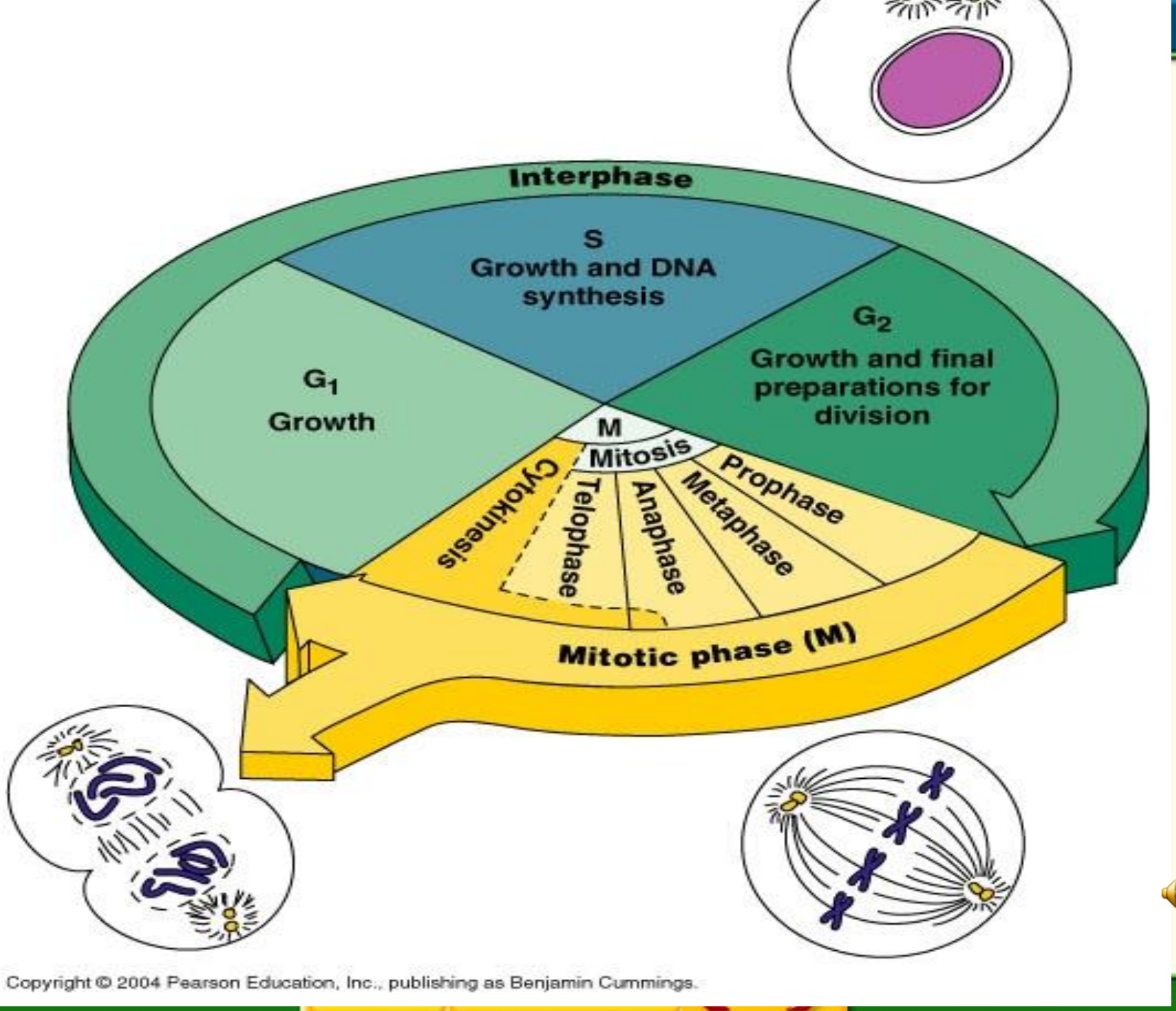
S—synthesis; DNA is replicated

G_1—cell grows and performs normal functions

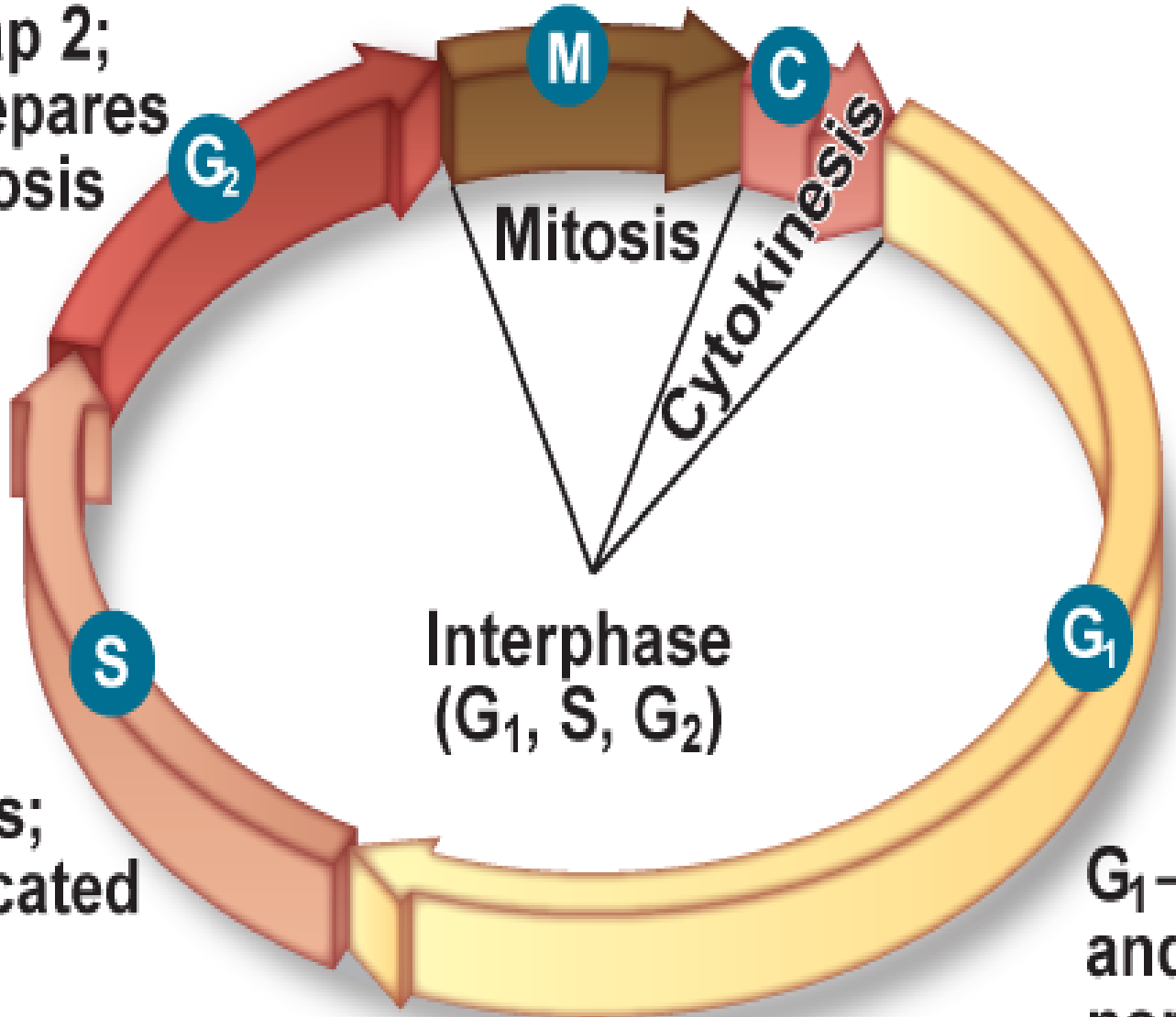
How long does the entire cell cycle take to complete?

Duration of cell cycle

- Varies depending on the type of cell
  - Some divide in as little as eight minutes while others might take up to one year.
- For most normal animal cells, the cycle takes 12-24 hours to complete
- Some cells do not divide at all—they stay in G1 phase



G_2—Gap 2; cell prepares for mitosis

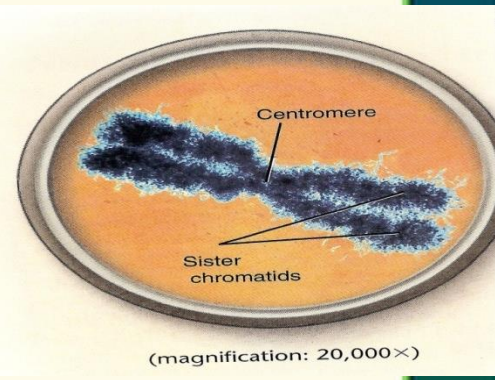


S—synthesis; DNA is replicated

G_1—cell grows and performs normal functions

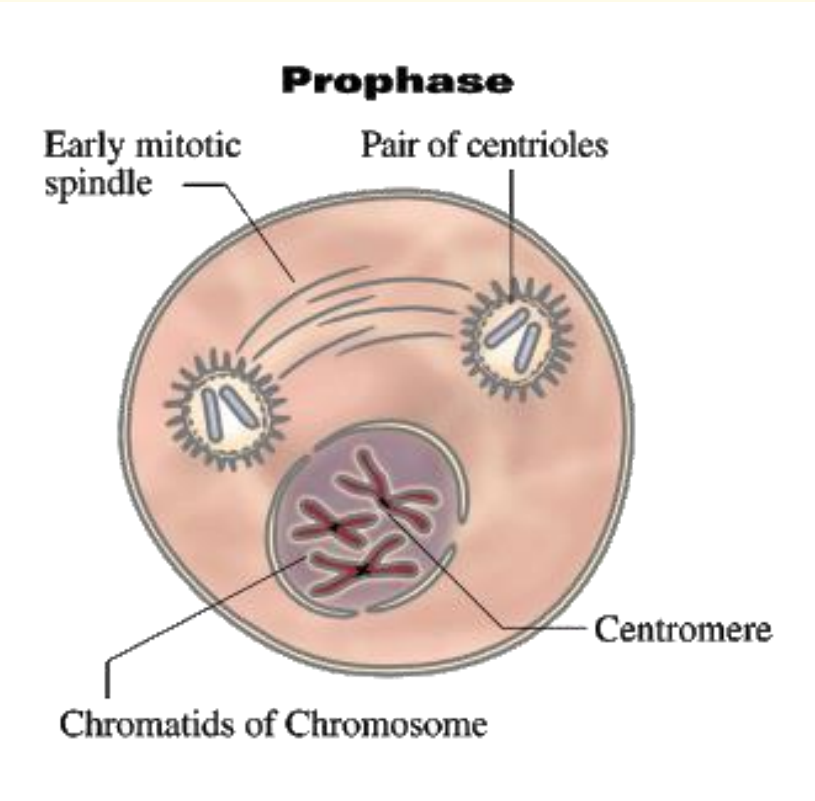
9.2 Cell Division- Mitosis and Cytokinesis of Eukaryotic cells

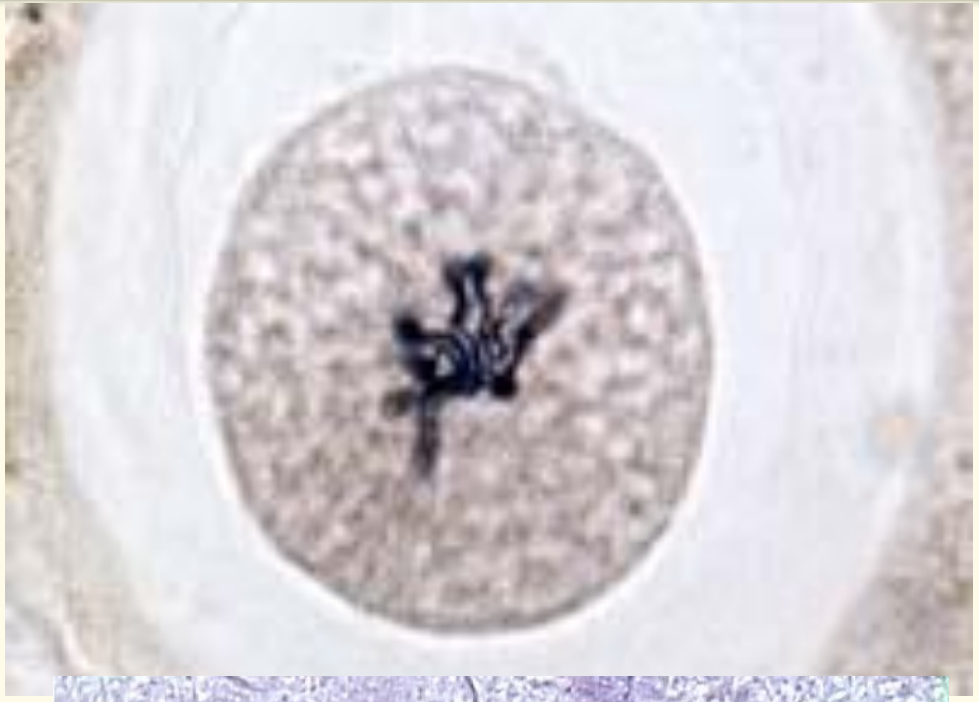
The Stages of Mitosis (M) (PMAT)

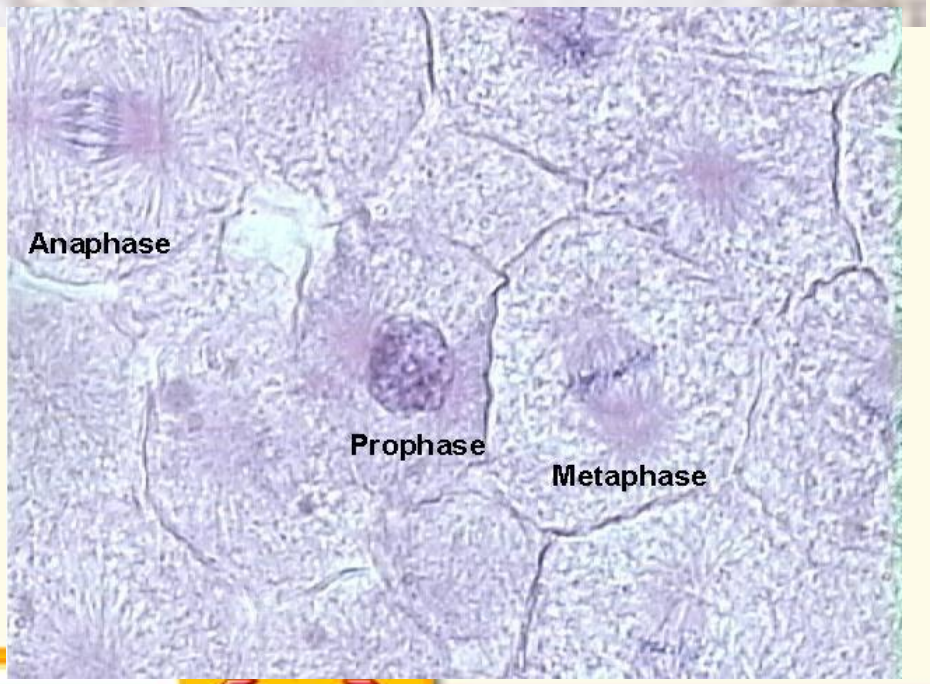


- Prophase (P)-longest phase of mitosis
  - The cell's chromatin tightens.
  - Sister chromatids are attached at the centromere in a chromosome.
  - Spindle fibers form in the cytoplasm.

- The nuclear membrane seems to disappear.

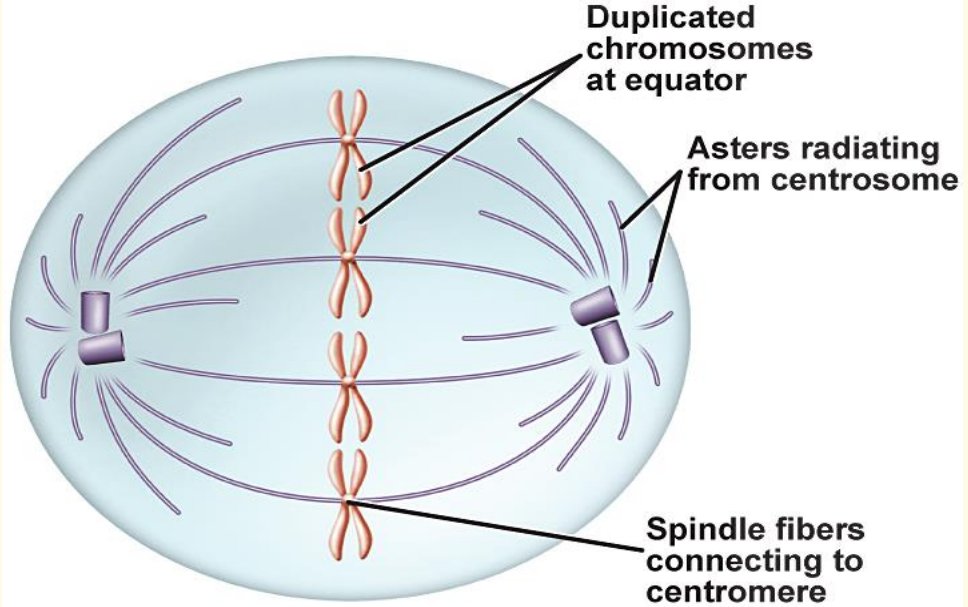






Metaphase (M)

- Sister chromatids are pulled along the spindle apparatus toward the center of the cell.
- They line up in the middle of the cell.

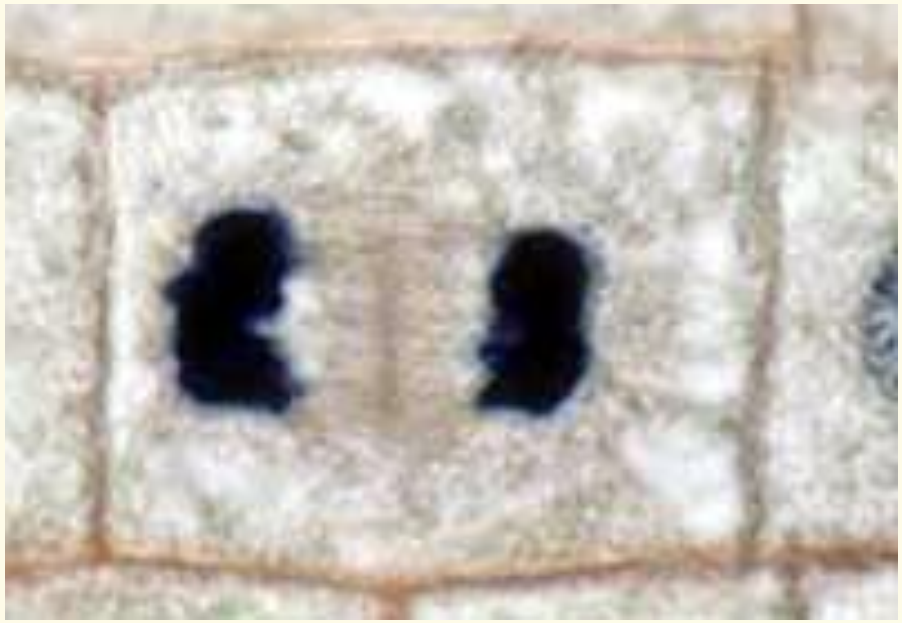


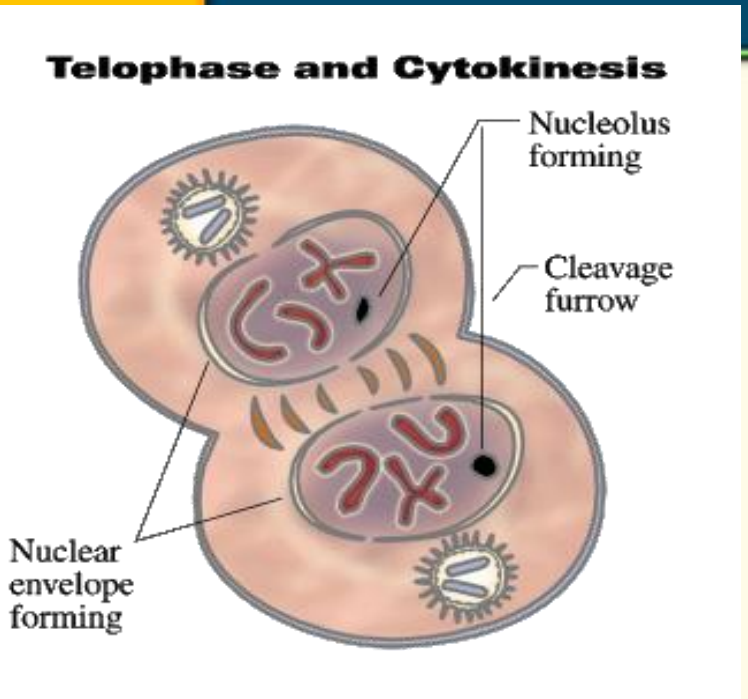
Anaphase (A)- Apart

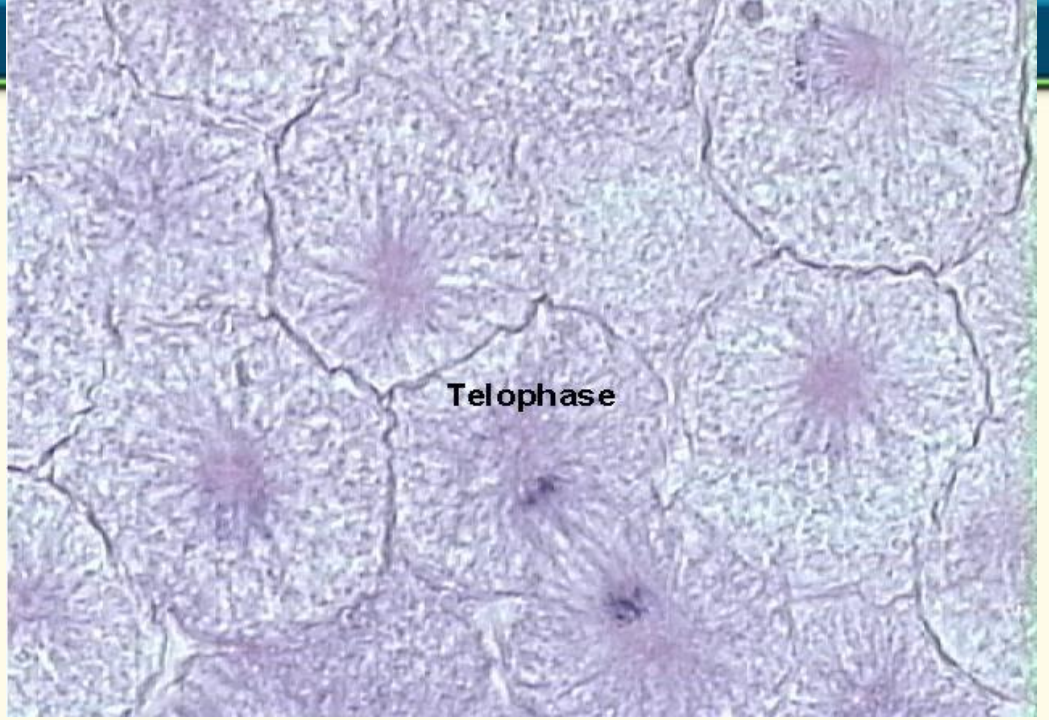
- The microtubules of the spindle apparatus begin to shorten.
- The sister chromatids separate.
- The individual chromosomes move toward the poles of the cell.

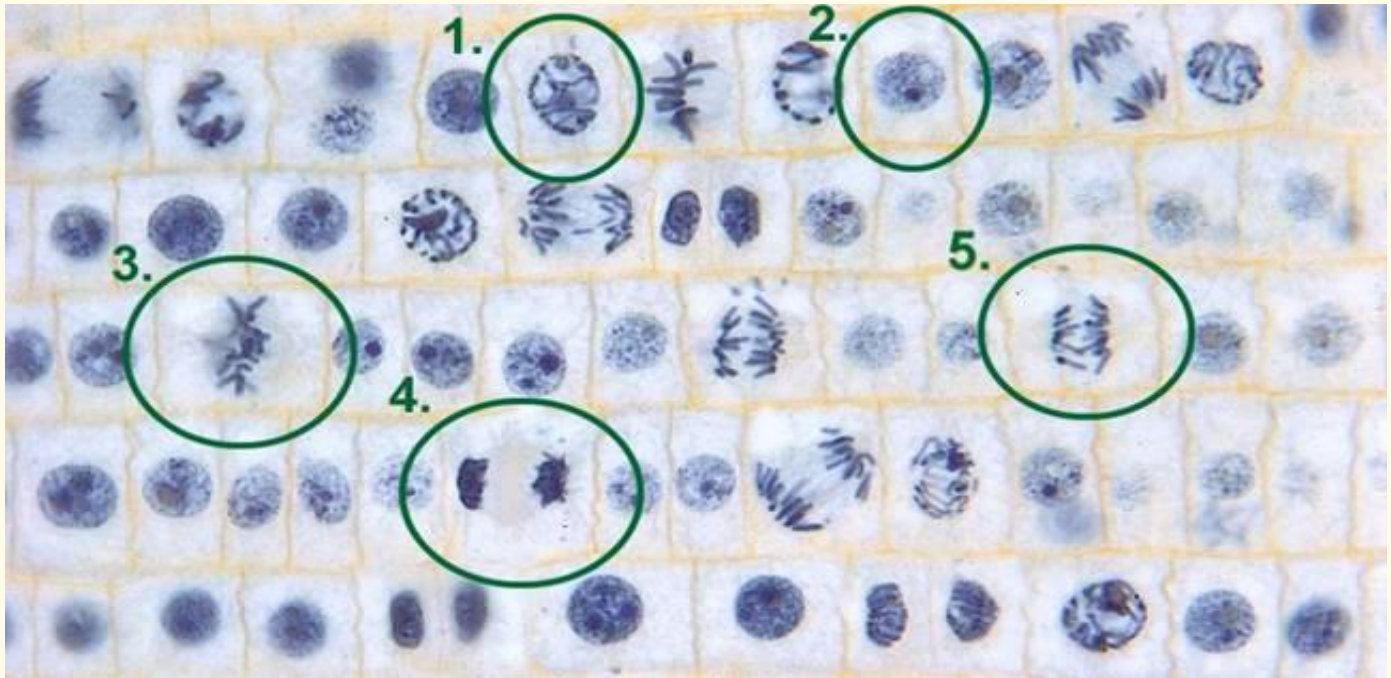
Telophase (T)

- The individual chromosomes arrive at the poles and begin to relax.
- Two new nuclear membranes begin to form and the nucleoli reappear.



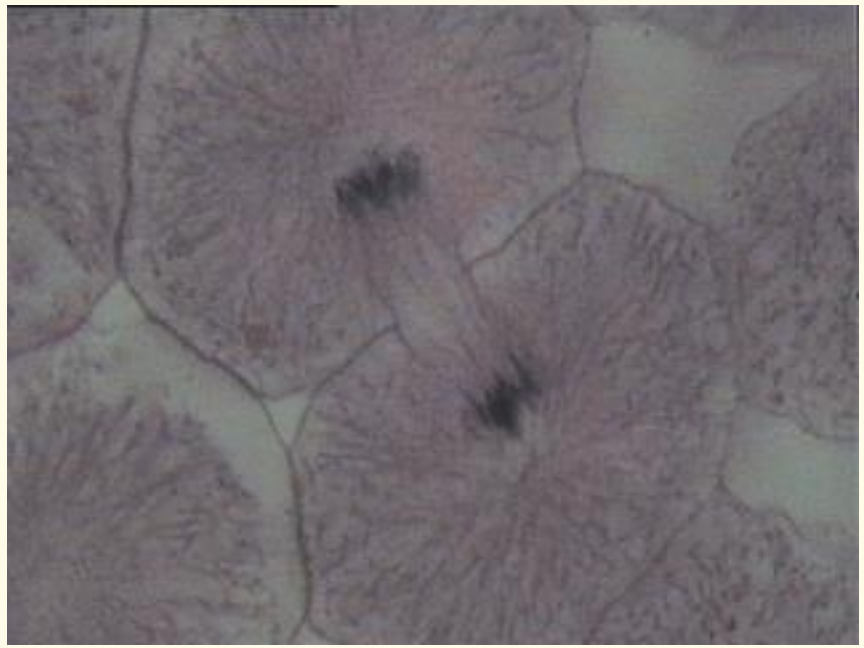

Telophase and Cytokinesis
Nucleolus forming
Cleavage furrow
Nuclear envelope forming


Telophase

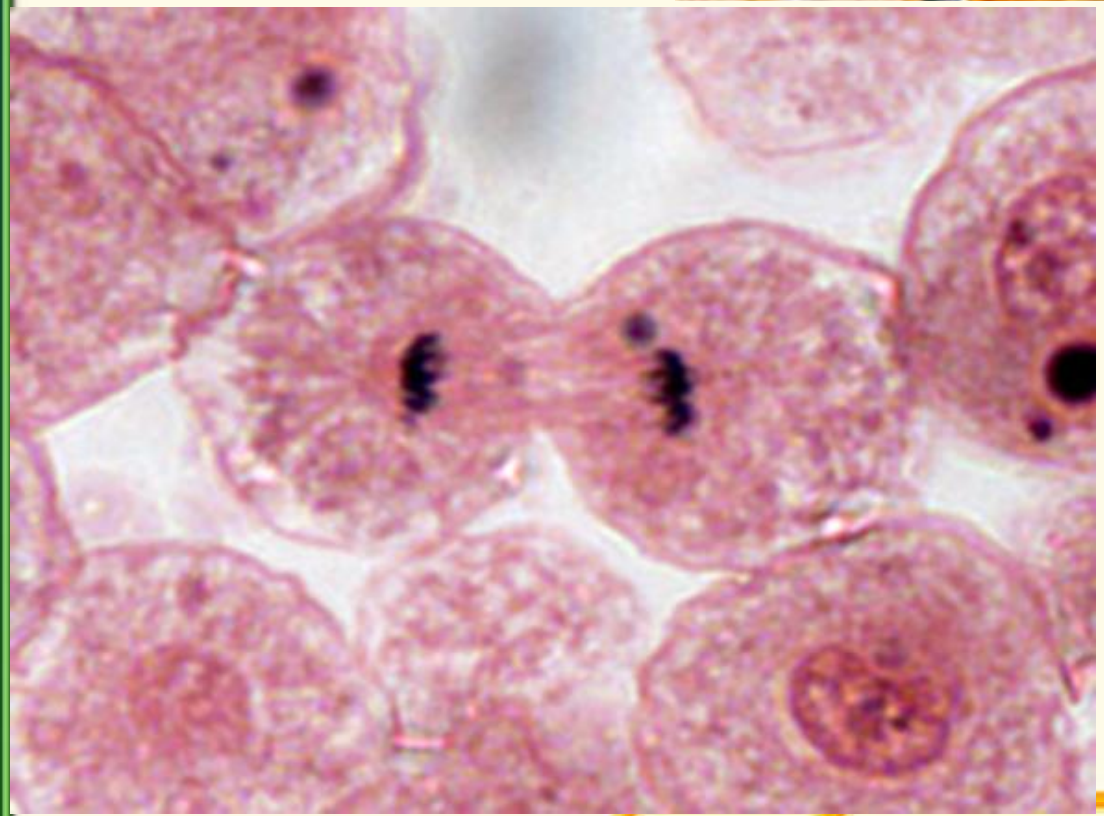

1.
2.
3.
4.
5.

Cytokinesis (C)-will often occur with telophase Division of the cytoplasm. Results in 2 new cells.

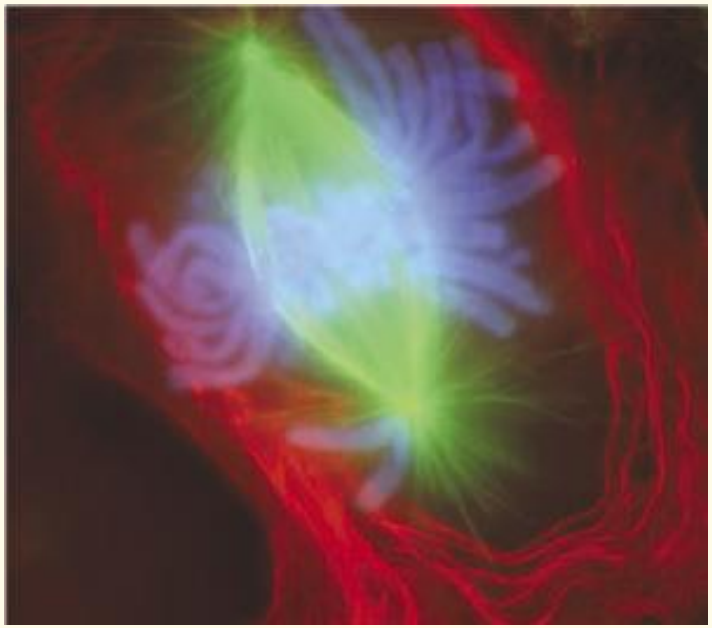
- In animal cells,a cleavage furrow is formed.
- In plant cells, a new structure, called a cell plate forms.

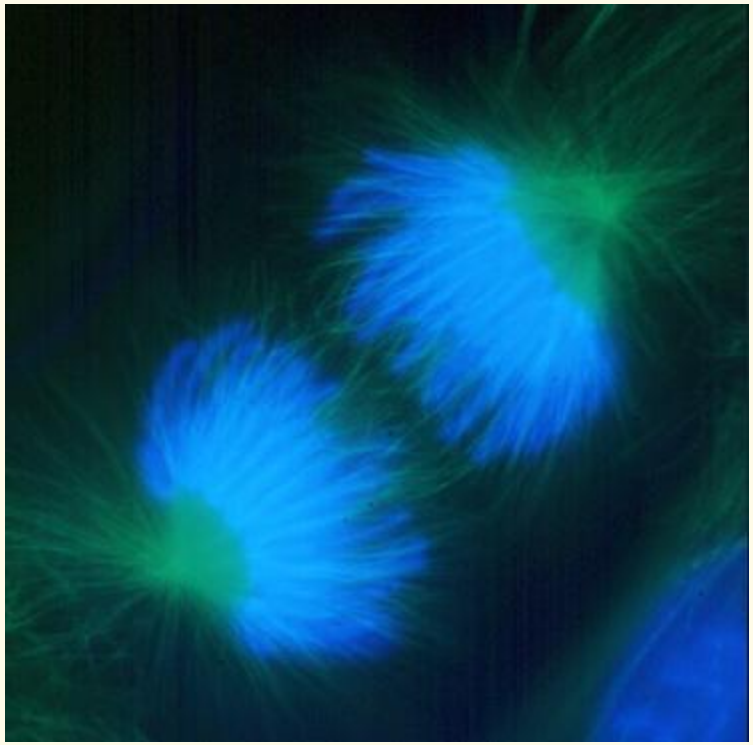



10 µm
6
7
8
9
10



Light Microscope Images of Newt Lung cells stained with fluorescent dye





Results of the cell cycle

- 2 new cells with the same # of chromosomes as the original cell (after cytokinesis).
- Occurs in all body cells except sex chromosomes
- We have 46
- Do you think the # of chromosomes determine intelligence?

Let’s hope not!

Potatoes have 24 pair, or 48.

Ferns have 600 pair or 1200.

Fruit flies have 8.

Carrots have 18.

Dogs have 78.

Goldfish have 94.

Cats have 32.

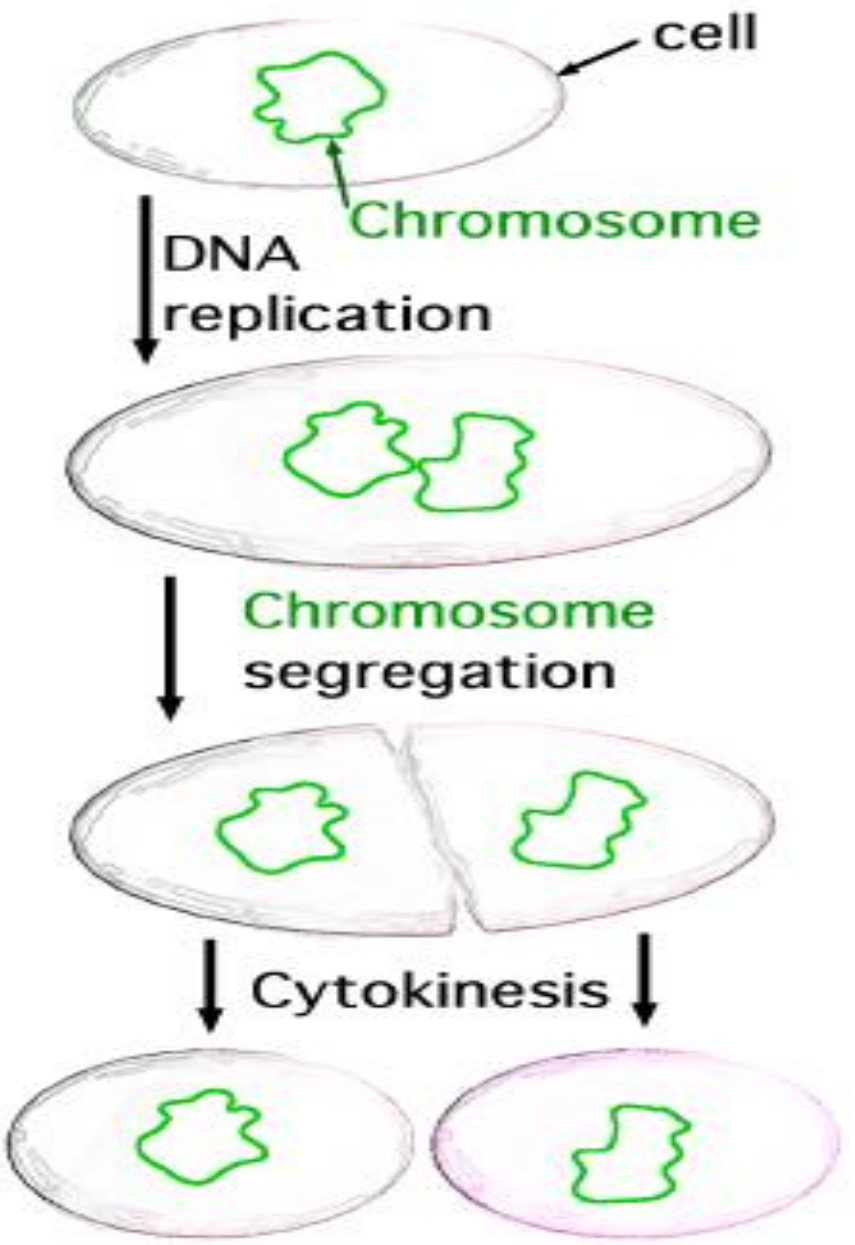
Orchids have 56.

Shrimp have 254.

Pigs have 64.

Binary Fission

- The cell division of <u>prokaryotic</u> cells
- Means “cell splitting”
- This process is simple because bacteria cells are simple with circular DNA

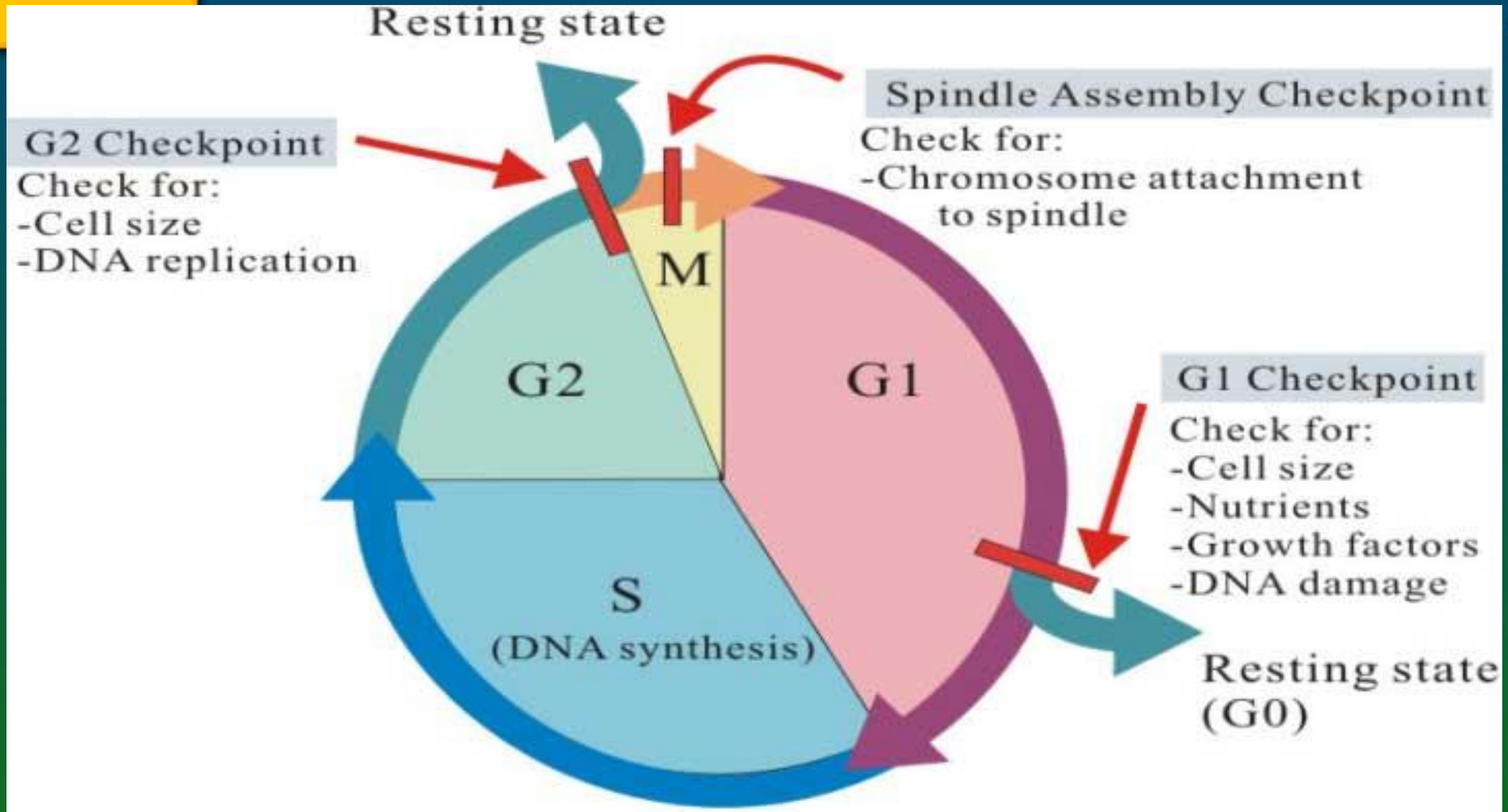


9.3 Normal Cell Cycle

- Several “checkpoints” are found within the cell cycle to ensure accurate and proper division of cells.
- Proteins called ***cyclins*** bind to enzymes called ***cyclin dependent kinases***
  - The binding of these molecules control the various steps within the cell cycle.

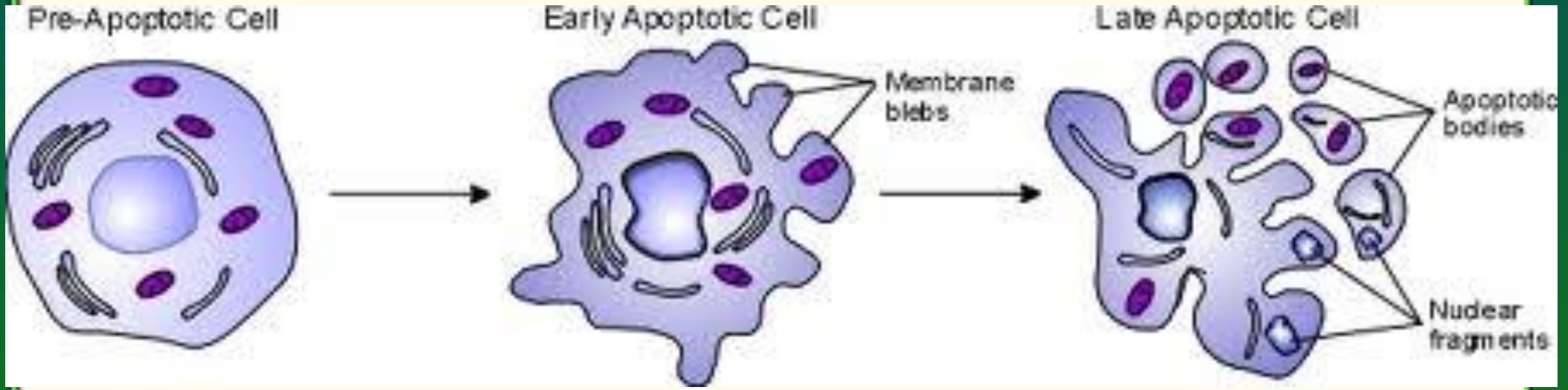
Normal Cell Cycle

- These checkpoints monitor the cycle and stop it if something goes wrong.
  - Monitors DNA replication, protein synthesis, and nuclear division during mitosis.


Resting state
Spindle Assembly Checkpoint
Check for:
-Chromosome attachment
to spindle
G2 Checkpoint
Check for:
-Cell size
-DNA replication
M
G2
G1
G1 Checkpoint
Check for:
-Cell size
-Nutrients
-Growth factors
-DNA damage
S
(DNA synthesis)
Resting state
(G0)

What happens when the cell finds a problem at a checkpoint?

- **Apoptosis**—programmed cell death
  - Occurs in damaged cells



Abnormal Cell Cycle: Cancer

- Cancer is the **uncontrolled** growth and division of cells
  - Occurs when there is a failure in the system of control checkpoints.

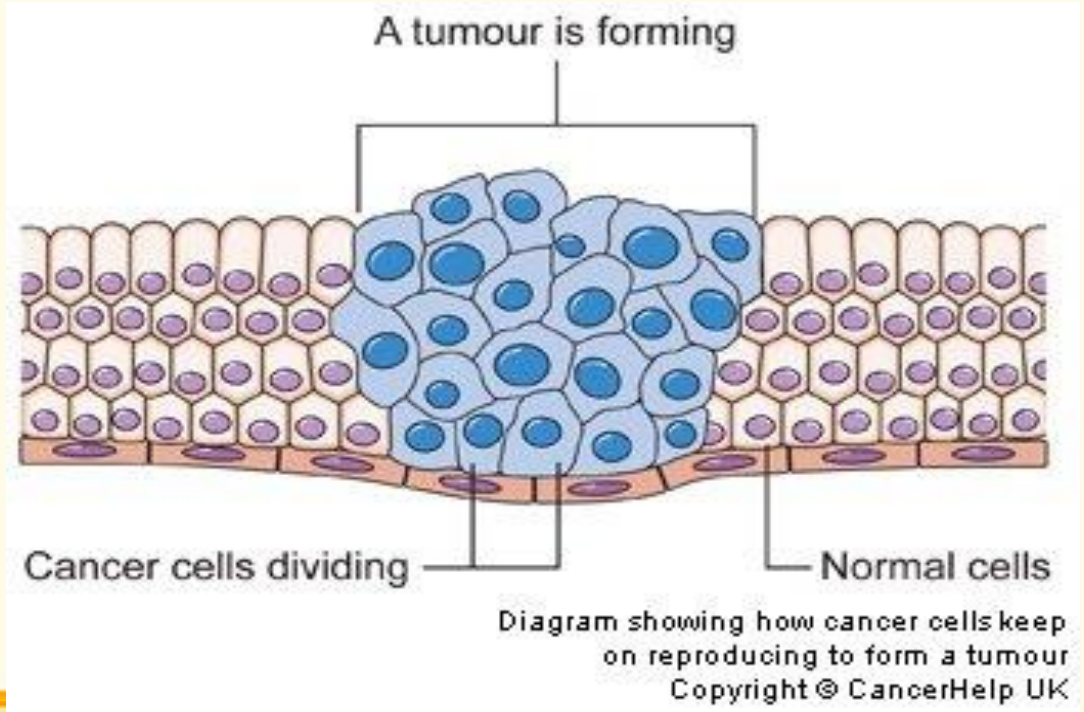
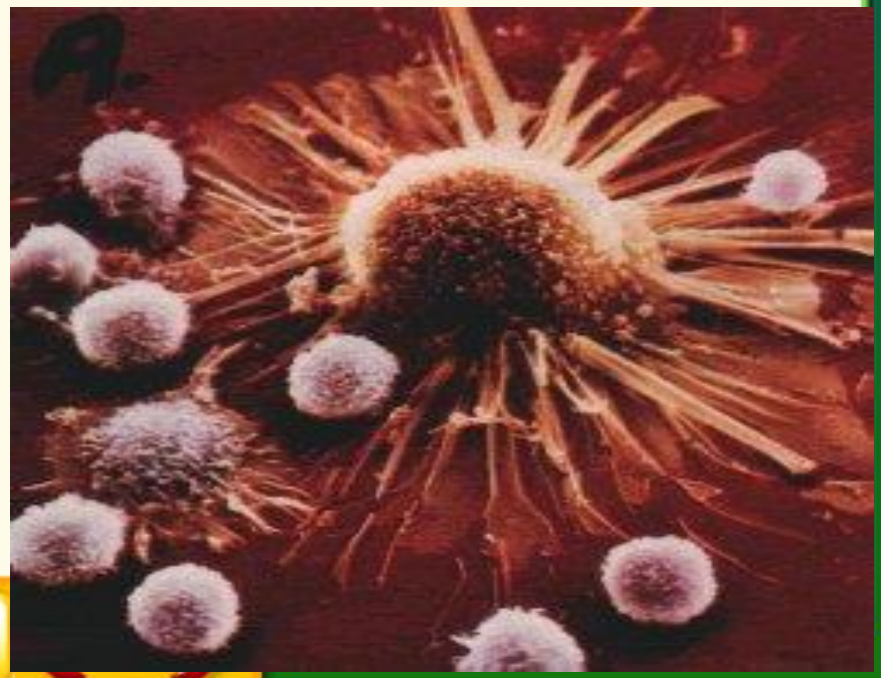
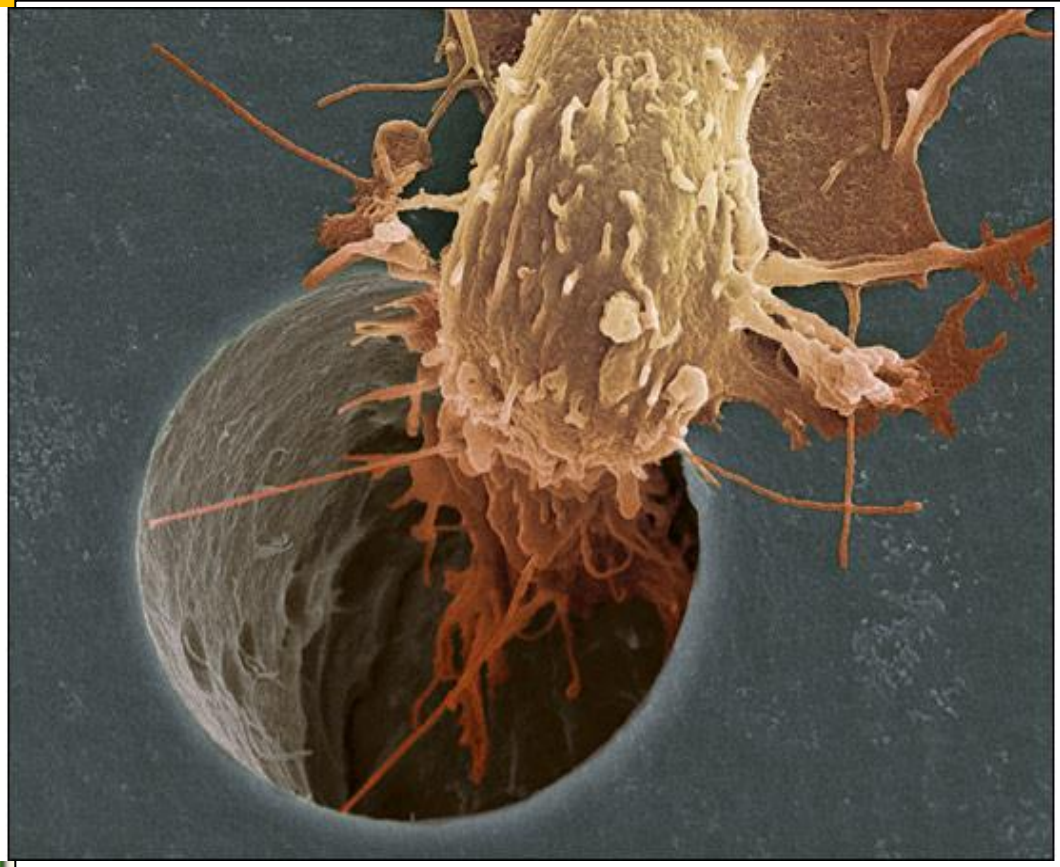


Diagram showing how cancer cells keep on reproducing to form a tumour

Cancer

- Cancer cells spend less time in interphase than normal cells.
  - This means they will grow and divide unrestrained as long as they are supplied with nutrients (tumors develop)






© 1996 Jeffrey L. Melton

What causes cancer?

- Mutations in the segments of DNA which code for the production of proteins which regulate the cell cycle (cyclins).
  - These mutations are often repaired, but if not then cancer develops
- Carcinogens
- Genetics (inherit cancerous genes from parents)

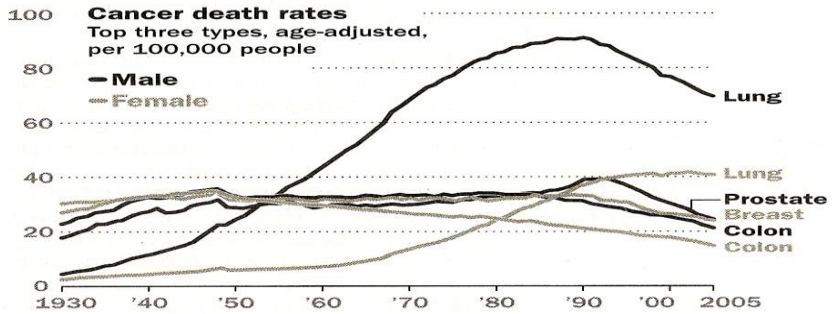
Carcinogens

- Environmental factors which influence the development of cancer:
  - Asbestos
  - Tobacco
  - Radiation (UV and X-ray)
  - Radon
  - Cell phones?

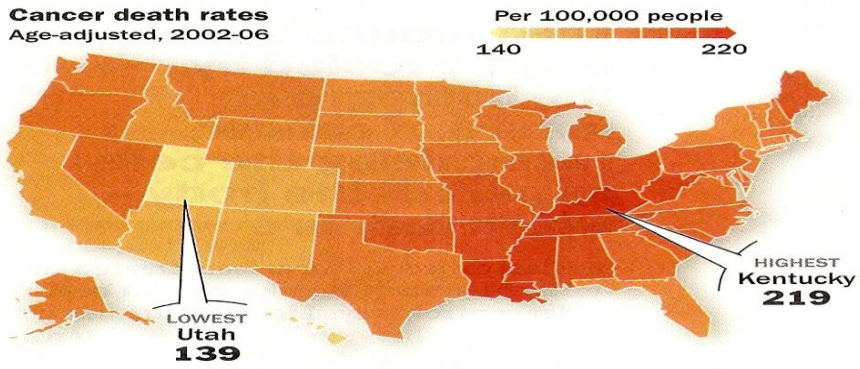
The State of Cancer

A confounding thing about cancer is that it's actually many diseases. Pancreatic cancer has a much poorer prognosis than skin cancer does. Smoking-related lung cancer is preventable in ways brain cancer isn't. All this makes keeping track of cancer stats tricky, but trends emerge from the numerical noise.

LUNG CANCER IS STILL THE LEADING CANCER KILLER OF MEN AND WOMEN ...

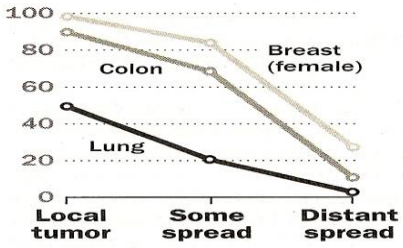


... DEATH RATES ARE SLIGHTLY HIGHER IN THE SOUTH ...



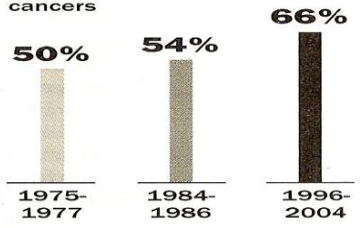
... EARLY DETECTION IS IMPORTANT ...

Five-year survival rate
By stage at diagnosis, 1996-2004



... AND BETTER DIAGNOSTICS HAVE KEPT MORE PEOPLE ALIVE LONGER

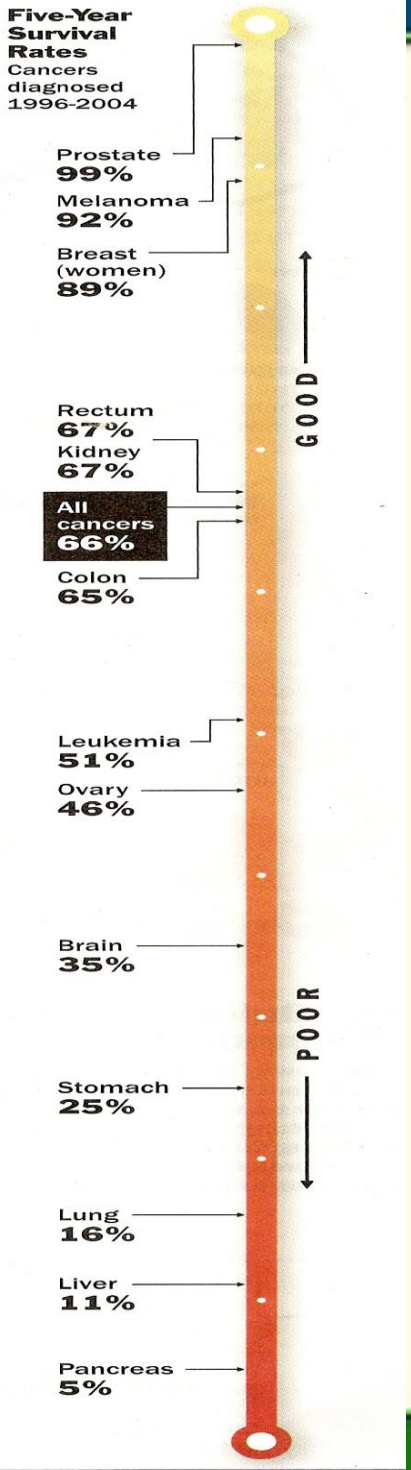
Five-year survival rate
Average for all cancers



Source: American Cancer Society

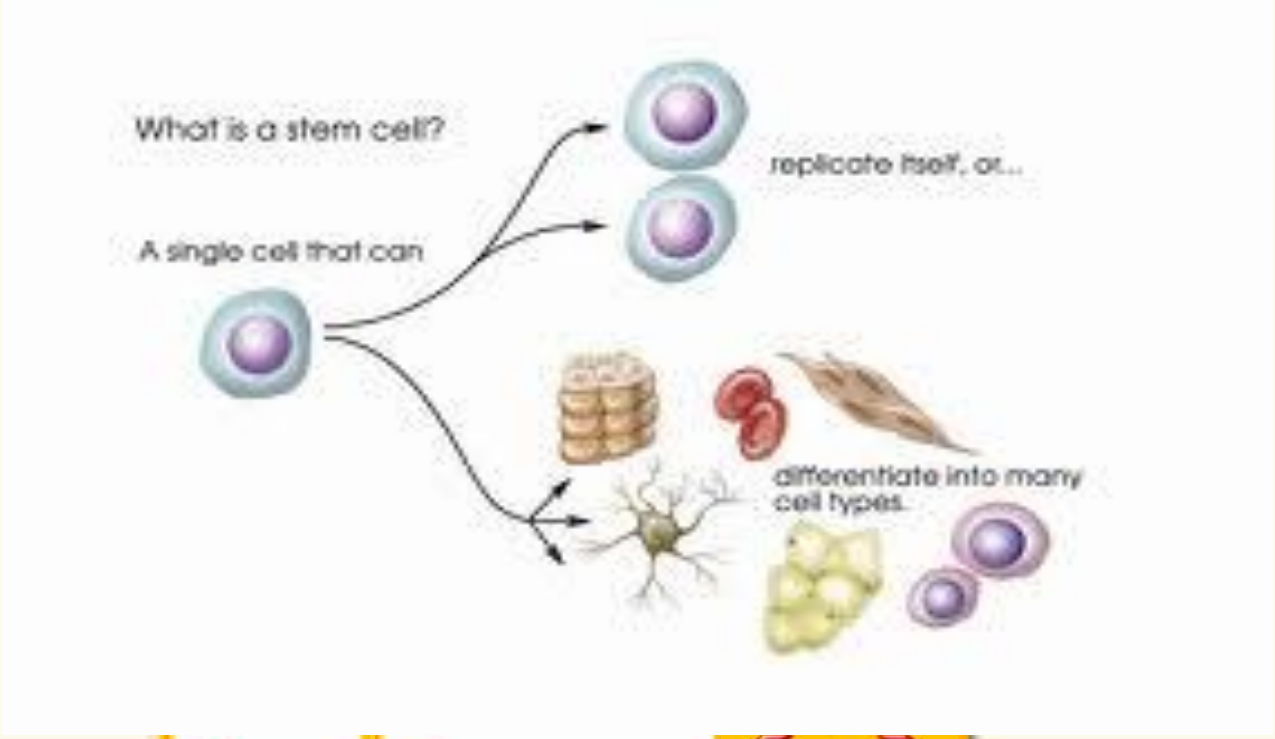
Five-Year Survival Rates

Cancers diagnosed 1996-2004



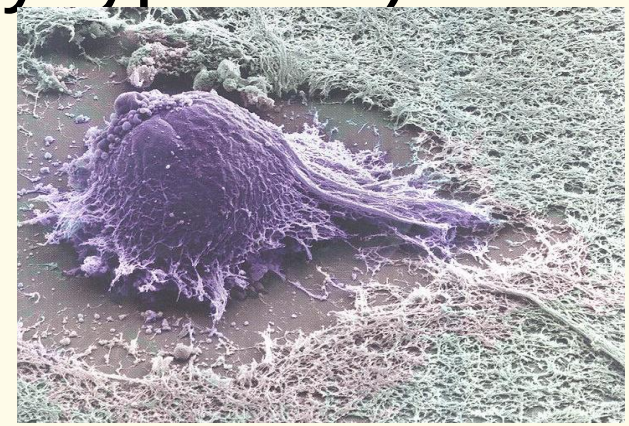
Stem Cells

- Unspecialized cells that can develop into specialized cells under the right conditions.
  - differentiation



Types of stem cells

- 1. Embryonic-found in embryos.
  + Pluripotent (can form into any type cell)
  - Kills the embryo.
- 2. Adult-found in bone marrow
  Multipotent (limited cell use)
  - painful to extract



Read page 258 in your book!

Types of stem cells

3. Induced pluripotent stem cells or iPS.

   Adult somatic cells are changed into pluripotent stem cells through forced gene expression.

   Still requires a lot of research

4. Umbilical cord blood

   Multipotent

   99% of it is thrown away now.

   Expensive to gather and store the cord blood.

Potential uses for stem cells

- Create replacement for faulty tissues and organs
  - Diabetes, kidney disease, etc.
- Spinal cord injuries
  - Christopher Reeve
- Other diseases
  - Multiple sclerosis, Parkinson's disease, Alzheimer's disease

- Ex. Christopher Reeve
- Died Oct. 11, 2004 (9 years after his fall from a horse)
- BBC NEWS | Entertainment | Actor Christopher Reeve dies

From Superman to social crusader

A lifelong community and political activist, Christopher Reeve was devoted to numerous causes. After his 1995 accident, Reeve focused his advocacy to help the disabled.

ORGANIZATION	OBJECTIVE	REEVE'S INVOLVEMENT
Christopher Reeve Paralysis Foundation	Supports research to treat spinal cord injuries and other central nervous system disorders; helps improve the quality of life for people with disabilities	Chairman of the Board
National Organization on Disability	Works to improve quality of life issues for the disabled	Vice Chairman
The Creative Coalition	Social and political advocacy organization of the entertainment industry	Board of Directors; a founder and Co-president
World T.E.A.M. Sports	Organizes and sponsors challenging sporting events for athletes with disabilities	Board of Directors
TechHealth	Assists relationships between patients and their insurance companies	Board of Directors
LIFE (Leaders in Furthering Education)	Helps improve the quality of life for families in need	Board of Directors

Other organizations receiving Reeve's support:
Save the Children, Amnesty International, Natural Resources Defense Council, Environmental Air Force and America's Watch

SOURCE: Christopher Reeve Paralysis Foundation AP

Reeve surpassed movie role using real-life heroics

■ Actor best known as Superman died Sunday at 52.

By the time he died, Christopher Reeve had at last "escaped the cape" — he had become bigger than the Superman character he portrayed on screen.

Reeve championed cutting-edge research into spinal cord injury, offering himself as a guinea pig for new therapies and vowing he would one day walk again. He never did. But his dream is now a plausible one for thousands of others who are paralyzed.

"The biggest hope is in biological research to allow the spinal cord to heal itself and even regenerate. That's just over the horizon but closer than ever before. Most people feel within the next 10 to 15 years, somewhere within our lifetimes," said Dr. Jack Ziegler, president of the American Spinal Injury Association.

Some even thought it would come in time for Reeve.

"I thought it was going to happen," said Dr. Doug Kerr, a Johns Hopkins University neurologist who works with stem cells — controversial research that Reeve advocated with superhuman strength even as he wheezed through a respirator from his wheelchair.

"It was Star Wars science fiction, this concept of rewiring the nervous

See REEVE, Page 8A

Dana Reeve dies of lung cancer

Death of resilient Reeve comes as shock

■ Widow of actor Christopher Reeve dies at 44 of lung cancer.

THE ASSOCIATED PRESS

NEW YORK — "How could this happen?"

For many, that was the inevitable question Tuesday in response to the news that Dana Reeve, the sunny and vibrant widow of Christopher Reeve, had died of lung cancer at the stunningly young age of 44.

It's not that people didn't know the statistics — most people know a diagnosis of lung cancer is devastating. But the image Reeve projected publicly — and lived privately, according to those who knew her — was so upbeat and resilient that people simply couldn't fathom she was gone, only months after being diagnosed.

Along with the shock of her death came deep sadness for her 13-year-old son, Will, who now has lost both parents in less than 18 months.

"Once you become a parent," said Susan Solovay, a mother of two in New York City, "the scariest thing you can imagine — outside of the obvious health issues for your child, or kidnapping — is leaving your child too soon. You think, who will love and take care of them the way I have?"

Reeve

Elaine Friedman, also of New York City, learned of Reeve's death on the morning news. "I felt so terribly sad," she said. "It's not just that she was so young. It's that she'd had so much tragedy already, with her husband. And then she gets diagnosed with lung cancer, and she wasn't even a smoker.

"In a way," Friedman said, "it seems to some degree that she died of a broken heart. It made me think that maybe she went to join him."

A similar shock wave greeted the news in August that Reeve, who won huge admiration with her tireless support of her husband during his nine years as a quadriplegic, had been diagnosed. Many expressed surprise that a woman in her 40s who had never smoked could be struck by the disease.

But doctors say one in five women diagnosed with lung cancer never lit a cigarette. Lung cancer under age 45 is rare — only 3 percent of lung cancers occur in that age category, regardless of smoking status — and experts say genes are the main explanation.

Reeve was upbeat about her prospects. "I hope before too long to be sharing news of my good health and recovery," she said in the announcement of her illness. A private person, she hadn't wanted to disclose the news even then, but she knew a tabloid was about to.

Then, in November, Reeve appeared at a gala fundraiser for the Christopher Reeve Foundation, which she chaired. If the crowd hadn't known she was ill, they wouldn't have been able to tell. She looked healthy and energetic in her multihued gow She wore an attractive, lon haired wig — her one visible co cession to chemotherapy.

Onstage, she smiled at t crowd and told them her tum was "shrinking and shrinking a shrinking."

"I'm beating the odds a defying every statistic the do tors can throw at me," she said, happy applause. Offstage, s cheerfully greeted her high-po ered guests: Meryl Streep, Gle Close, Robin Williams, Pa Newman, Diane Sawyer and Mi Nichols, Michael Douglas a Catherine Zeta-Jones.

Friends say Reeve tried to ke her life as normal as possible f her young son, taking trips a picking him up at school wh she could.