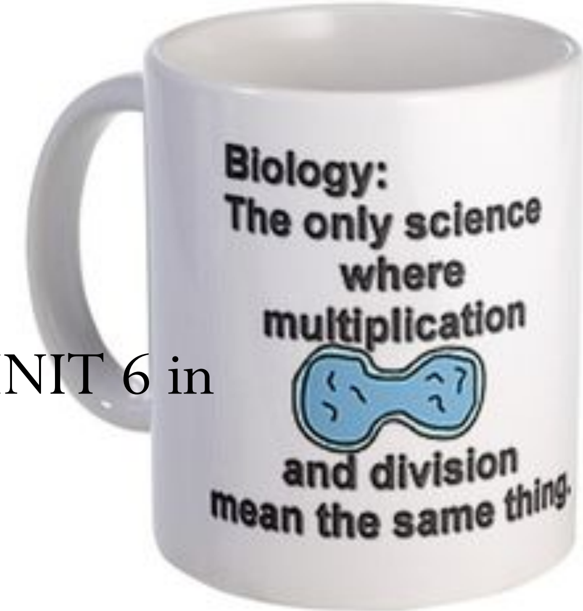
Warm-up 1/5



If you have not already done so, set up UNIT 6 in your composition notebook.

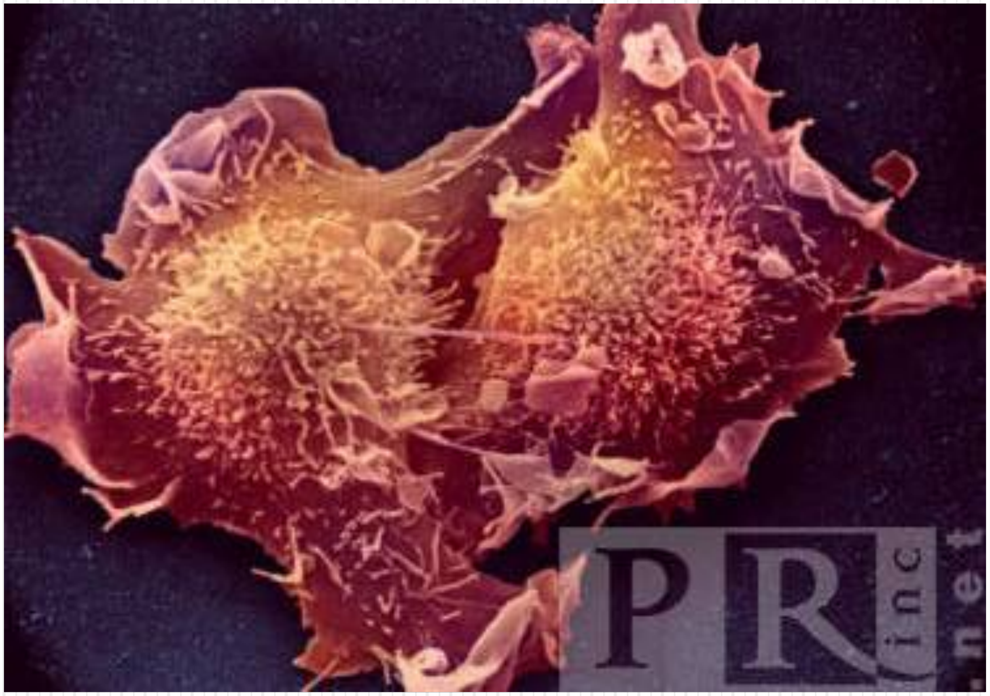
Title: All cells come from other cells

or Cell Division

1. Make a list of all the words that come to mind when you think of cell's dividing.

***This is a class competition. Longest list wins so don't share with later classes.

Unit 6 - All Cells Come From Cells



Turn in your Lab Discussion Tonight!

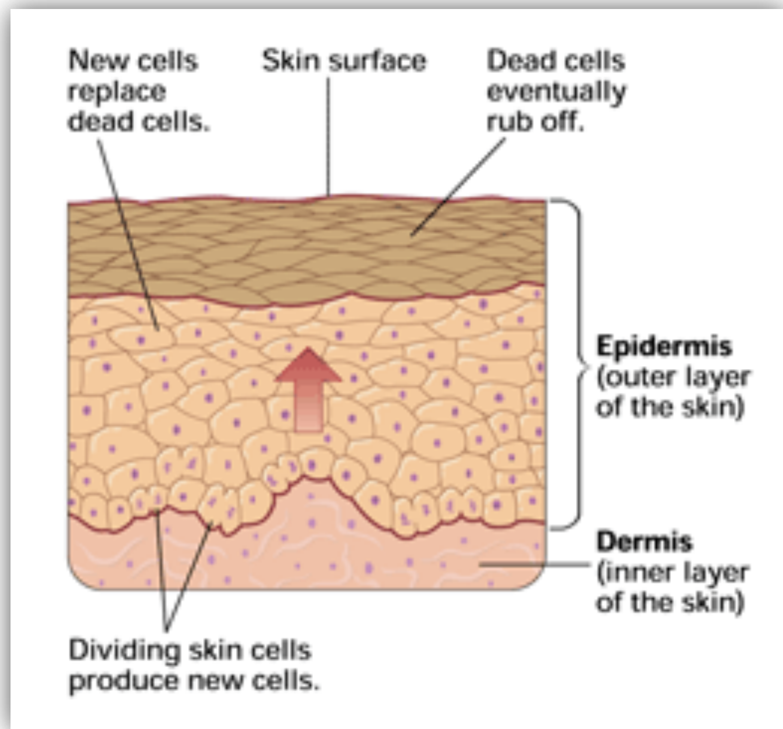
How a Student Turns In an Assignment

Classroom

- The division of cells into more cells enables living things to repair damage, to grow, and to produce offspring.

Repair and Growth

- **<u>Important roles of cell reproduction</u>**
  - <u>1. the replacement of lost or damaged cells</u> (repair)
  - <u>2. growth</u>—simply increasing in size



Cell reproduction enables your body to produce new skin cells that replace dead cells at your skin's surface.

Reproduction

- While the production of new cells can result in growth and repair *within* organisms, cell division also has an essential role in the reproduction of *entire* organisms
  - 2 methods of Reproduction
    - Asexual reproduction
    - Sexual reproduction

Asexual Reproduction

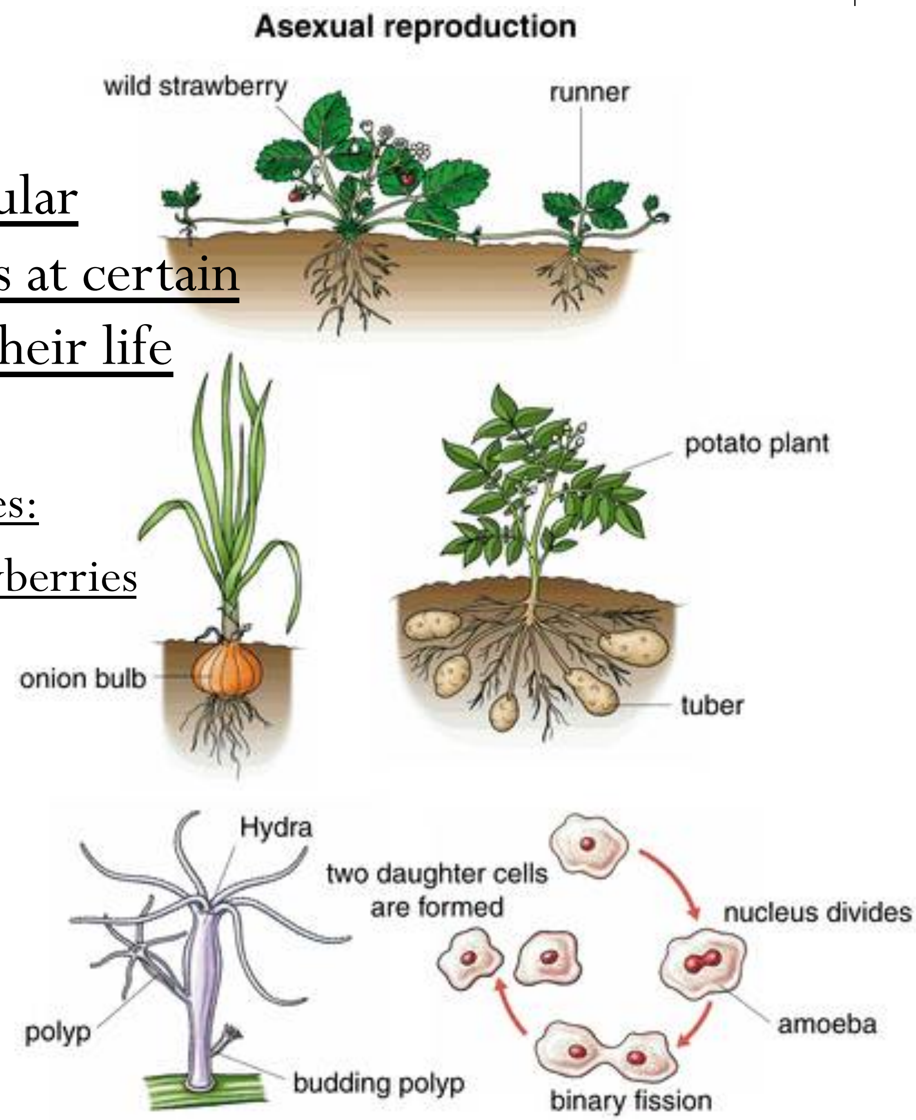
- Asexual reproduction : organisms reproduce by simple cell division, in which a single cell or group of cells duplicates its genetic material and then splits into two new genetically identical cells.
  - offspring inherit all their genetic material from just one parent.
  - offspring are genetically identical to one another and to their parent.

Sexual vs Asexual Reproduction

Asexual Reproduction Examples:

- Binary Fission – a single cell divides into two equal parts.
  - Examples:
    - *Paramecium*
    - E.coli bacteria

- Multicellular organisms at certain times in their life cycle.
  - Examples:
    - Strawberries
  -

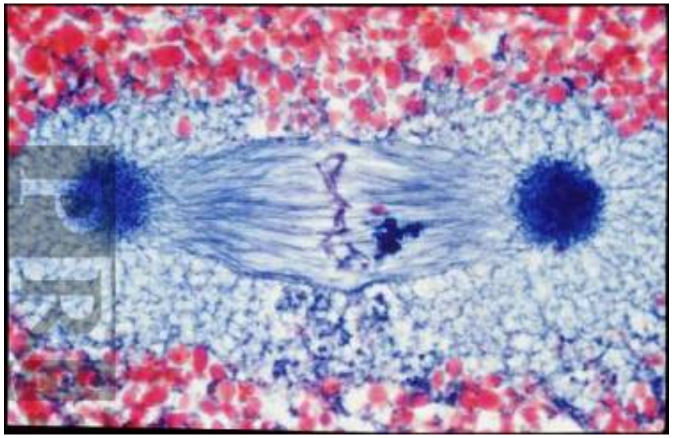


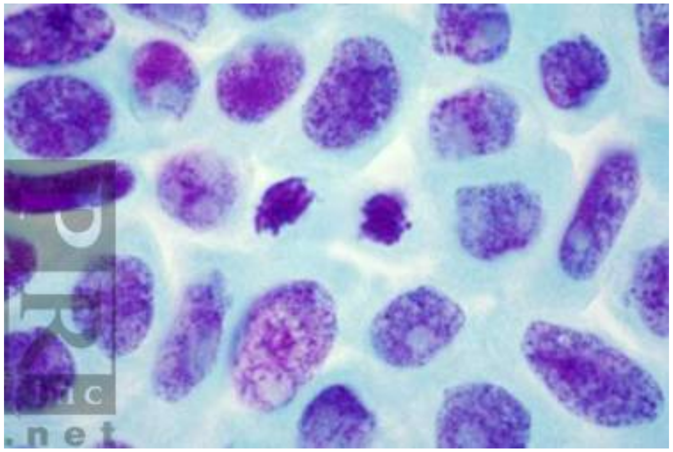
Sexual Reproduction

- Sexual reproduction : two parents are involved in the production of offspring; genetic material from each parent combines, producing offspring that differ genetically from both parents.
  - Examples: involves the union of sex cells, such as an egg and a sperm.

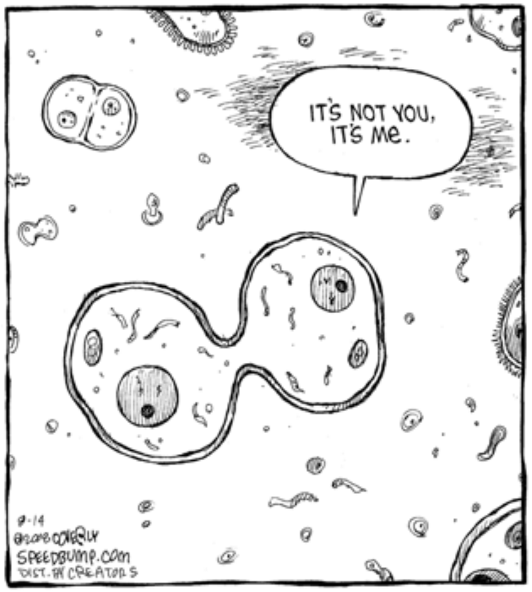
Reproduction and Growth

- Whether reproduction is sexual or asexual, all multicellular organisms depend on cell division for growth.





Warm-up 1/6/17



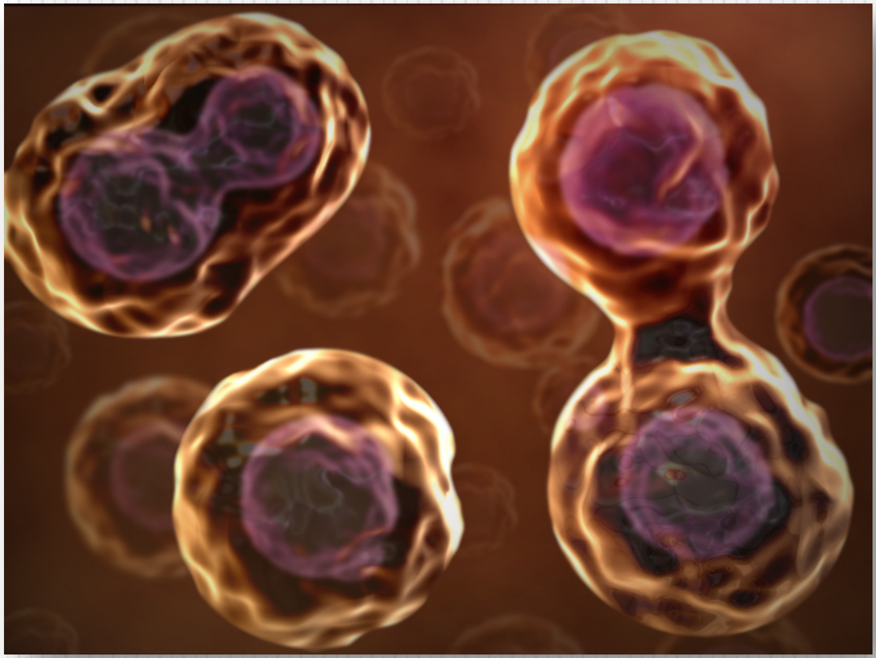
- 2. Identify the type of reproduction that
  - Results in genetically identical offspring
  - Results in genetically different offspring
  - Has 1 parent
  - Has 2 parents

- 3. Why is it important for cells to reproduce? List at least two reasons.

Let's make a foldable!

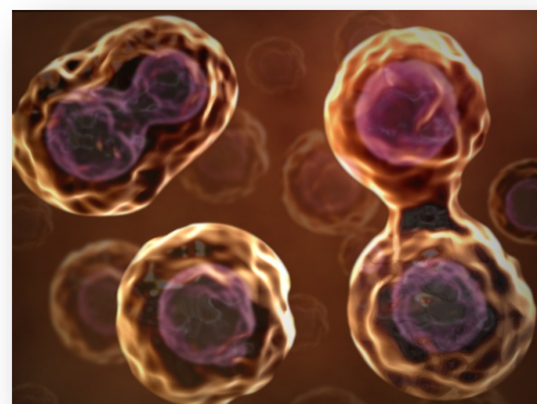
- Follow my close instructions on how to make The Cell Cycle Foldable.
- Page Headings
  - 1. The Cell Cycle
    - Put your name at the bottom
  - 2. Interphase
  - 3. The Mitotic Phase – Prophase
  - 4. The Mitotic Phase – Metaphase
  - 5. The Mitotic Phase – Anaphase
  - 6. The Mitotic Phase – Telophase
  - 7. Cytokinesis
  - 8. Important Vocabulary

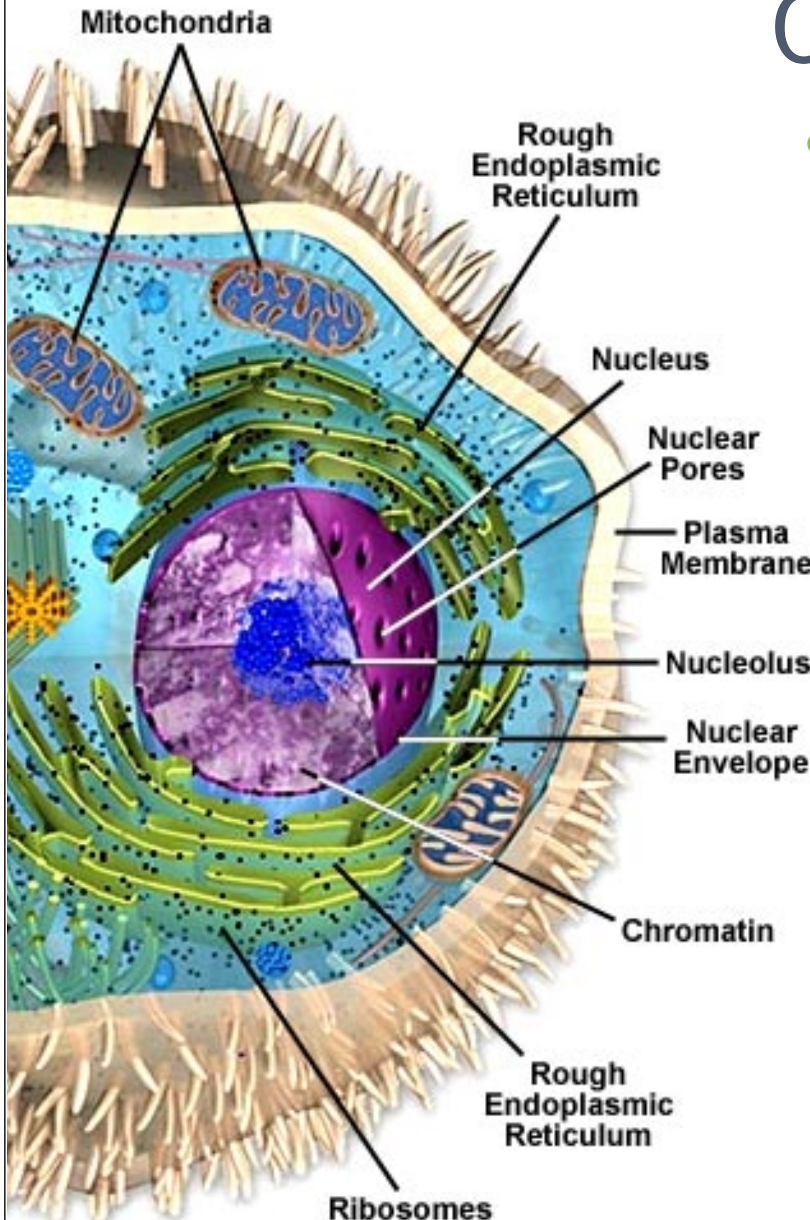
The Cell Cycle Multiplies Cells



Think about it…

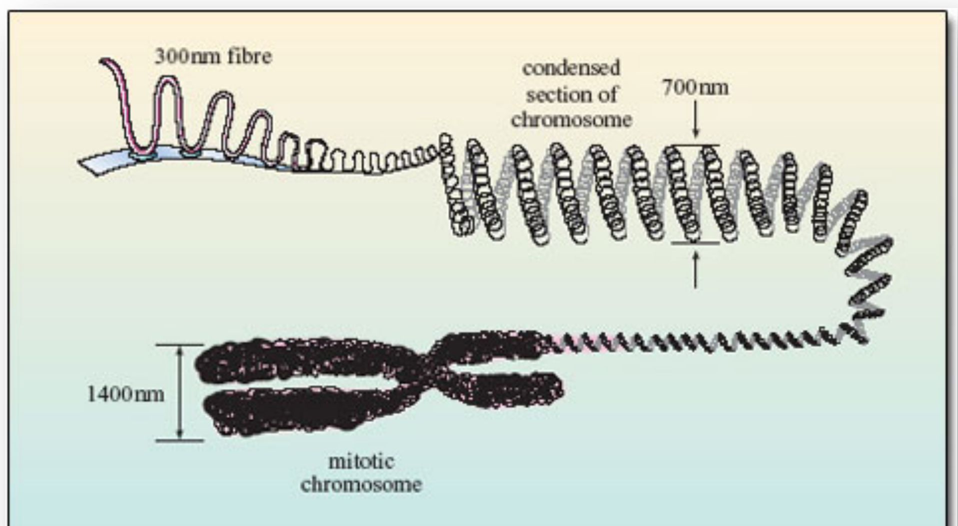
- At this moment, millions of cells in your body are dividing, each forming two new cells.
- However, the vast majority of your cells (about 200 trillion) aren't dividing but are going about other cell activities—
  - building proteins
  - breaking down food
  - consuming energy
  - and so on
    - How does cell division fit into the life of a cell?





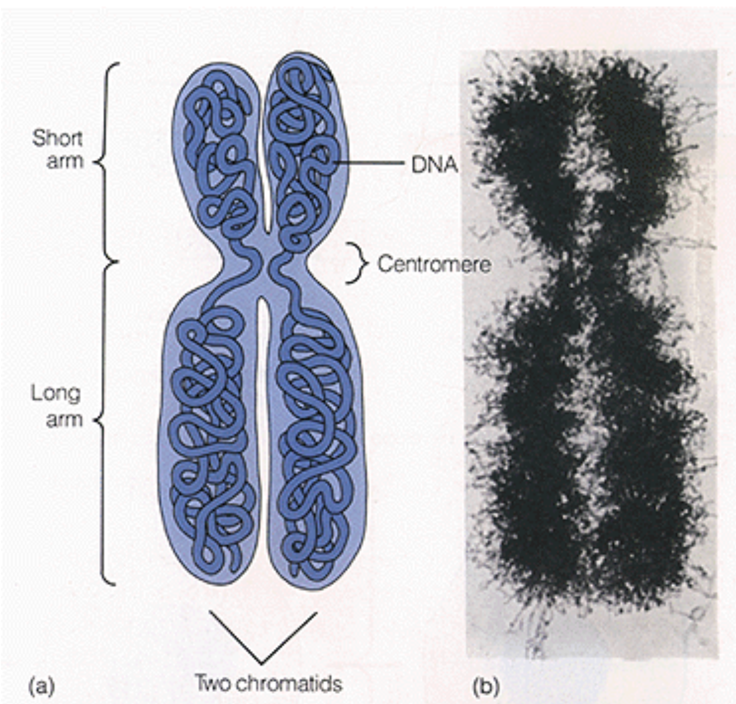
Chromatin

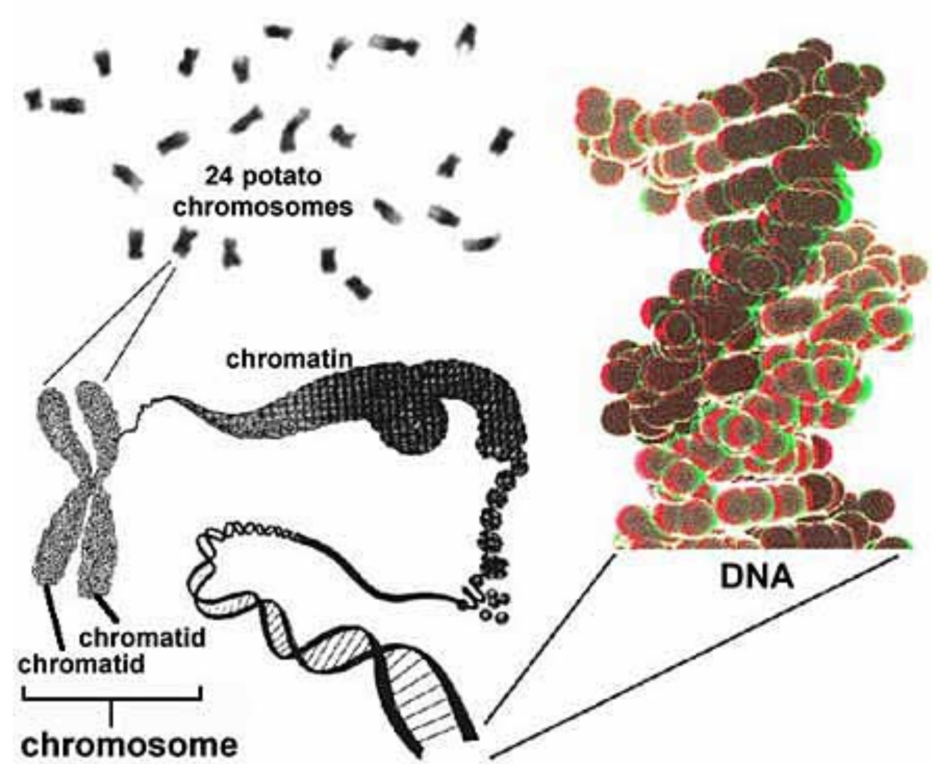
- Genetic material is located in the cell nucleus, and exists as a mass of very long fibers that are too thin to be seen under a light microscope-
  - This is chromatin, long fibers of DNA and protein molecules combined.



Chromosomes

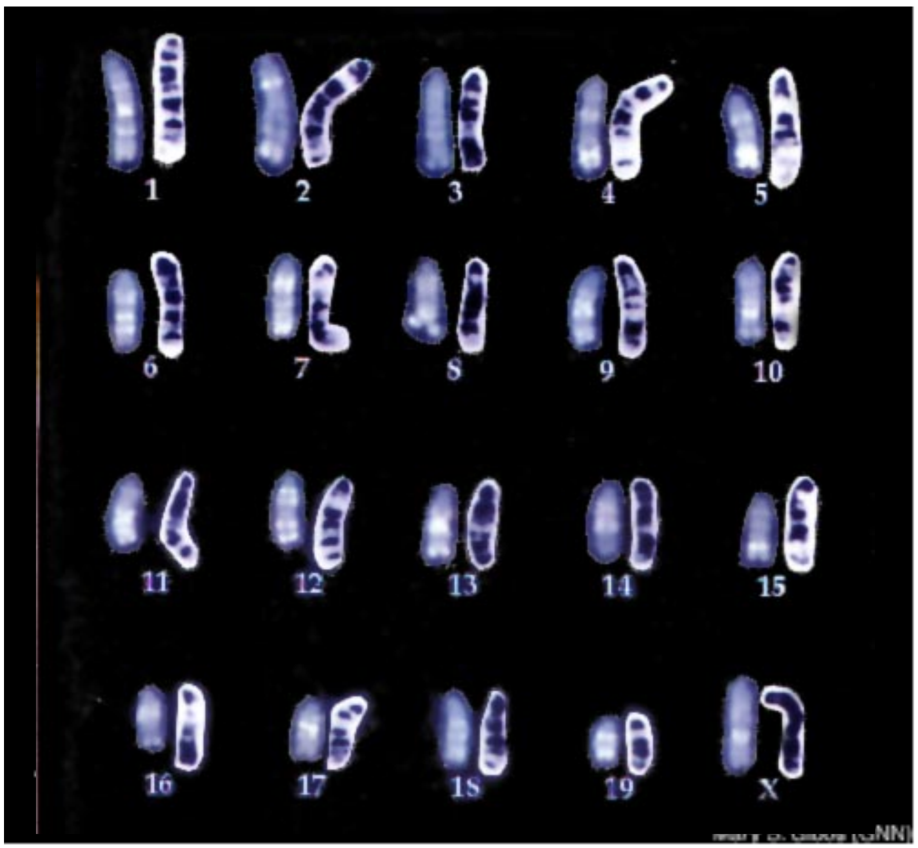
- As a cell prepares to divide, its chromatin fibers condense, becoming visible as the compact structures called chromosomes.
- Each chromosome may contain many hundreds of genes





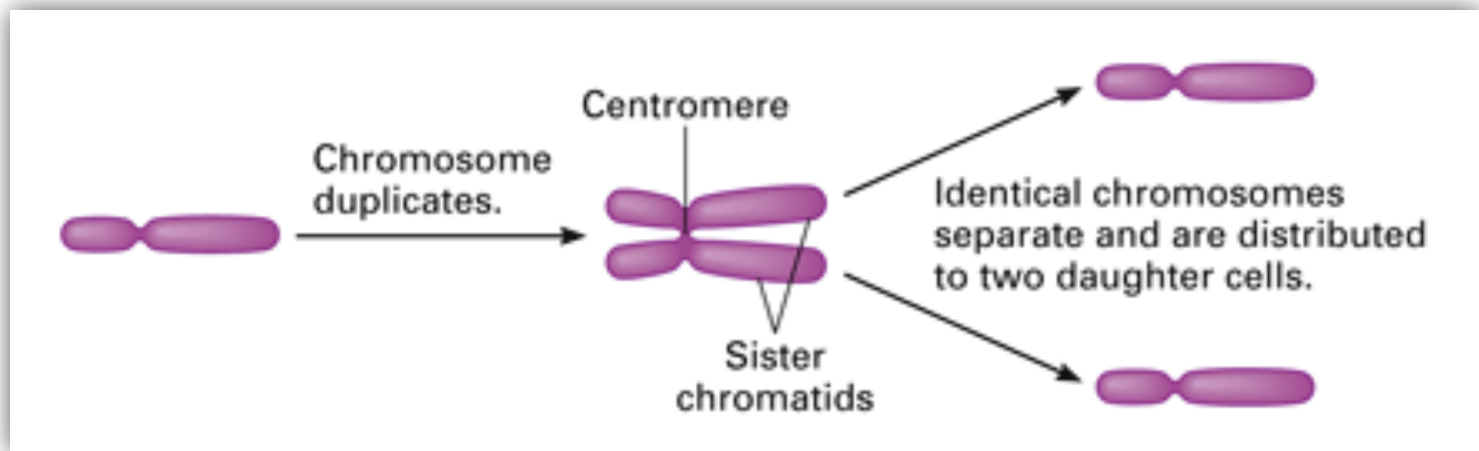
Chromosomes

- The number of chromosomes in a eukaryotic cell depends on the species.
  - For example, human body cells generally each have 46 chromosomes, gorilla 48, mouse 40, fruit fly 12.



Chromosomes and Cell Division

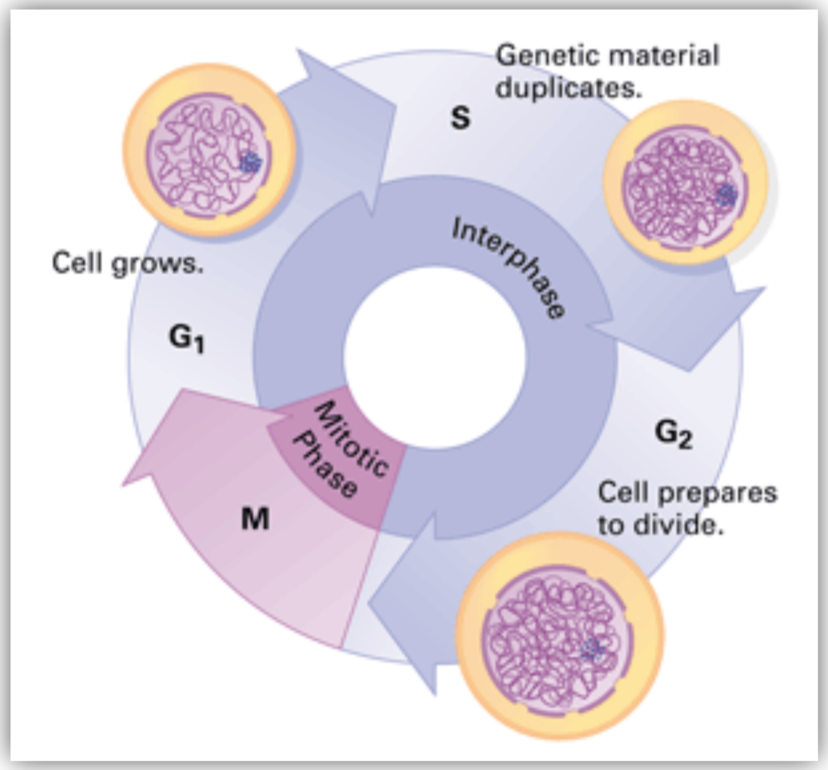
- Before cell division begins, a cell duplicates all of its chromosomes.
- Each chromosome now consists of two identical joined copies called sister chromatids.
- The region where the two chromatids are joined tightly together is called the centromere.



The Cell Cycle

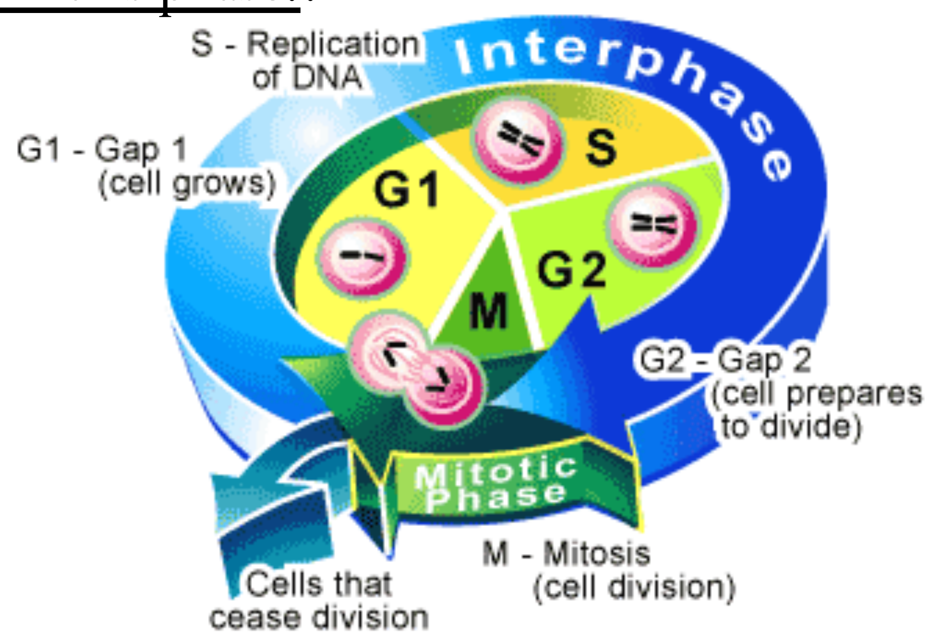
- Eukaryotic cells that divide undergo an orderly sequence of events known as the cell cycle.
- The cell cycle extends from the "birth" of a cell to the time the cell reproduces

- 2 Main phases:
  - Interphase
  - Mitotic phase



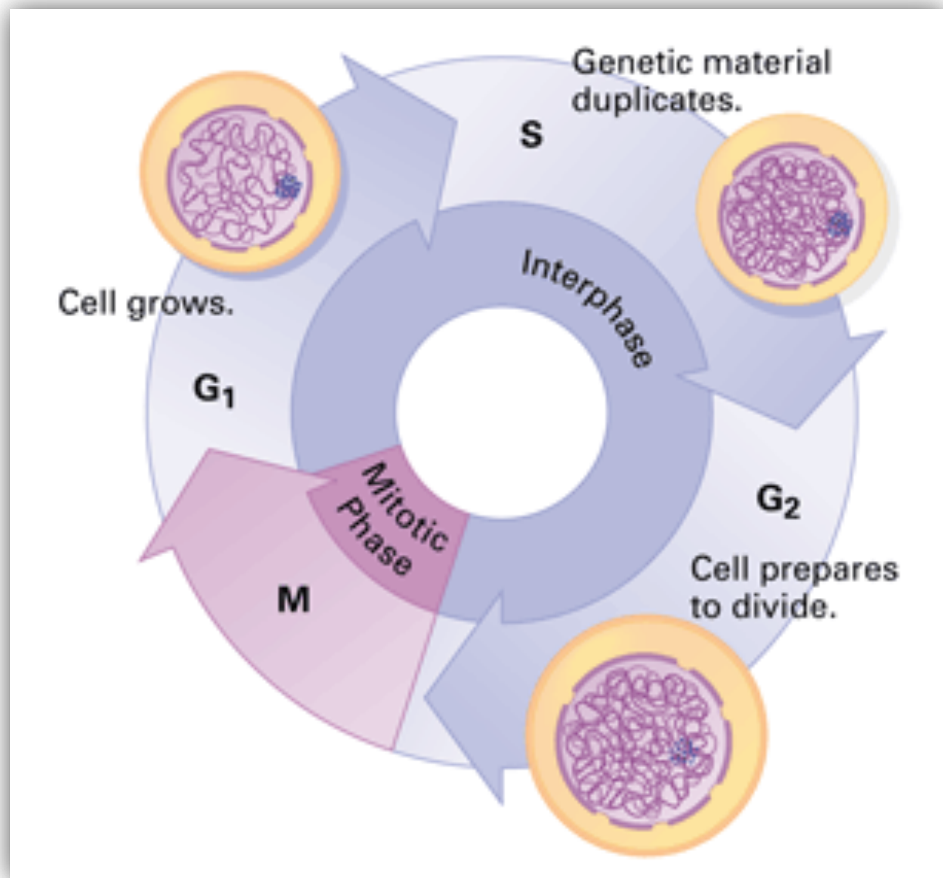
Interphase

- 1. Interphase is the stage during which a cell carries out its metabolic processes and performs its functions.
  - Cell is just living its life
  - 90 percent of cell life spent in this phase..
  - 3 phases:
    - 1. G1-
    - 2. S -
    - 3. G2 -



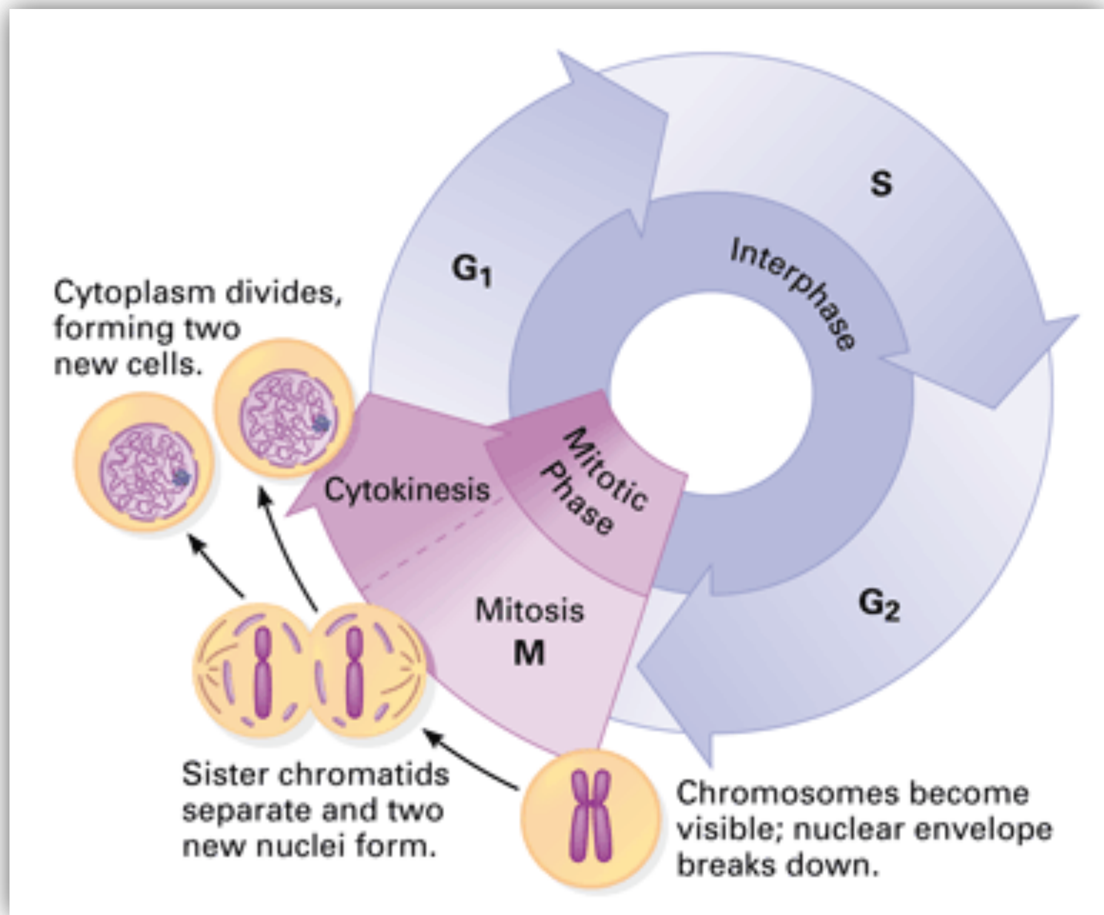
Interphase

- 1. G_1 Phase: cell is growing
  - *G* stands for *gap*
- 2. S phase: key event, duplication of the DNA in the cell's chromosomes.
  - *S* stands for DNA *synthesis*
- 3. G_2 phase: each duplicated chromosome remains loosely packed as chromatin fibers and the cell grows. The cell is now ready to begin mitosis.



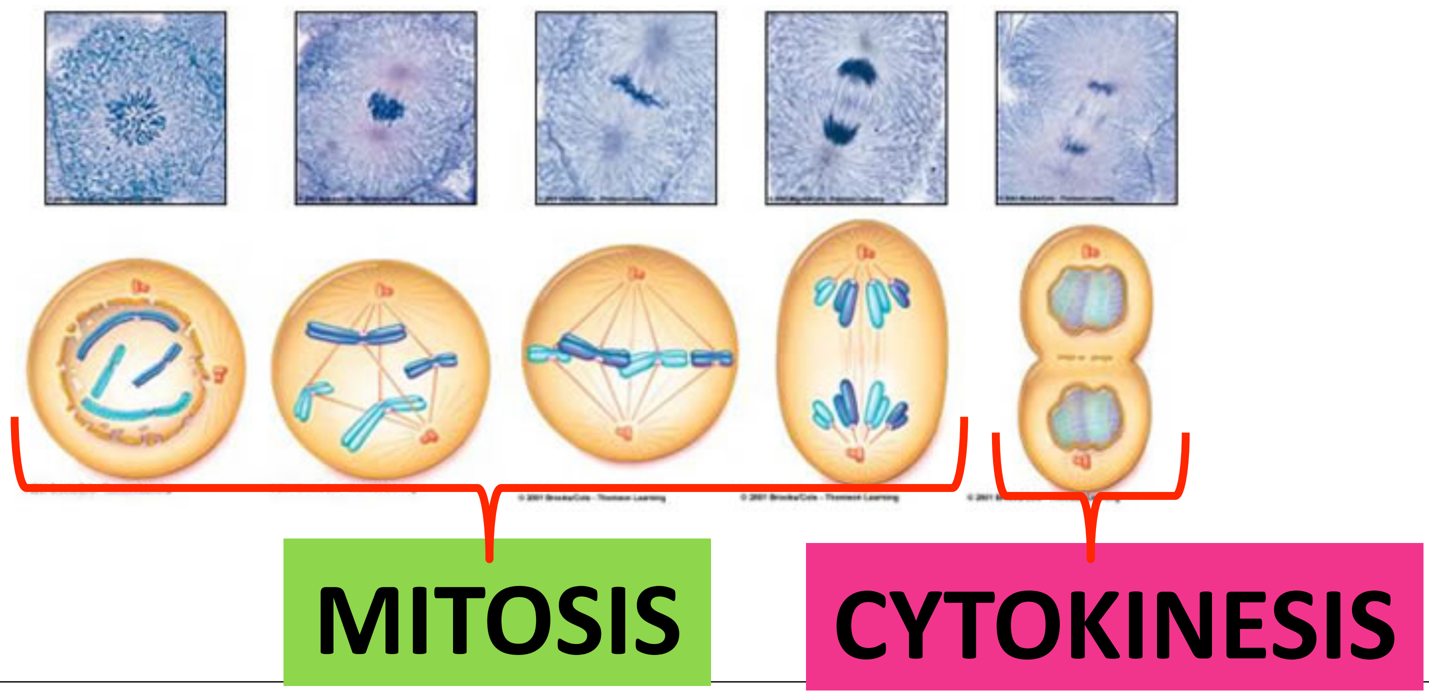
Mitotic Phase

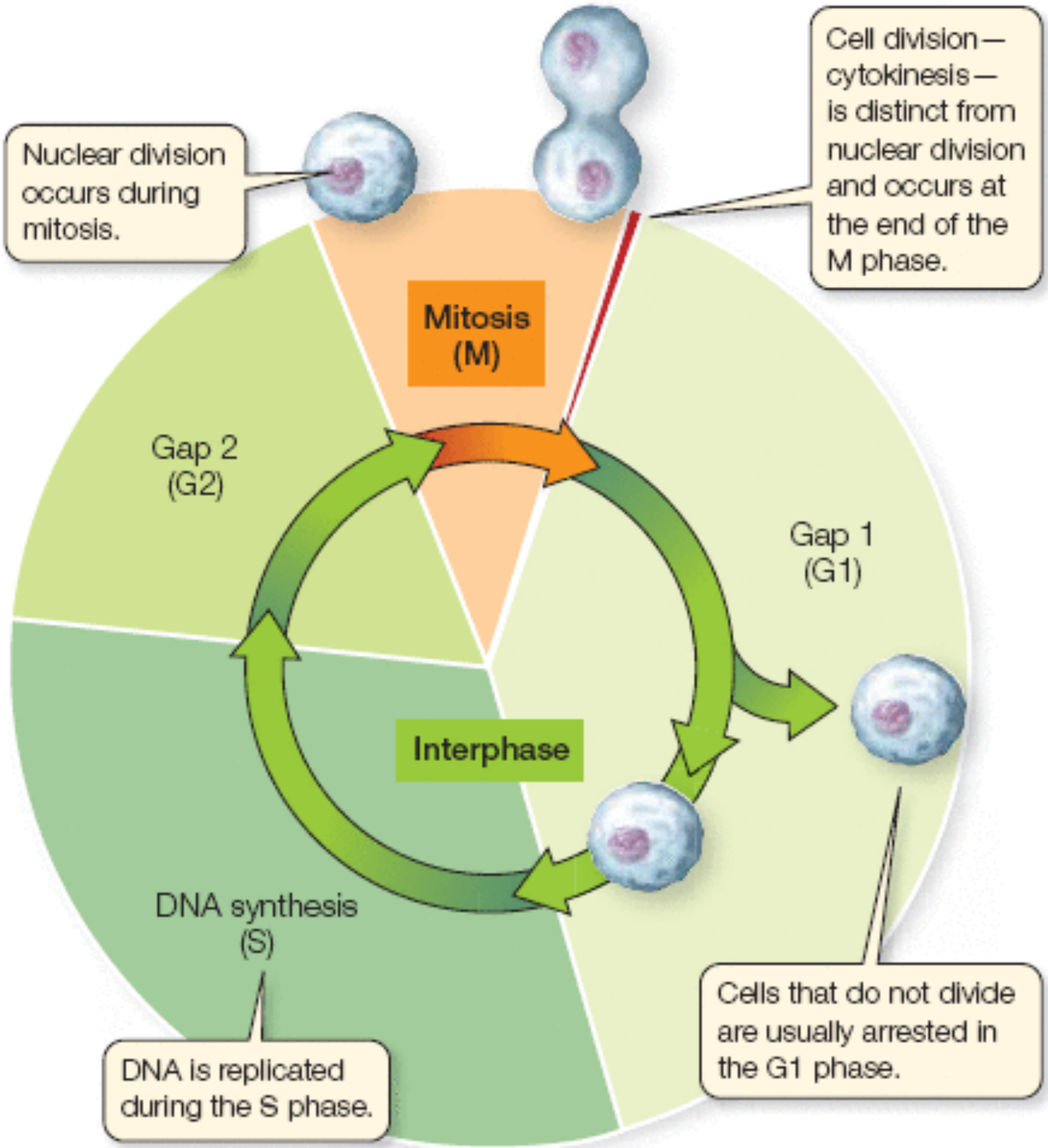
- Mitotic phase: (M phase) <u>the stage of the cell cycle when the cell is **actually dividing**</u>
  - includes two processes
    - Mitosis
    - Cytokinesis

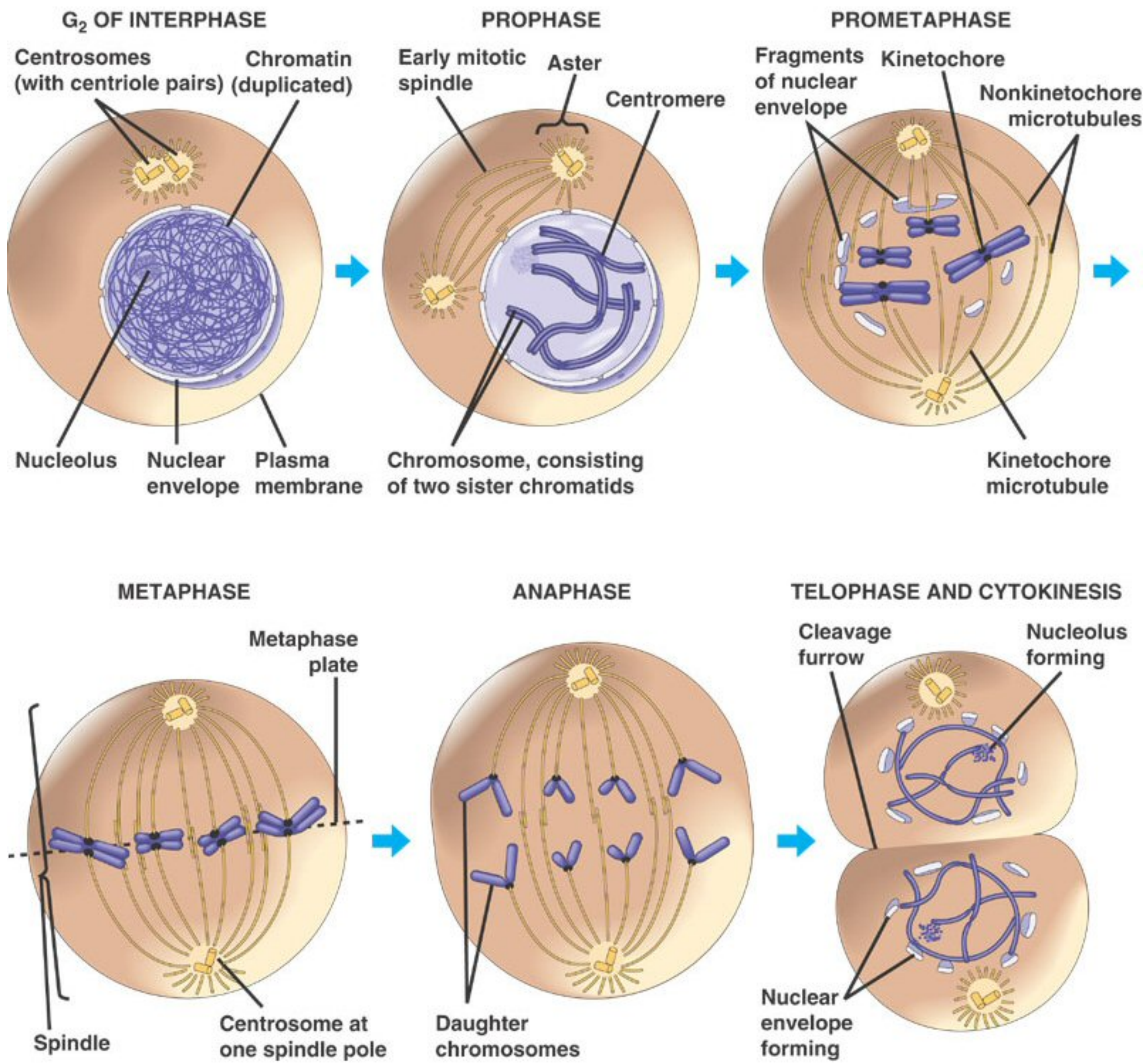


Mitotic Phase

- Mitosis
  - nucleus and the duplicated chromosomes divide and are evenly distributed, forming two "*daughter*" *nuclei*.
- Cytokinesis
  - process by which the cytoplasm is divided in two.
  - usually begins before mitosis is completed.




Nuclear division occurs during mitosis.
Cell division—cytokinesis—is distinct from nuclear division and occurs at the end of the M phase.
Mitosis (M)
Gap 2 (G2)
Gap 1 (G1)
Interphase
DNA synthesis (S)
DNA is replicated during the S phase.
Cells that do not divide are usually arrested in the G1 phase.

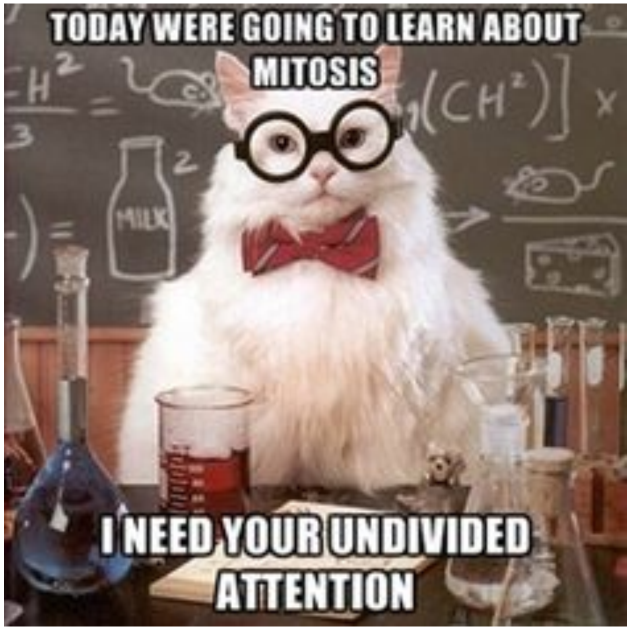


G_2 OF INTERPHASE
Centrosomes (with centriole pairs)
Chromatin (duplicated)
Nucleolus
Nuclear envelope
Plasma membrane
PROPHASE
Early mitotic spindle
Aster
Centromere
Chromosome, consisting of two sister chromatids
PROMETAPHASE
Fragments of nuclear envelope
Kinetochore
Nonkinetochore microtubules
Kinetochore microtubule
METAPHASE
Metaphase plate
Spindle
Centrosome at one spindle pole
ANAPHASE
Daughter chromosomes
TELOPHASE AND CYTOKINESIS
Cleavage furrow
Nucleolus forming
Nuclear envelope forming

Trivia: How often *do* cells divide?

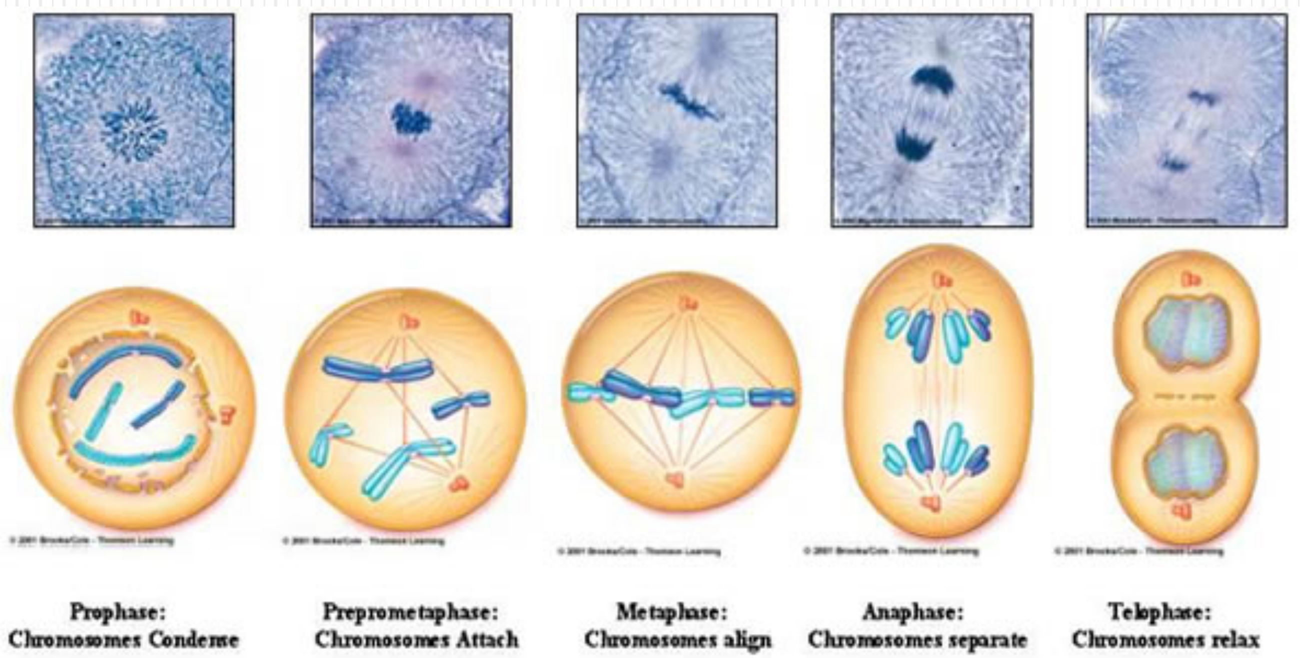
- How often a cell divides depends on the type of cell.
  - Some cells divide once a day.
  - Some divide more often; others, less often.
  - Some highly specialized cells, such as mature muscle cells, do not divide at all.

Warm-up 1/9

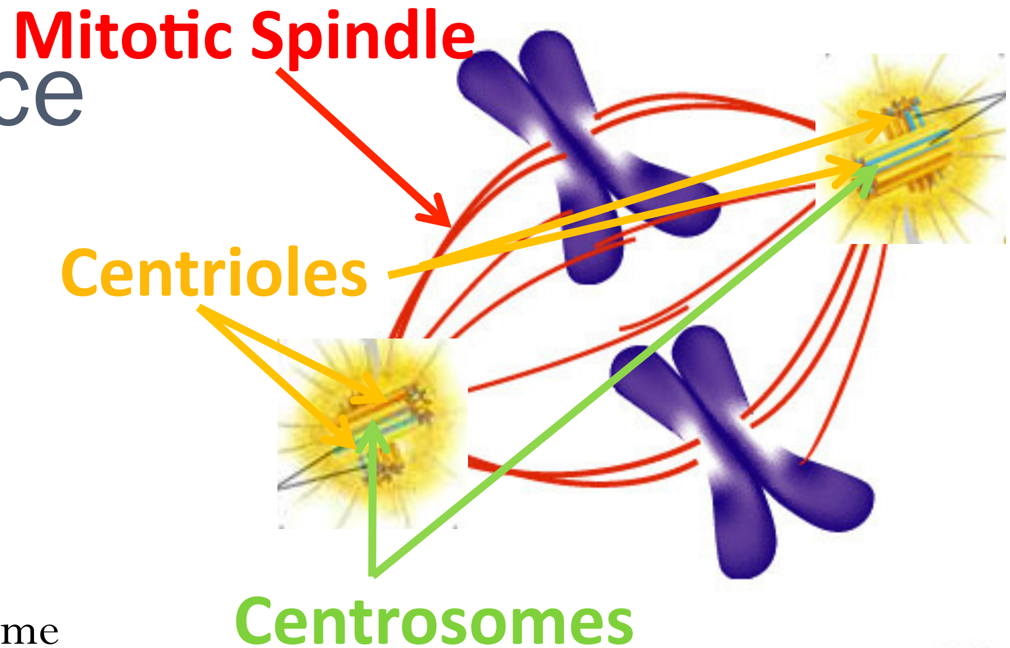


- 4. A cell spends most of its time in which stage of the cell cycle?
- 5. When in the cell cycle is DNA synthesized (copied)?
- 6. What cell structure pulls chromosomes through the stages of cell division?
  - Hint: It is shaped like a football.

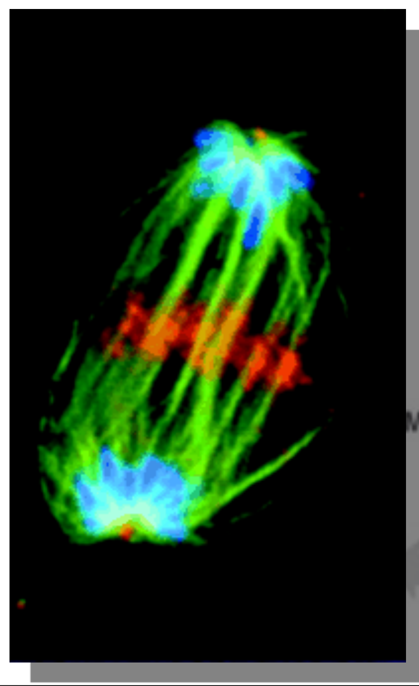
Cells divide during the Mitotic Phase

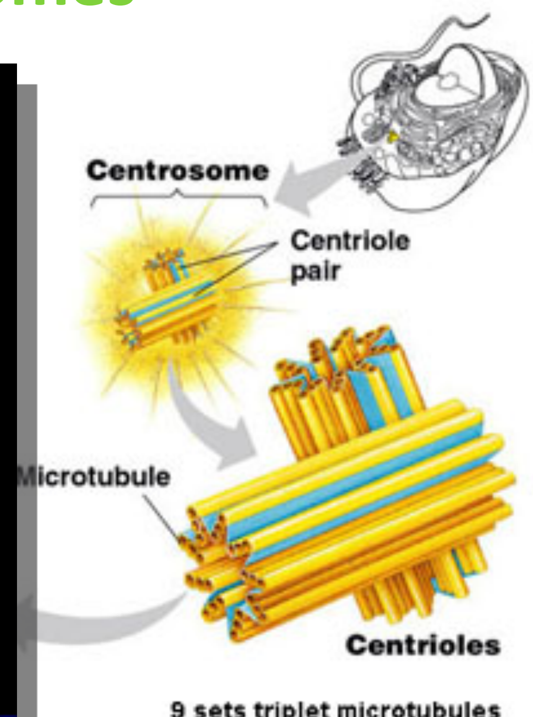


The Mitosis Dance



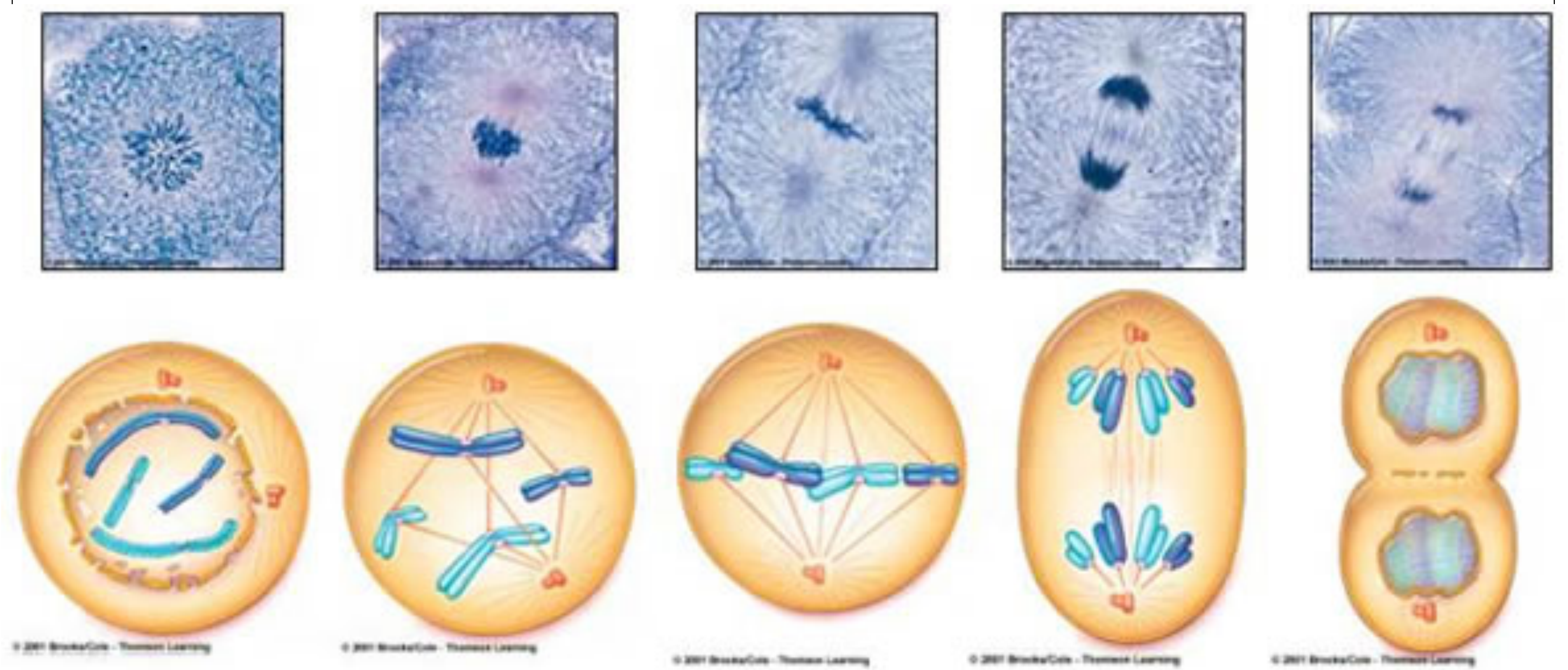
- Mitotic Spindle
  - Football-shaped framework of microtubules that guide chromosome movement during mitosis
- Centrosomes
  - spindle microtubules grow from 2 centrosomes, regions of cytoplasmic material that, in animal cells, contain structures called centrioles.
- Centrioles
  - The role of centrioles in cell division is a mystery. Destroying them has no effect





The Mitosis Dance

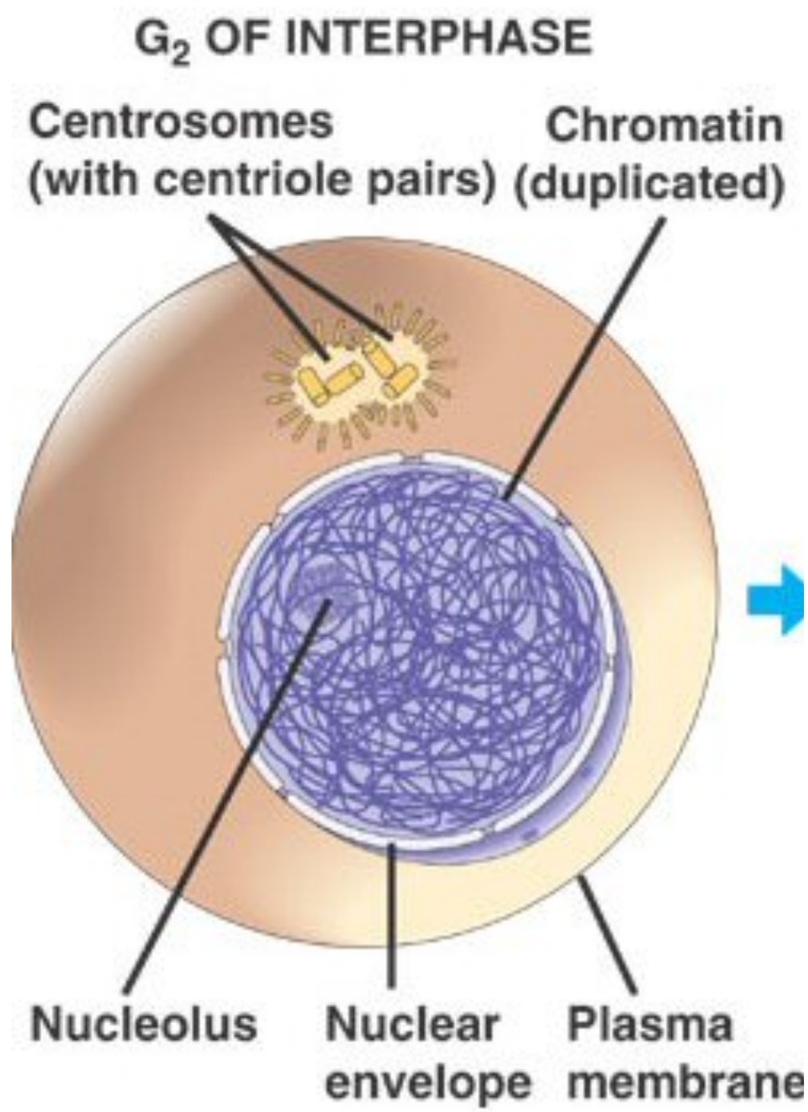
- Mitosis is a CONTINUAL process.
  - the mitotic phase has been divided into *4 main stages* to aid study:



1.Prophase | Preprometaphase: Chromosomes Attach | 2.Metaphase | 3.Anaphase | 4.Telophase

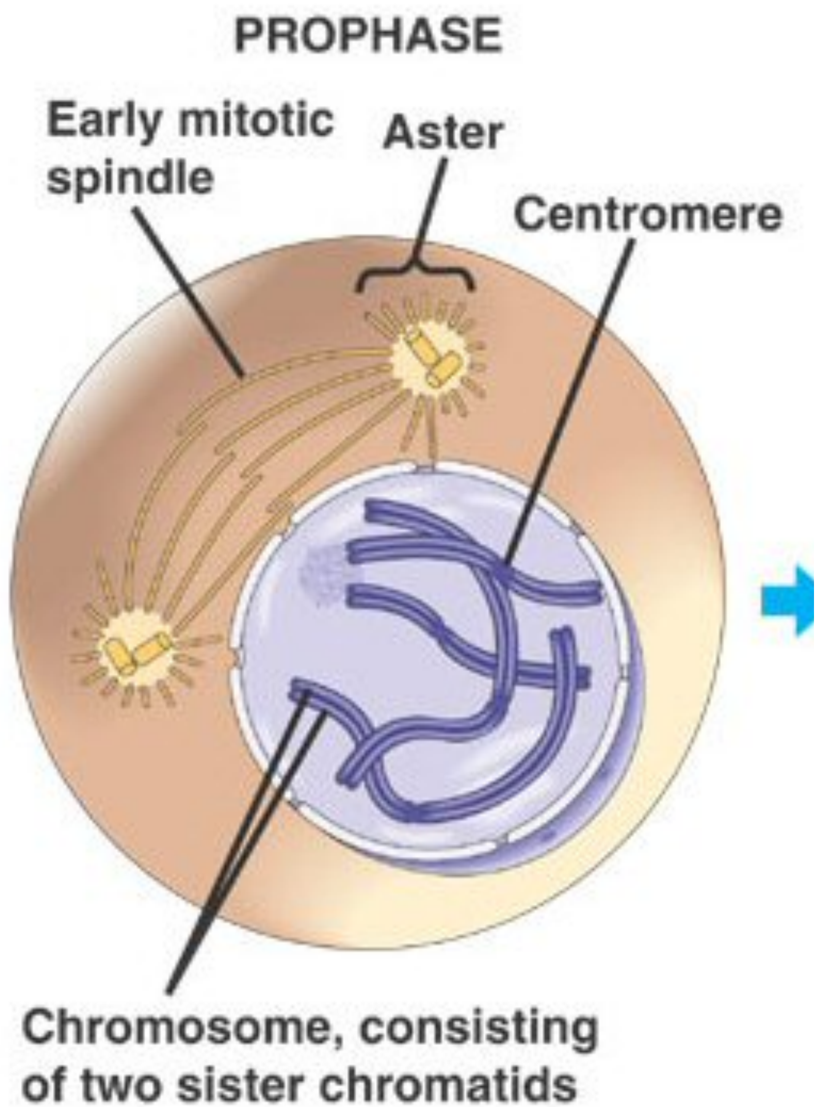
Interphase

- The cell is busy making new molecules and organelles.
- Cell has duplicated its DNA.
- Can't see chromosomes yet -still loosely packed chromatin fibers.
- The presence of the nucleolus indicates that the cell is still producing ribosomes.



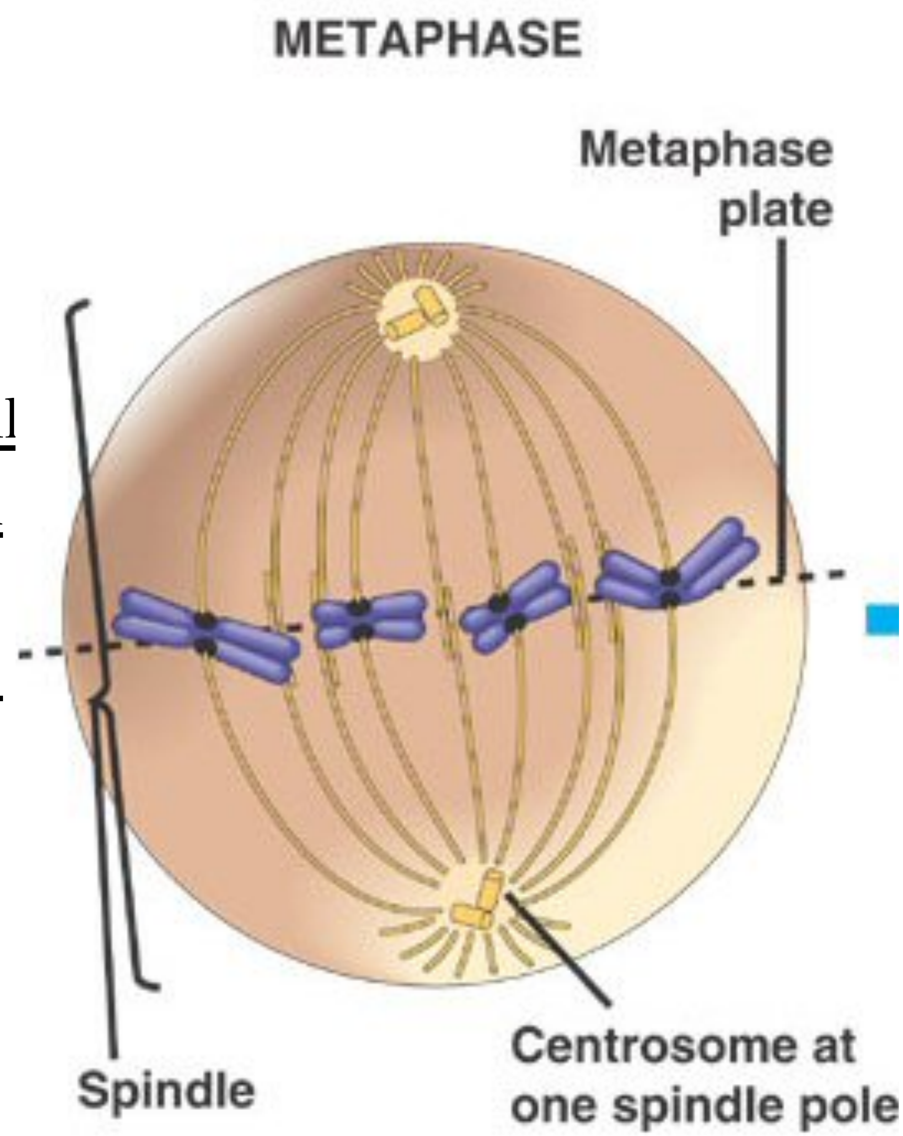
1. Prophase

- **1st Stage of Mitosis**
- **chromosomes visible**
  - Each chromosome can be clearly seen now to (**consist of a pair of sister chromatids joined at the centromere**.)
  - **nucleolus disappears-cell stops making ribosomes.**
  - **nuclear envelope breaks down.**
  - **mitotic spindle forms.**
  - **chromatids attach to spindle.**
  - **spindle starts tugging the chromosomes toward the center of the cell** for the next step in the dance.



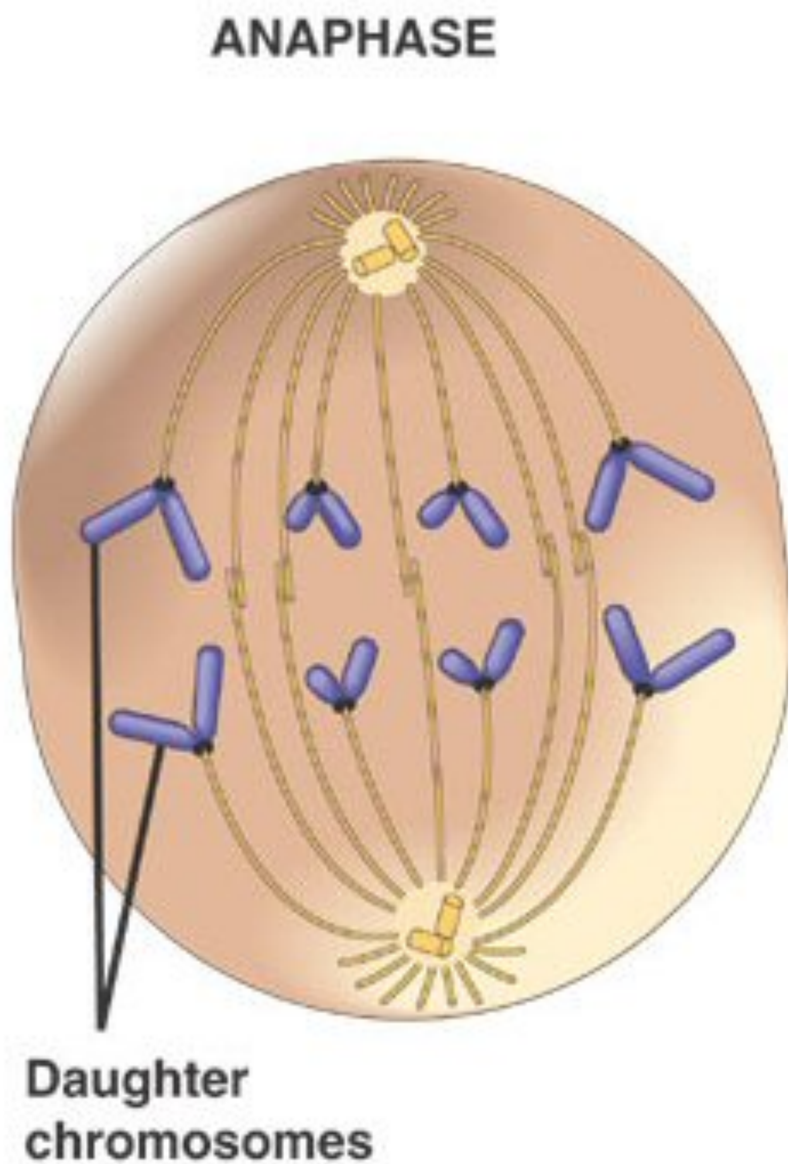
2. Metaphase

- **MIDDLE**
- **second stage, short**
  - **chromosomes all gather** in a plane across the middle of the cell
  - **mitotic spindle fully formed**
  - **All chromosomes are attached to the spindle with their centromeres lined up about halfway between the two ends of the spindle.**



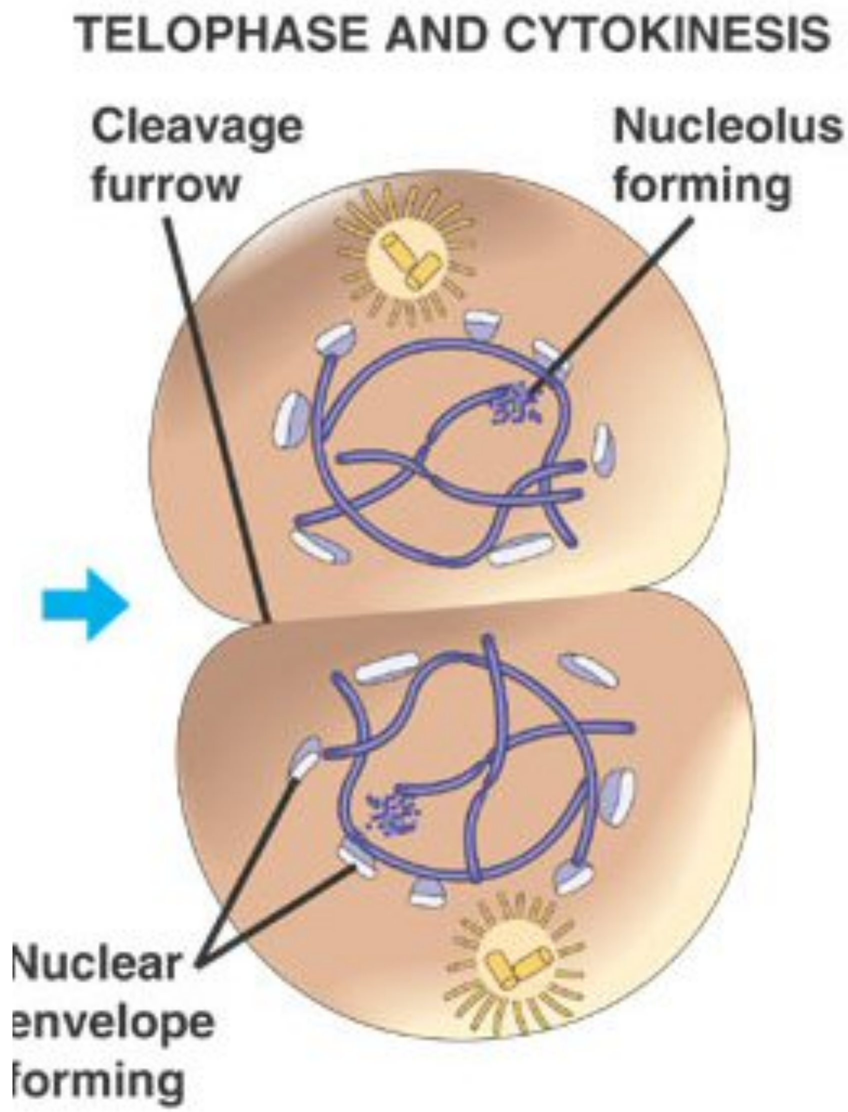
3. Anaphase

- **APART**
- **3rd Stage**
  - **sister chromatids separate from their partners.**
  - **Each chromatid is now a daughter chromosome, that will move along the spindle toward the ends.**
  - **Some microtubules shorten, bringing chromosomes closer to the poles.**
  - **Some spindle microtubules** not attached to centromeres they do the opposite— **grow longer, pushing the poles farther apart.**



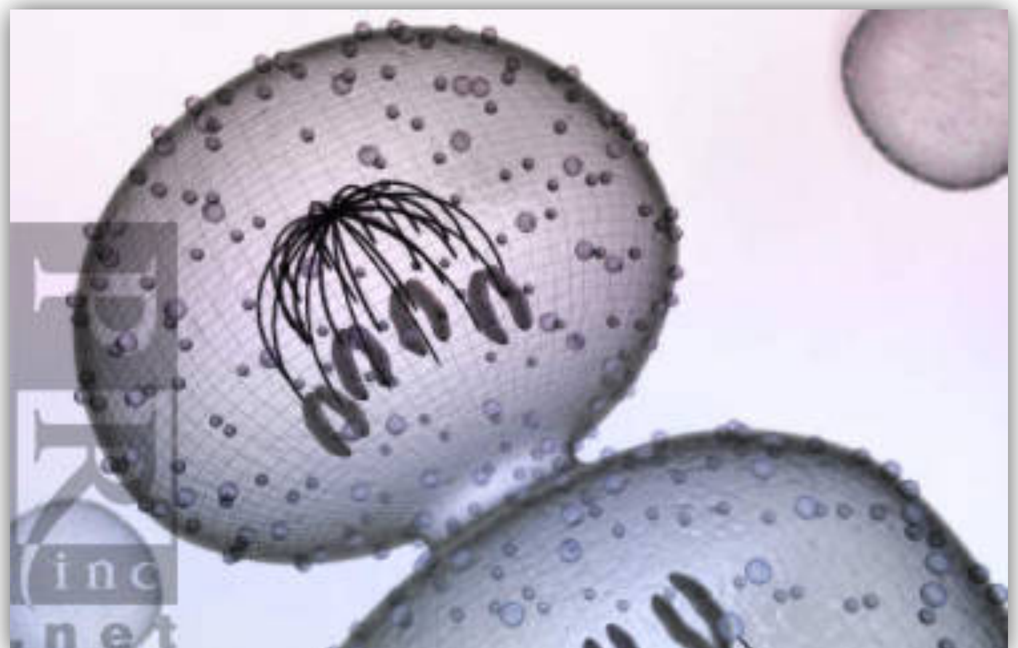
4. Telophase

- **Final Phase**
- **Reverse of prophase**
- **spindle disappears**
- **two nuclear envelopes reform** (one around each set of daughter chromosomes)
- **the chromosomes uncoil and lengthen**
- **nucleoli reappear.**
- **Mitosis**, the division of one nucleus into two genetically identical daughter nuclei, **is now finished.**



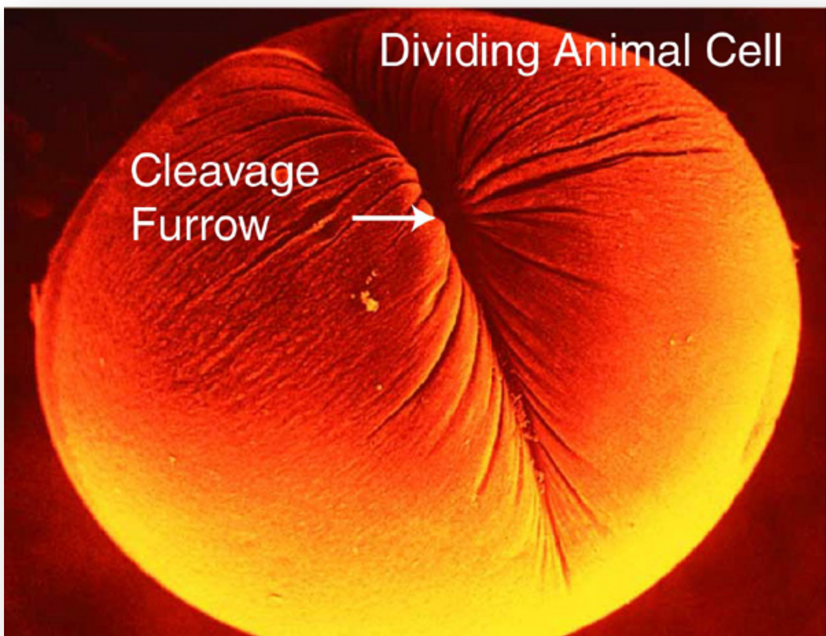
Cytokinesis

- **Cytokinesis completes the cell division process**
  - **It divides the cytoplasm into two daughter cells, each with a nucleus.**
  - **Occurs along with telophase.**



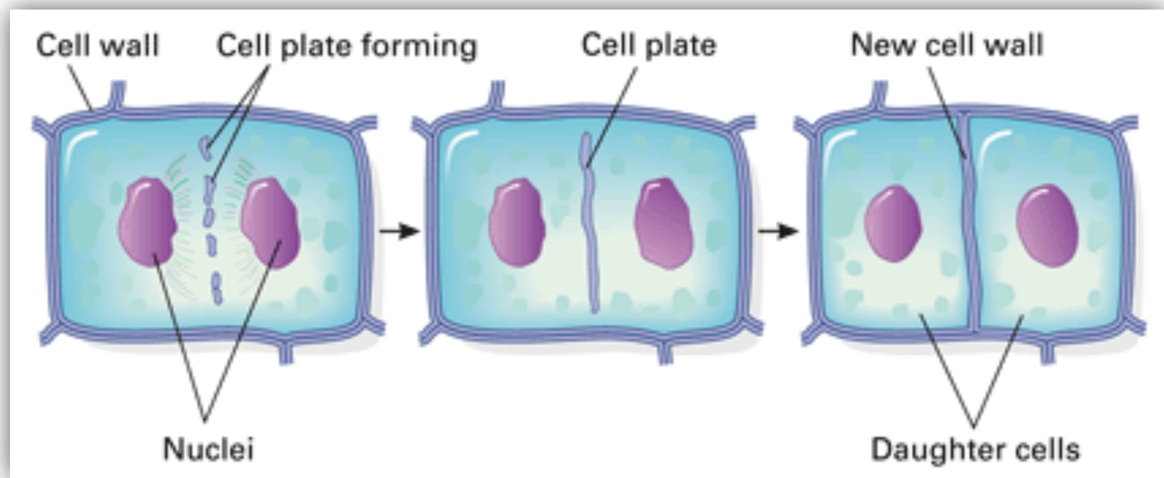
Cytokinesis in Animals

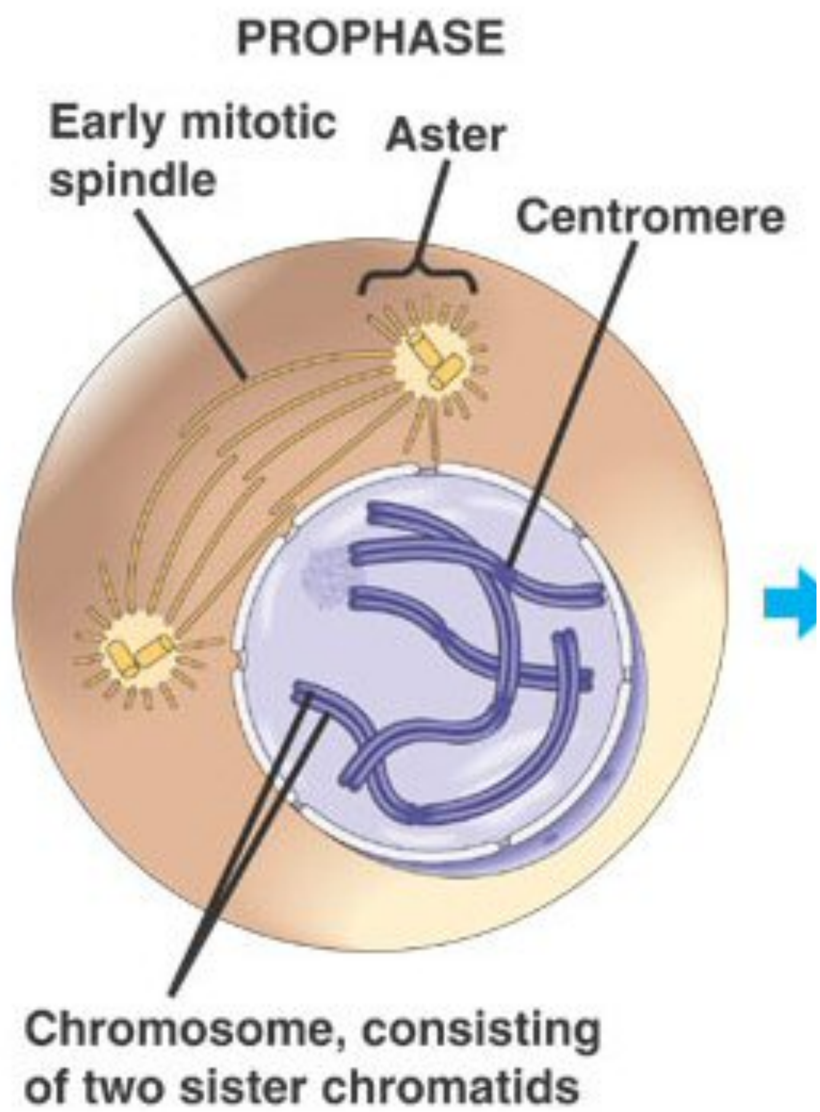
- <u>Animal cells</u>
  - first sign of cytokinesis is the appearance of an indentation around the middle of the cell
  - <u>Pinching apart</u> of cell.
  - two new nuclei are forming at the ends of the cell, cytokinesis results in two new cells.

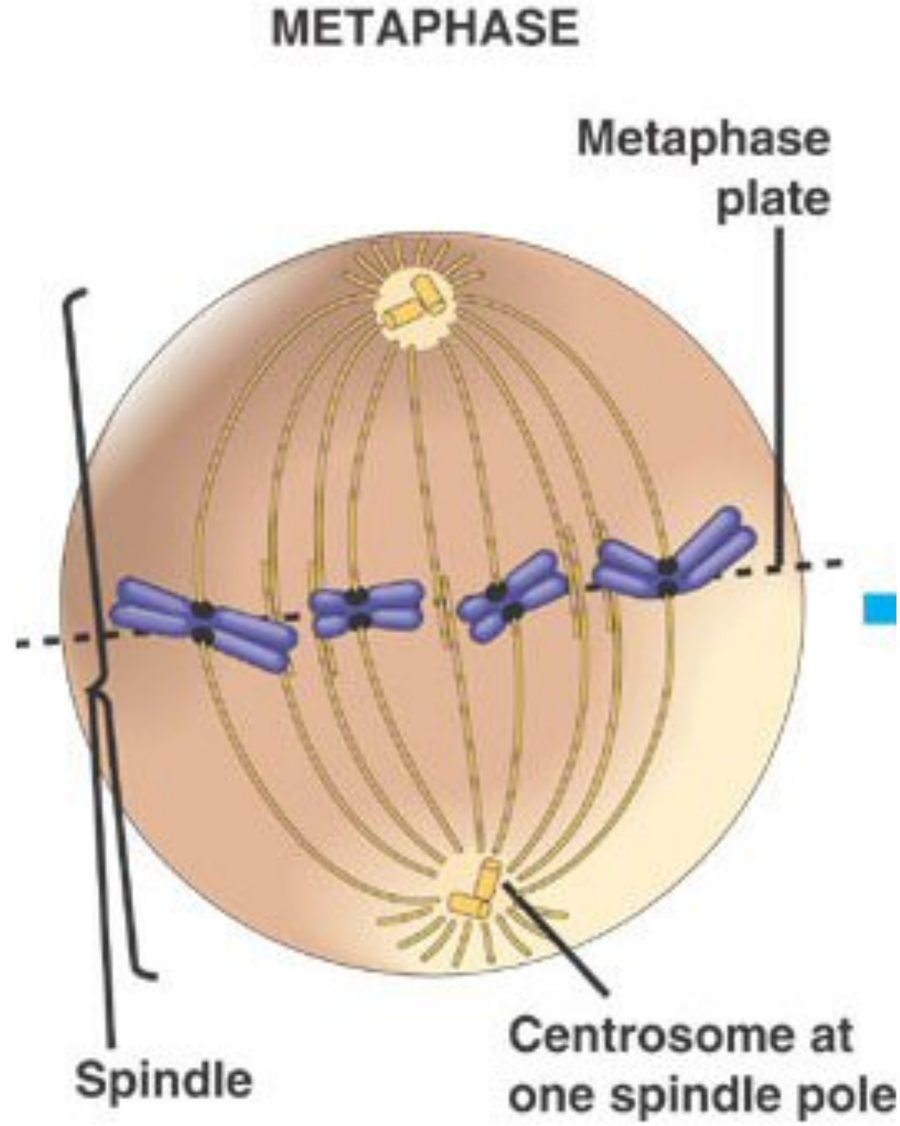


Cytokinesis in Plants

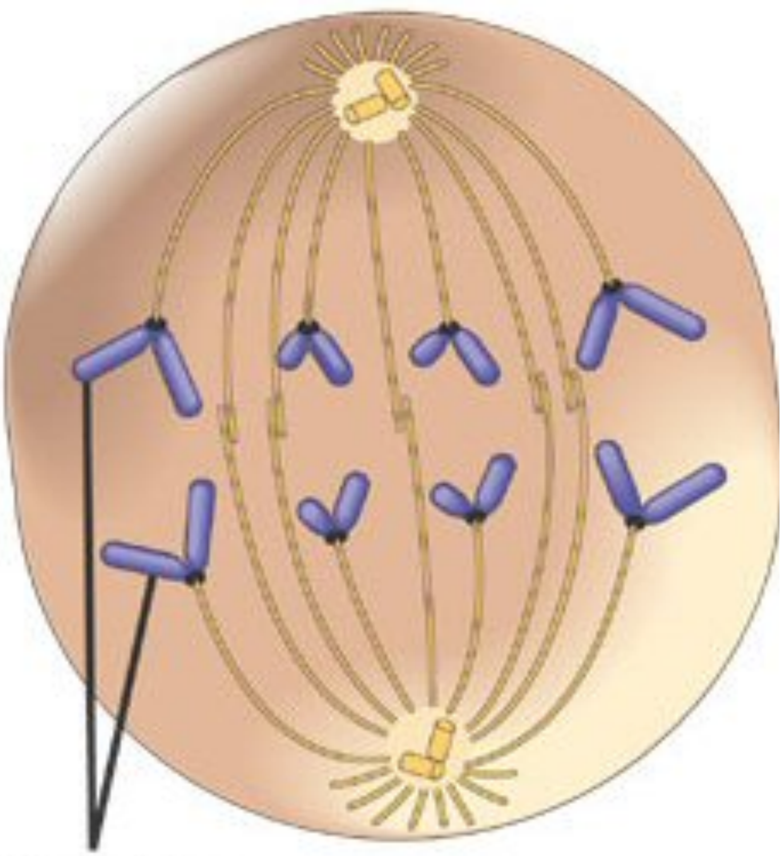
- Cytokinesis in a plant cell occurs differently
- A disk containing cell wall material called a cell plate forms inside the cell and grows outward.
- new piece of cell wall divides the cell in two.
- result is two daughter cells, each bounded by its own continuous membrane and its own cell wall.




PROPHASE
Early mitotic spindle
Aster
Centromere
Chromosome, consisting of two sister chromatids


METAPHASE
Metaphase plate
Spindle
Centrosome at one spindle pole

ANAPHASE



Warm-up 1/10

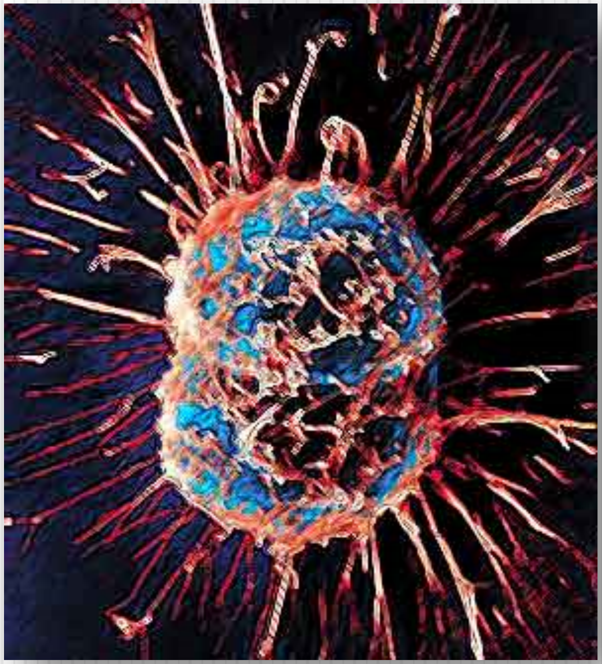
- 7. Each chromosome joins two identical copies called ______________________________, that are joined at the ____________________.
  - Draw a picture to accompany this statement!
- 8. Identify the stage of mitosis
  - A. The chromosomes line up in the middle
  - B. The sister chromatids pull apart
  - C. The chromosomes become visible
  - D. Two daughter nuclei are present

Honors Extension Questions

- Unit 6
- Cell Reproduction – Science Matters Chapter 15

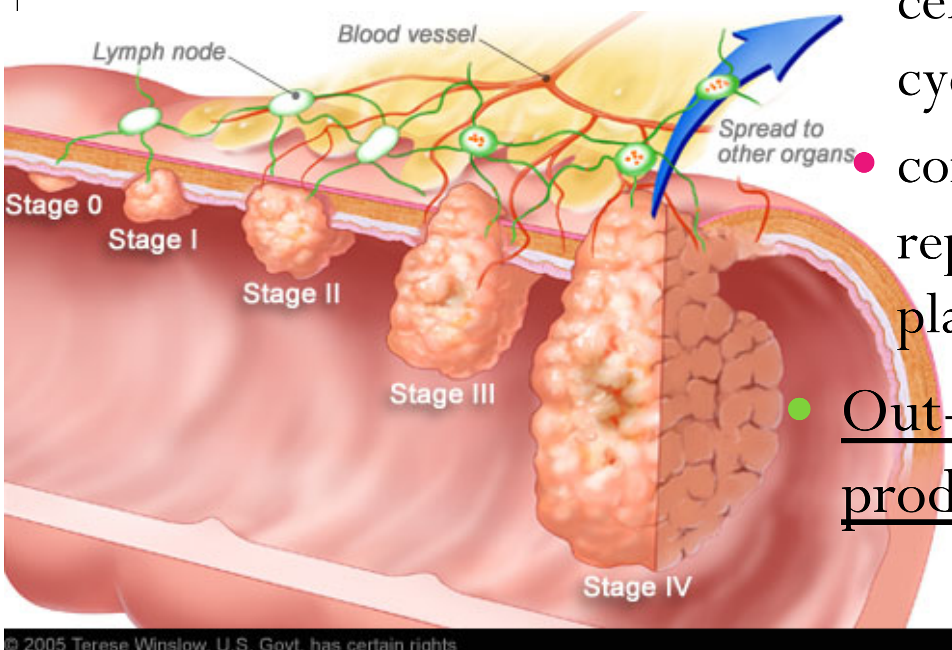
- 1. What are the 4 types of molecules essential to the working of a cell? Give 2 specific examples of each type.
- 2. What is enfolding? What cell structure is thought to have formed this way?
- 3. Differentiate between the 3 ways that cells can produce energy.
- 4. What are the 3 domains used to classify organisms? How are they different?

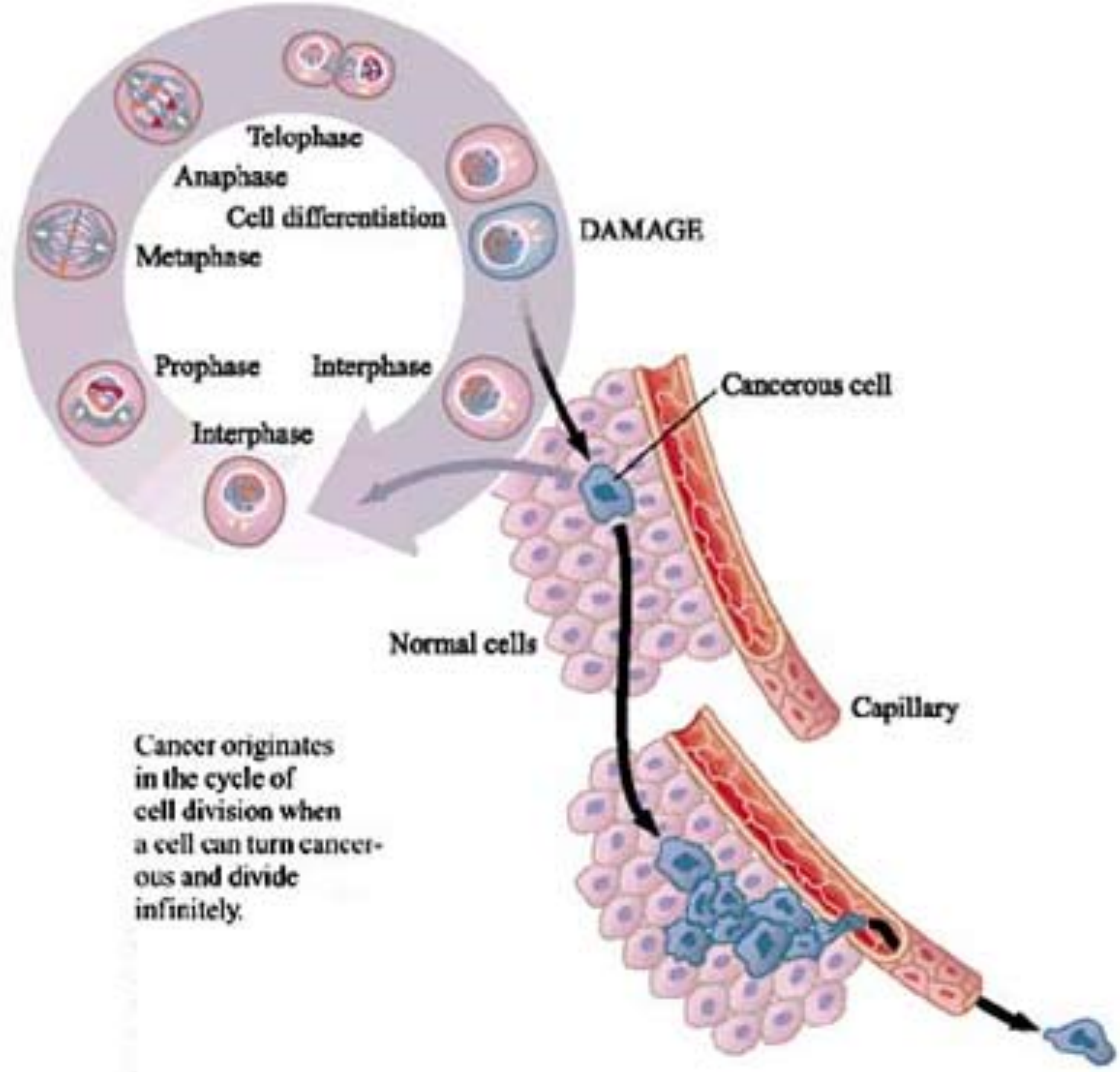
Cancer Cells Grow and Divide Out of Control

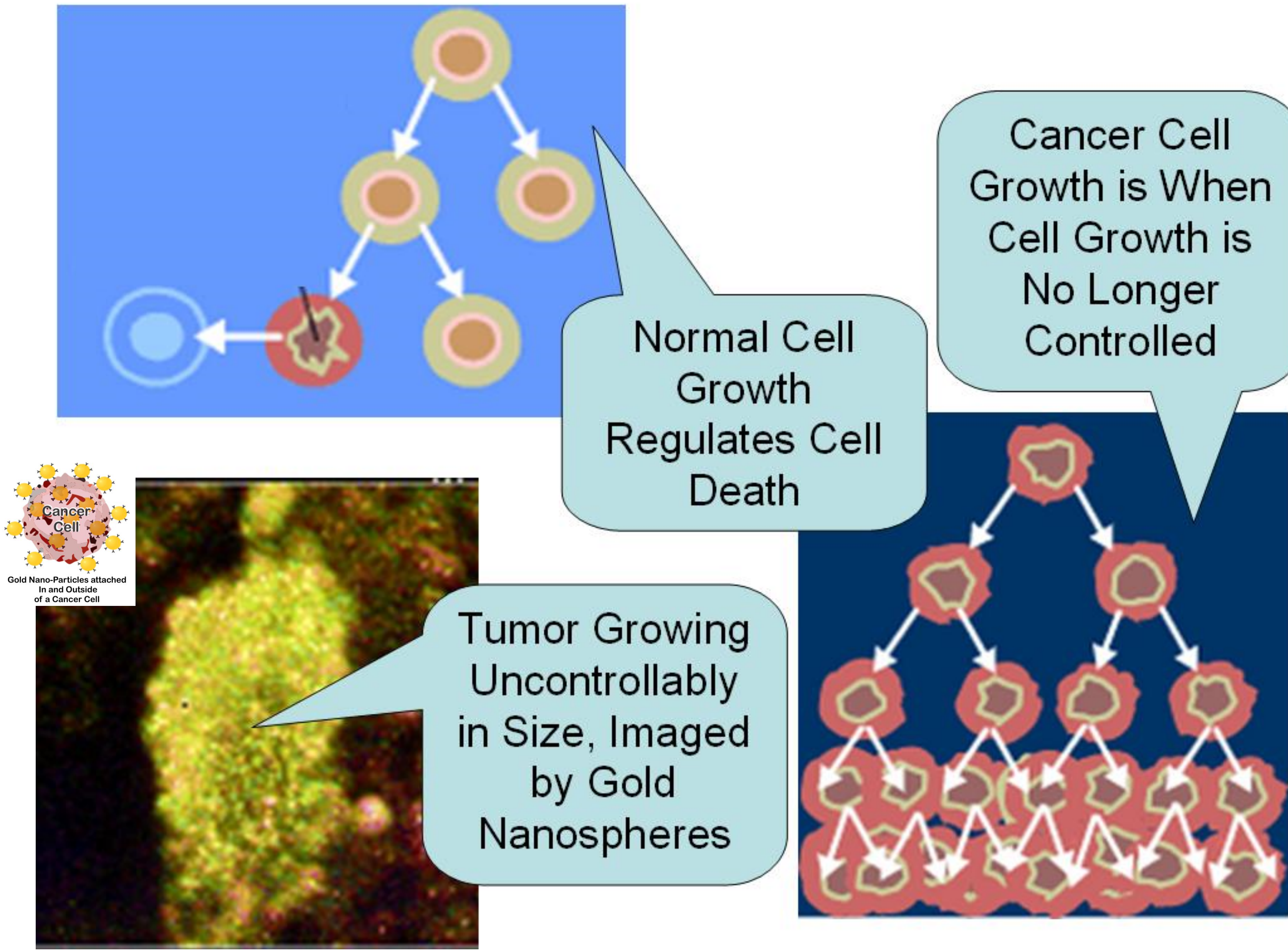


Tumors and Cancer

- The timing of cell division is critical to normal growth and development.
  - "control system" made of proteins in cell directs sequence of events in cell cycle.
  - control system malfunction = cells reproduce at wrong time or in wrong place.
- <u>Out-of-control cell reproduction can produce a mass of cells called a tumor.</u>

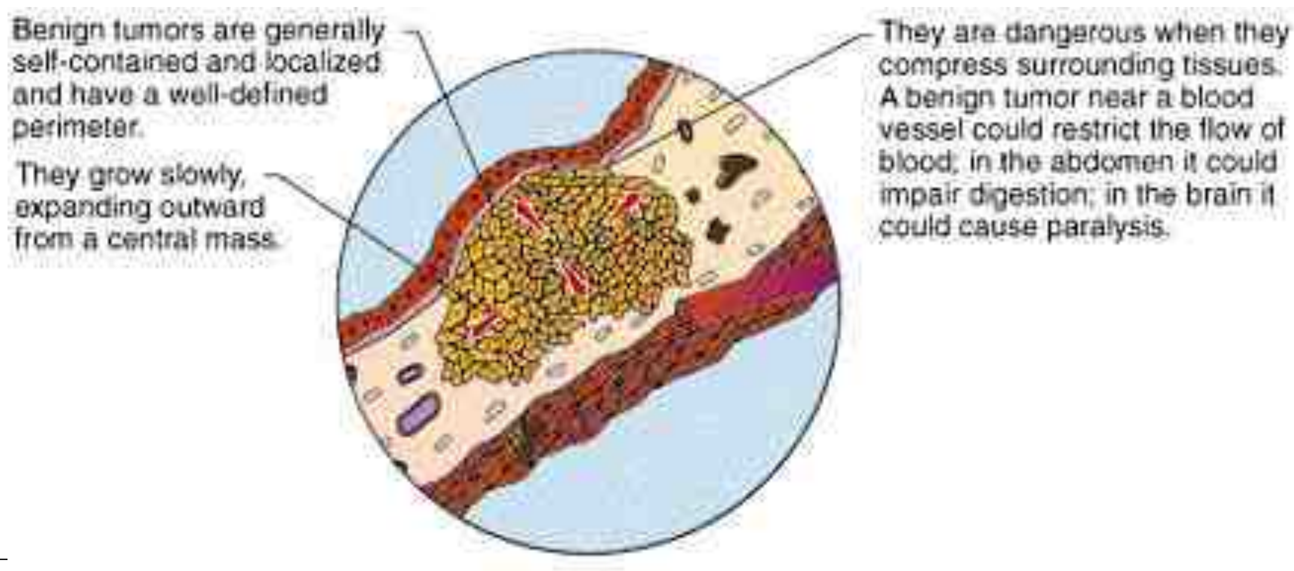



Telophase
Anaphase
Cell differentiation
DAMAGE
Metaphase
Prophase
Interphase
Cancerous cell
Interphase
Normal cells
Capillary
Cancer originates in the cycle of cell division when a cell can turn cancerous and divide infinitely.


Cancer Cell Growth is When Cell Growth is No Longer Controlled
Normal Cell Growth Regulates Cell Death
Cancer Cell
Gold Nano-Particles attached In and Outside of a Cancer Cell
Tumor Growing Uncontrollably in Size, Imaged by Gold Nanospheres

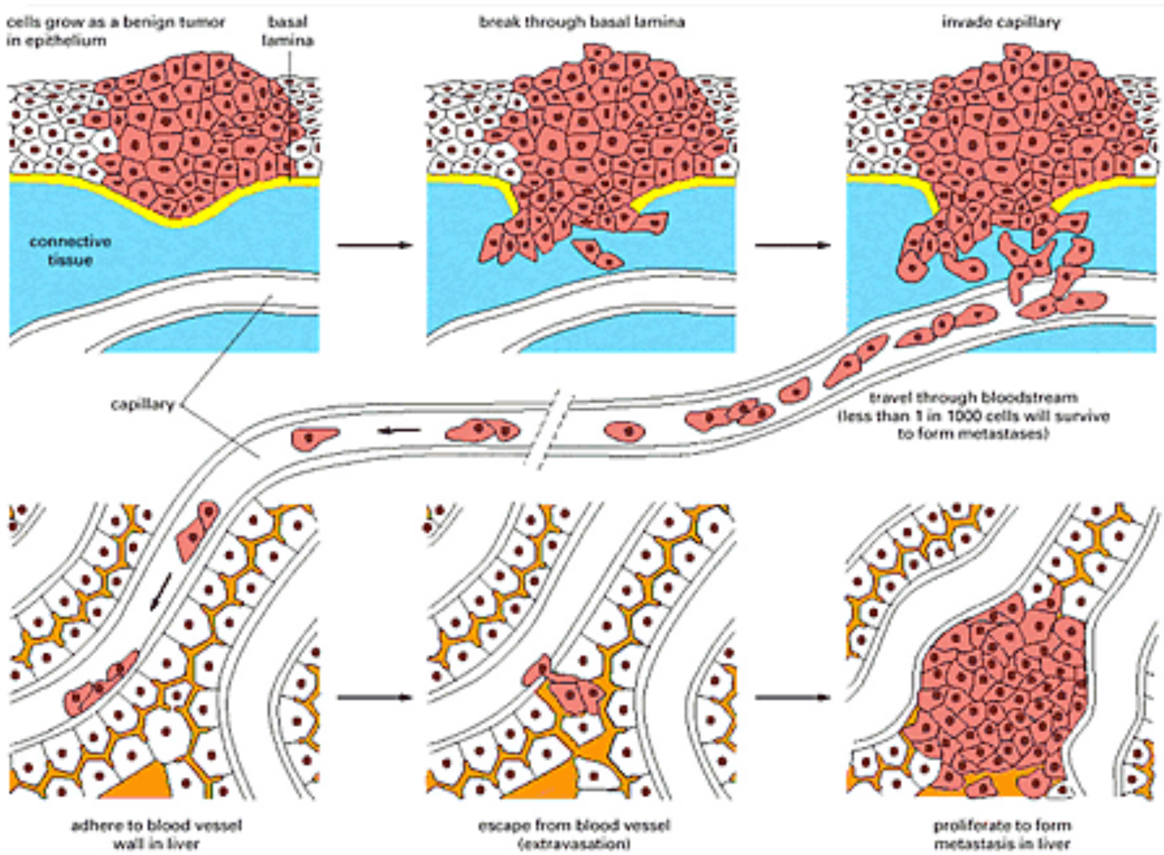
Benign Tumor

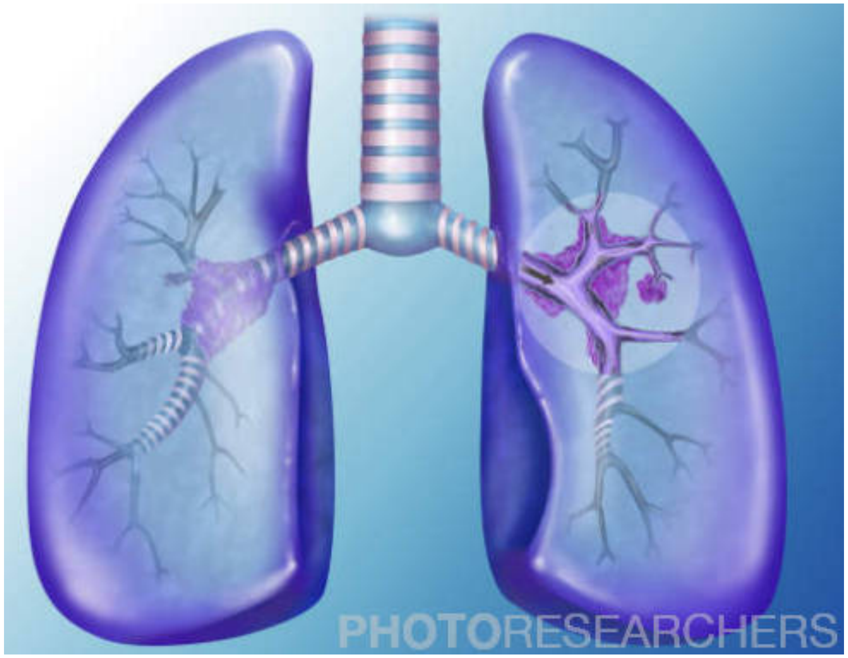
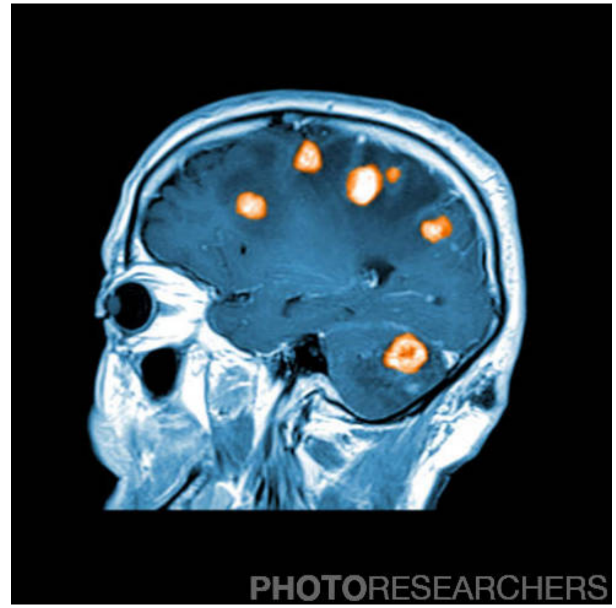
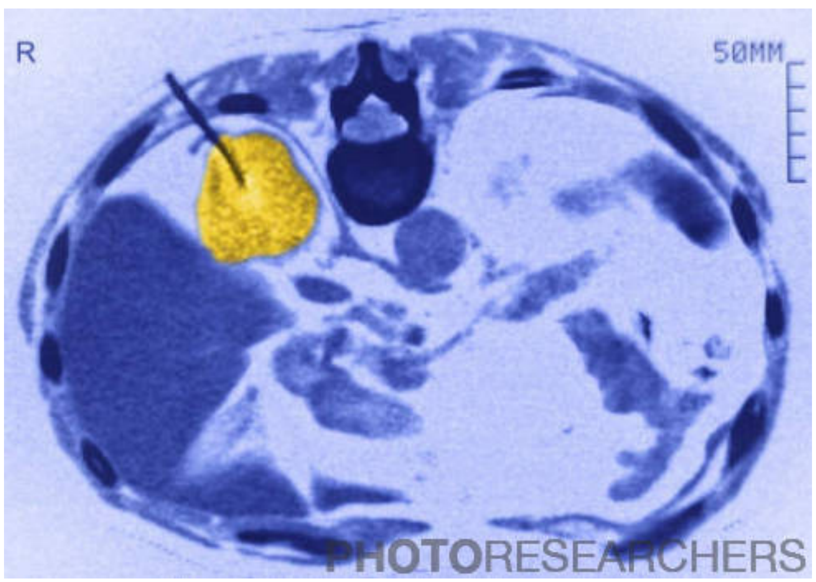
- Benign tumor: an abnormal mass of essentially normal cells
  - Depending on location in the body, benign tumors can cause health problems
  - usually they can be completely removed by surgery
  - cells of benign tumors always remain at their original site in the body.



Malignant Tumor

- <u>Malignant Tumor: more problematic than benign, masses of cells that result from the reproduction of cancer cells</u>

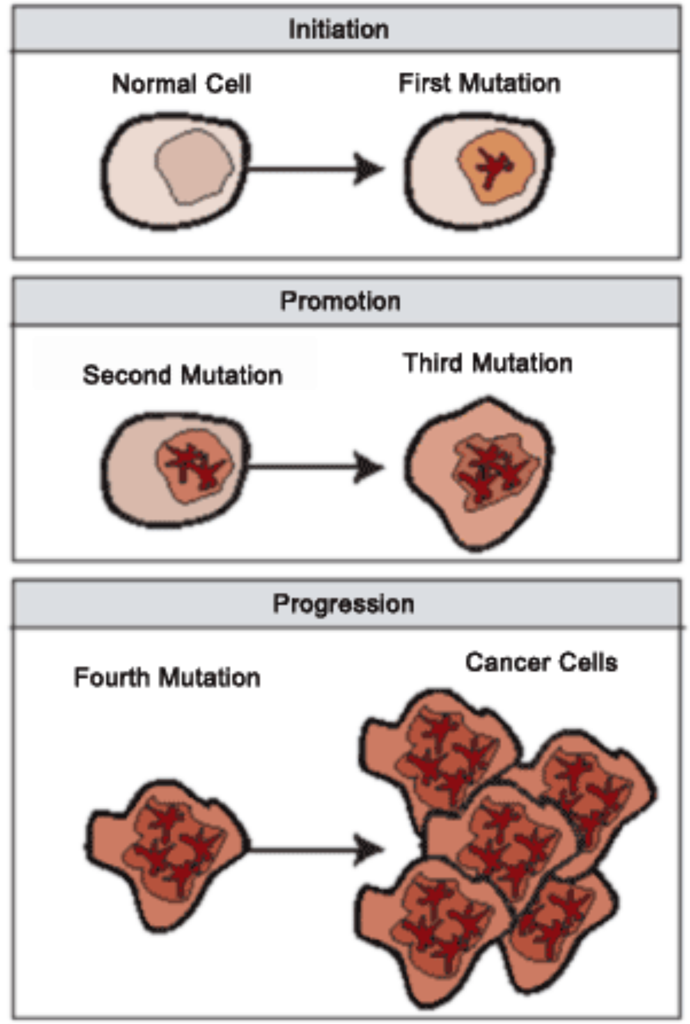



PHOTORESEARCHERS

PHOTORESEARCHERS

R
50MM
PHOTORESEARCHERS

PHOTORESEARCHERS

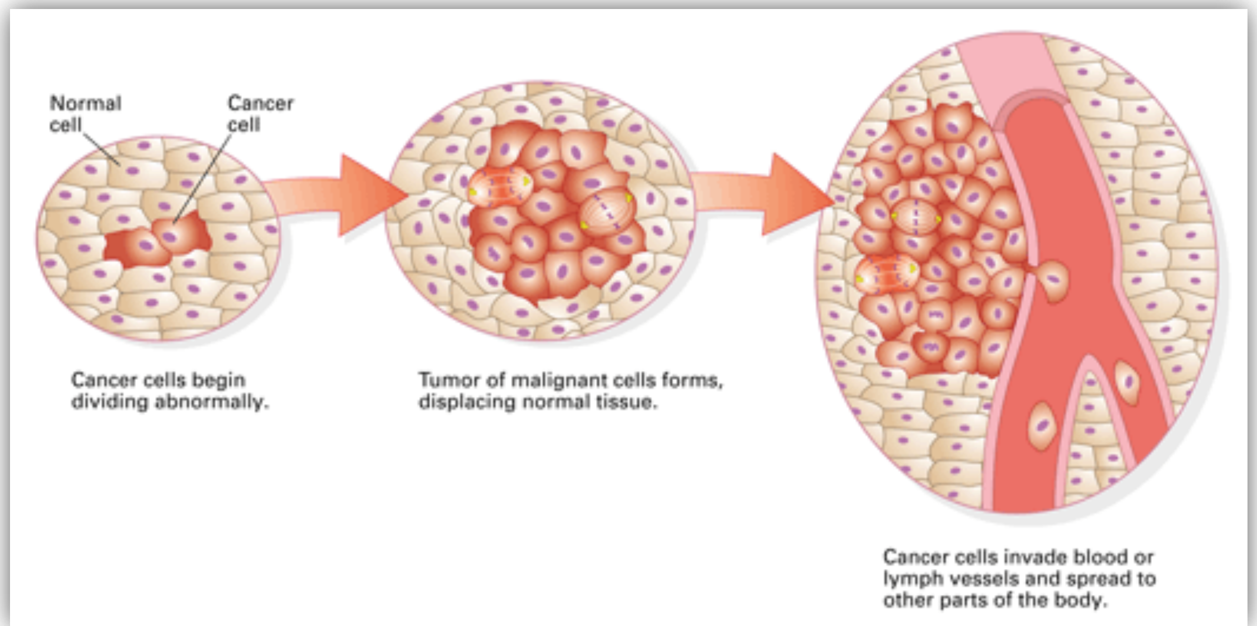
Cancer

- Cancer is a disease caused by the severe disruption of the mechanisms that normally control the cell cycle.
  - disruption leads to uncontrolled cell division
  - if unchecked can result in death.
  - most dangerous characteristic of cancer cells is their ability to spread.



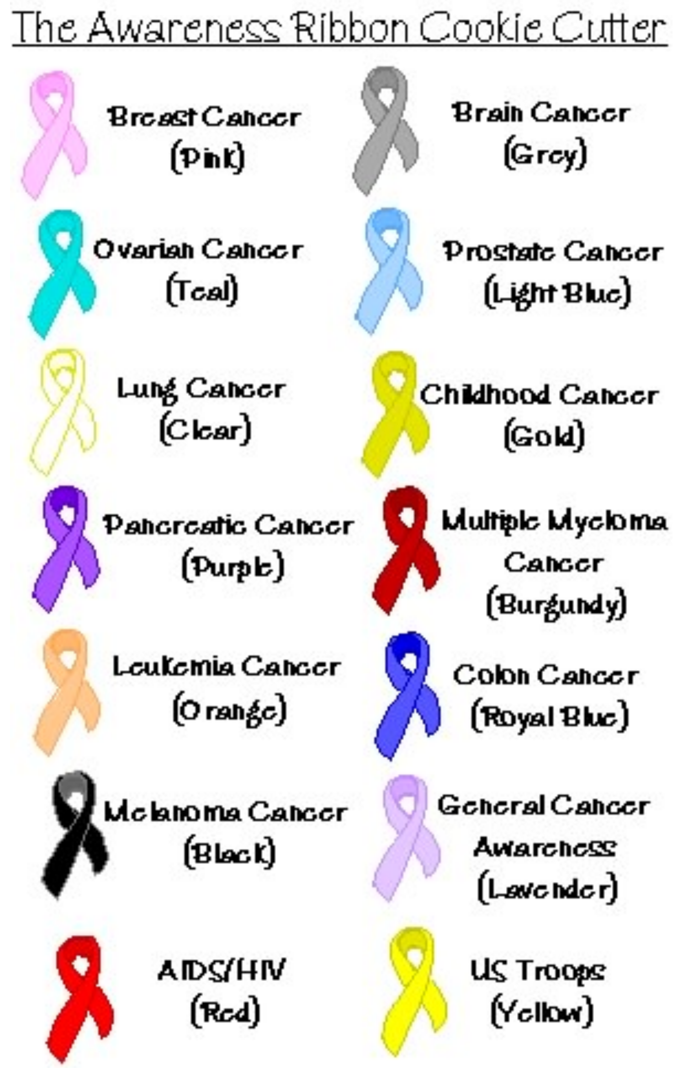
Cancer

- A malignant tumor displaces normal tissue as it grows.
- If a malignant tumor is not killed or removed, it can spread into surrounding tissues.
- More alarming still, cells may split off from the tumor and travel to other parts of the body, where they can form new tumors.
- The spread of cancer cells beyond their original site is called metastasis



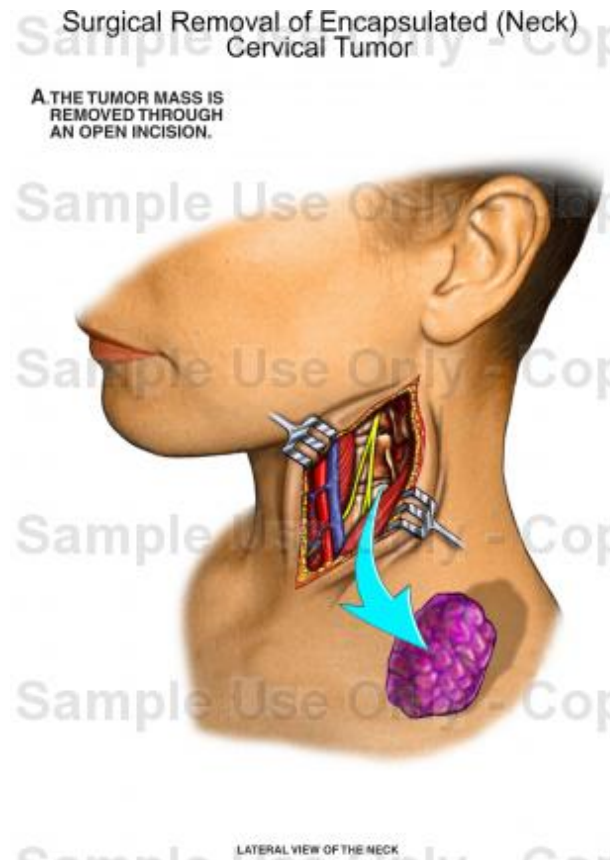
Cancer

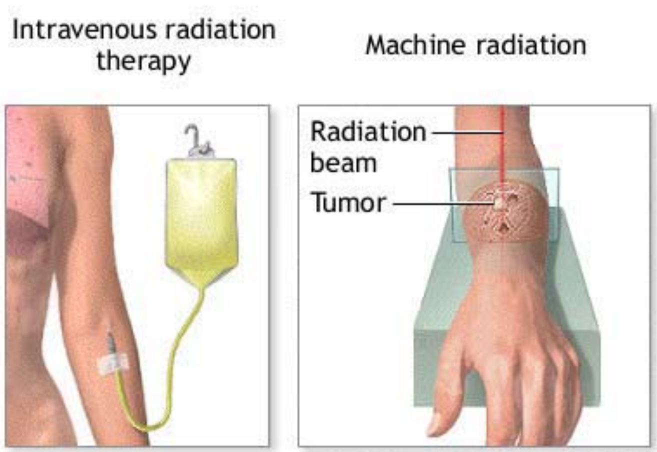
- Many different biochemical changes can affect the cell cycle and result in cancer.
- Thus, there is no single "cure," but rather multiple approaches to controlling or halting the progress of the disease.



Cancer Treatment

- <u>When possible, malignant tumors are removed by surgery.</u>
- difficult to successfully remove all traces of cancer cells with surgery.
- <u>Treat cancer at cellular level→ radiation therapy or chemotherapy.</u>
  - Both attempt to stop cancer cells from dividing.

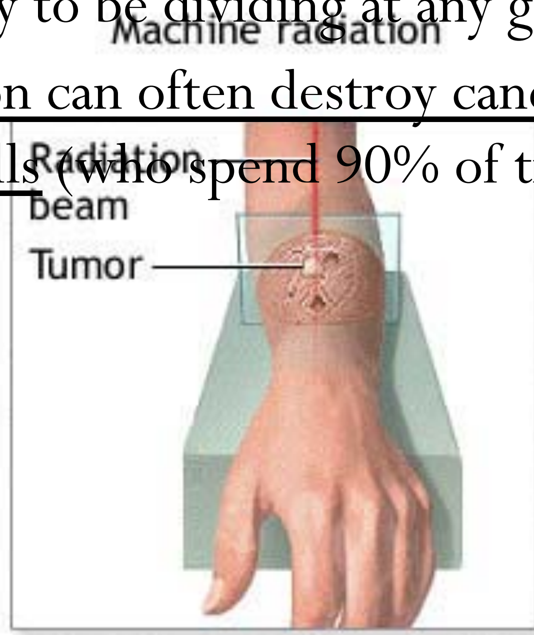


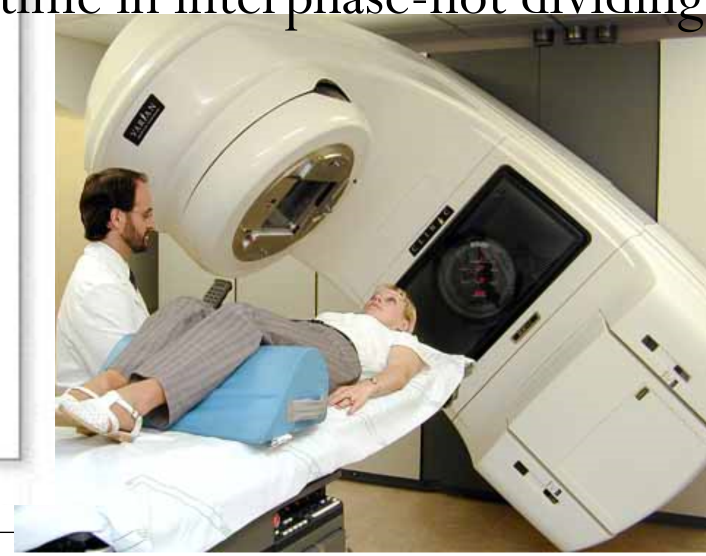


Surgical Removal of Malignant Tumor

Cancer Treatment

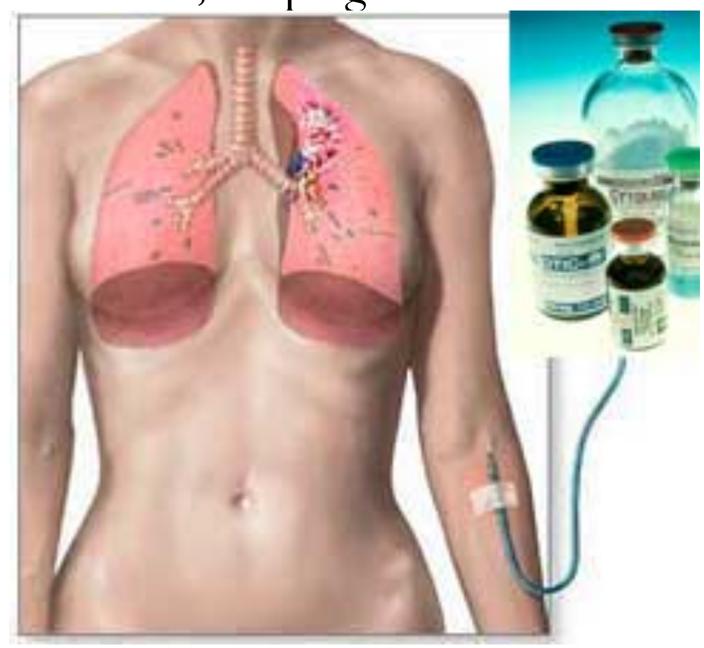
- Radiation Therapy
  - the parts of the body with cancerous tumors are exposed to high-energy radiation- which disrupts cell division.
  - B/c cancer cells divide more often than most normal cells, they are more likely to be dividing at any given time.
  - So radiation can often destroy cancer cells with minimal damage to normal cells (who spend 90% of time in interphase-not dividing).





Cancer Treatment

- Chemotherapy
  - involves treating the patient with drugs that disrupt cell division.
  - These drugs work in a variety of ways.
    - Some, called antimitotic drugs, prevent cell division by interfering with the mitotic spindle.
    - One antimitotic drug prevents the spindle from forming in the first place.
    - Another drug "freezes" the spindle after it forms, keeping it from functioning.



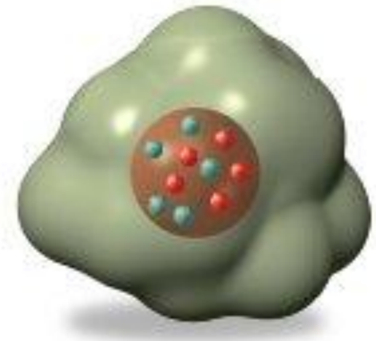
Cancer Treatment

- Side Effects
  - Both radiation and chemotherapy can cause undesirable side effects in normal body cells that divide fairly often.
  - Radiation, for example, can damage cells of the ovaries or testes, causing sterility.
  - Intestinal cells or hair follicle cells can be affected by chemotherapy, leading to nausea or hair loss.

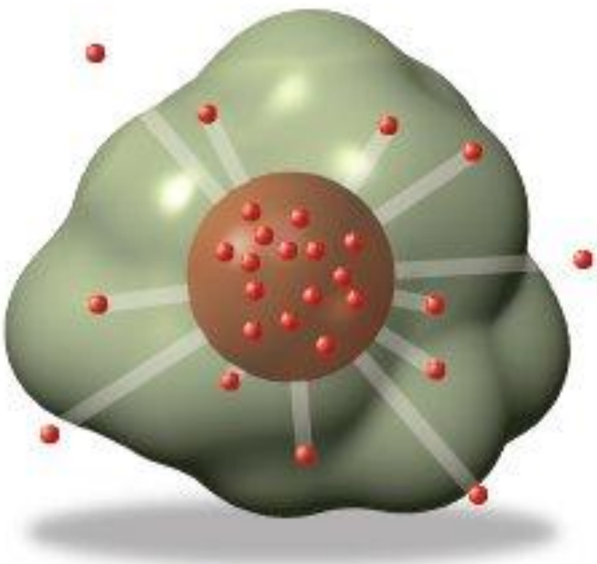
KILLING CANCER

What makes cancer cells different – and how to kill them

Normal cells (blue) in the middle of a benign growth are starved of oxygen but can survive by switching to glycolysis, a different way of making energy. In the process the mitochondria, which contain the cells' self-destruct mechanism, switch off. This makes the cells "immortal" and cancerous (red), so they carry on replicating and the tumour grows



Glycolysis also generates lactic acid, which lets the cancer cells eat through tissue, escape and form secondary cancers elsewhere in the body



A drug called dichloroacetate switches the mitochondria in the cancer cells back on (blue) so they halt glycolysis and start making energy in mitochondria again. The self-destruct mechanism is then activated, and the cells wither and die (brown)

The Anatomy of Cancer

Genomic Testing of Cancer

[redacted]

How do cancer cells differ from normal cells?

Skin Cancer Prevention

NORMAL		CANCEROUS
	**"A" IS FOR ASYMMETRY** • If you draw a line through the middle of the mole, the halves of a melanoma won't match in size.	
	**"B" IS FOR BORDER** • The edges of an early melanoma tend to be uneven, crusty or notched.	
	**"C" IS FOR COLOR** • Healthy moles are uniform in color. A variety of colors, especially white and/or blue, is bad.	
	**"D" IS FOR DIAMETER** • Melanomas are usually larger in diameter than a pencil eraser, although they can be smaller.	
	**"E" IS FOR EVOLVING** • When a mole changes in size, shape or color, or begins to bleed or scab, this points to danger.	

Warm-up 1/11/17

- 9. What is a tumor? Differentiate between the two types of tumors.
- 10. What is metastasis?

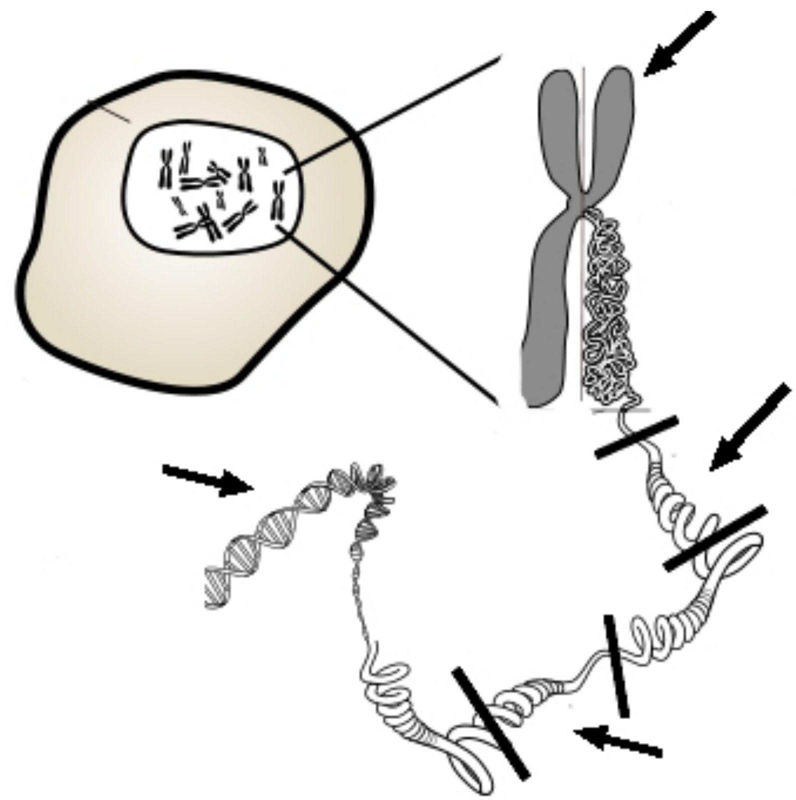
HeLa cells

[redacted]

Cancer: Out of Control Cells

Name:___________________________________

Cancer: Out of Control Cells



Cells do not live forever, and they will reach a point where they will divide through mitosis, or die through a process called **apoptosis**. Cancer cells are the exception, these cells do not die and divide uncontrollably as they crowd out healthy, productive cells. Cancer can have many causes, but most are thought to be related to **carcinogens** in the environment. Carcinogens are chemicals that can damage DNA and interfere with a cell's normal cycle, thus disrupting the cells ability to control when and how often it divides.

While most cells do not live forever, cancer cells do continue to divide as long as they are provided with nutrients. Research has been conducted for many years on an immortal line of cells called **HeLa cells**, named after Henrietta Lacks, who was a female with cervical cancer. All HeLa cells are derived from the original sample taken from her when she was a patient in 1951; Henrietta Lacks died that same year.

How Cancer Works

Cancerous transformation results from changes of the DNA and the genes that control the cell cycle. Two types of

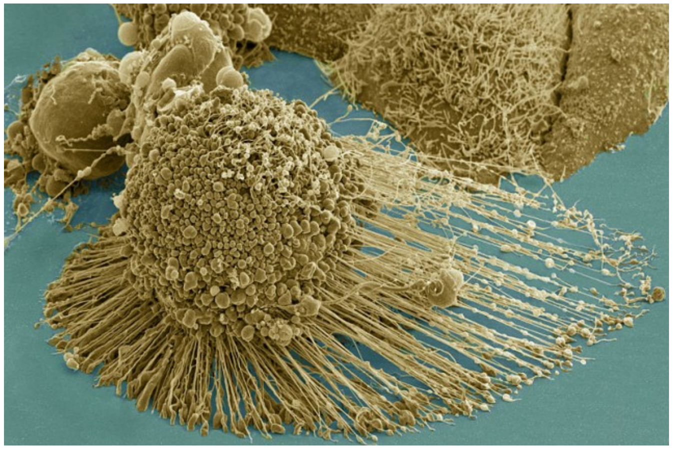
Mr. W is back with his silky rhymes!

[redacted]

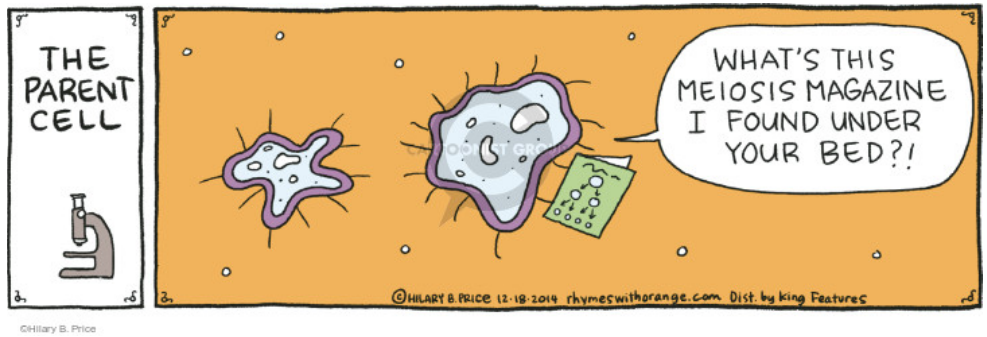
Warm-up 1/12

- 11. Identify 3 ways to treat cancer.
- 12. How many men and women will be diagnosed with cancer in their lifetime?
- 13. Cancer is a ___________ tumor.
- 14. List a common cancer found in women and men.

Vacuolization is where substances are taken up from the outside of the cell by deformation of the cell membrane into pockets inside the cell called vacuoles. The cells went into over drive, and the huge accumulation of vacuoles meant that the cell membrane eventually collapsed, causing the cell to essentially explode all of its contents and die.



Warm-up 1/13

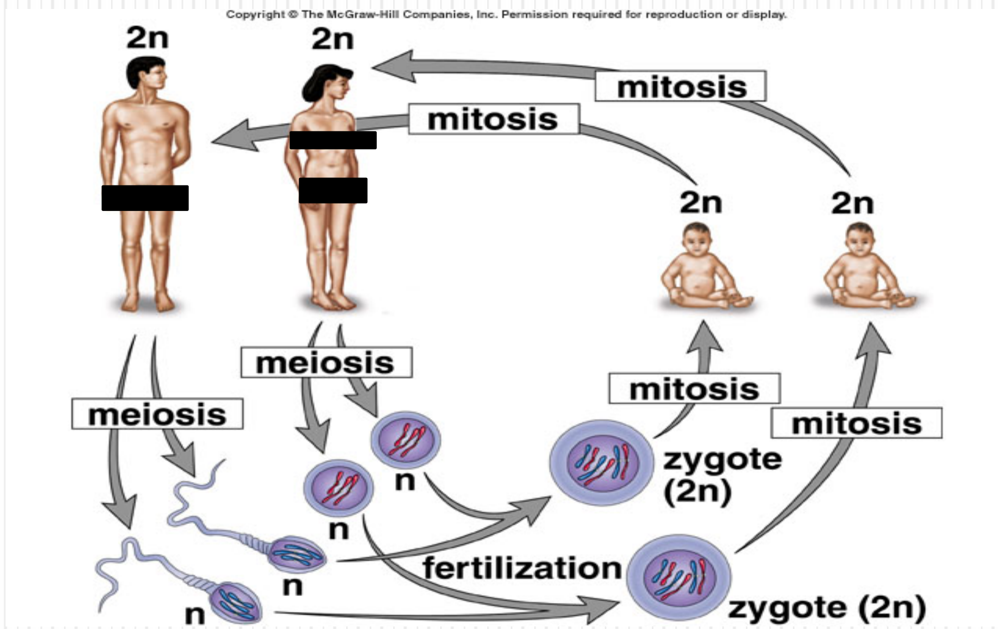


15 . Draw the concept map into your composition notebook with the answers included/highlighted in your drawing.

Let’s talk about SEX!

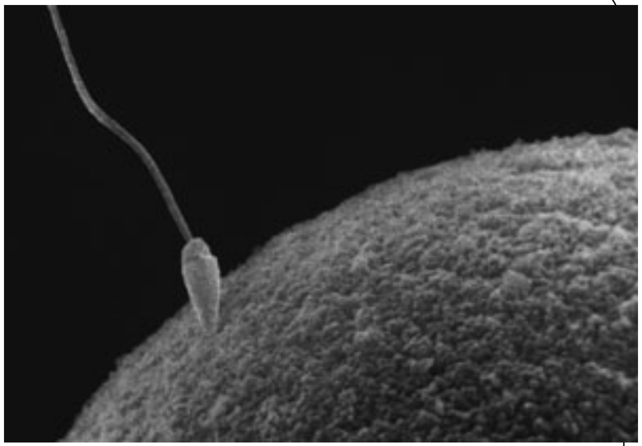
Scientifically speaking, of course…

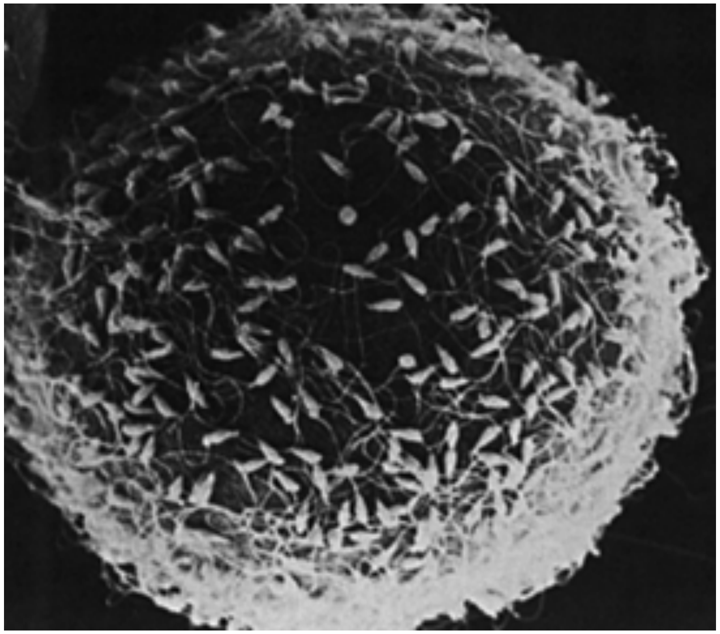
Meiosis Functions in Sexual Reproduction



Let's Review…

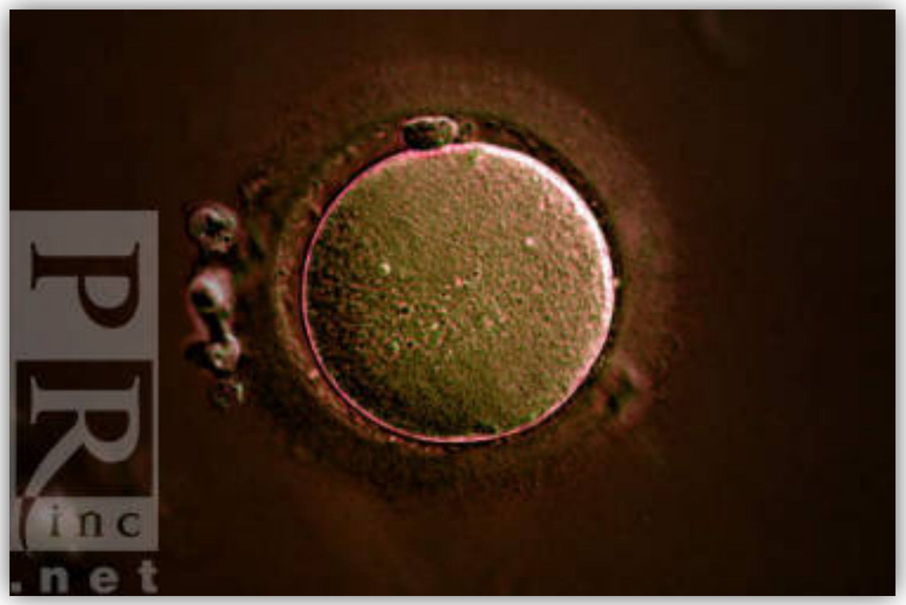
- Sexual reproduction involves the fusion of male and female gametes.
- The resulting cell is called a zygote.





Homologous Chromosomes

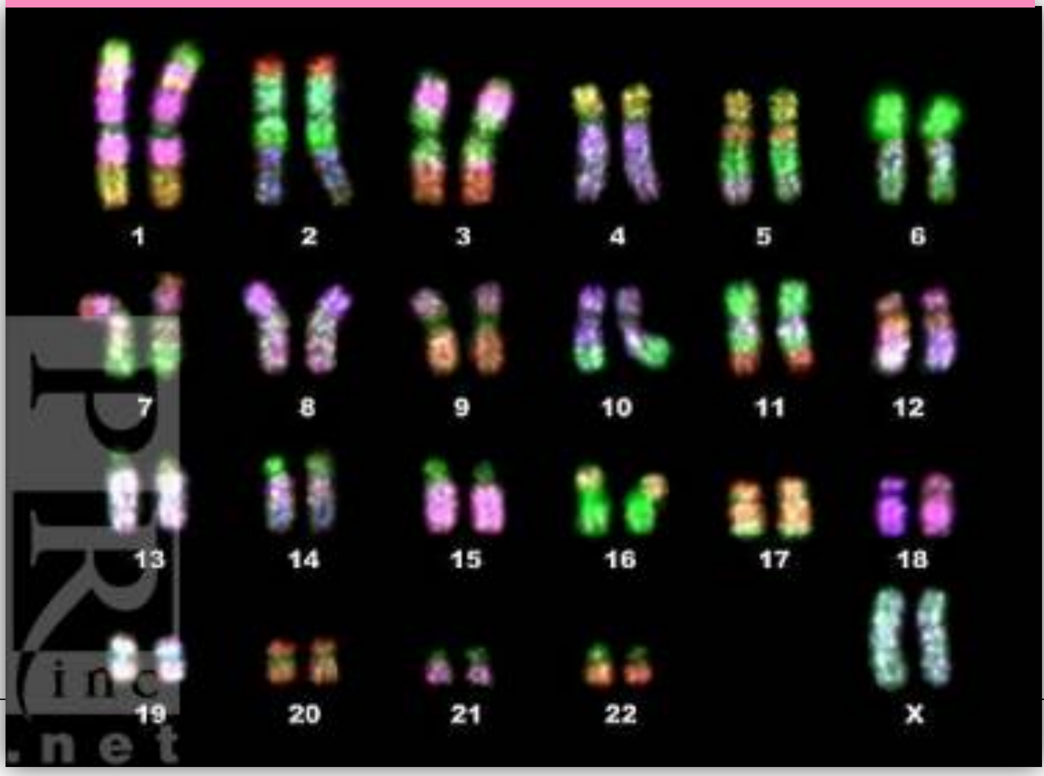
- **Sexual reproduction** depends in part on MEIOSIS.
  - Meiosis - type of cell division that produces four cells, each with half the number of chromosomes as the parent cell.
    - Forms sex cells…sperm and egg
    - Occurs in the sex organs—the testes in males and the ovaries in females.



Homologous Chromosomes

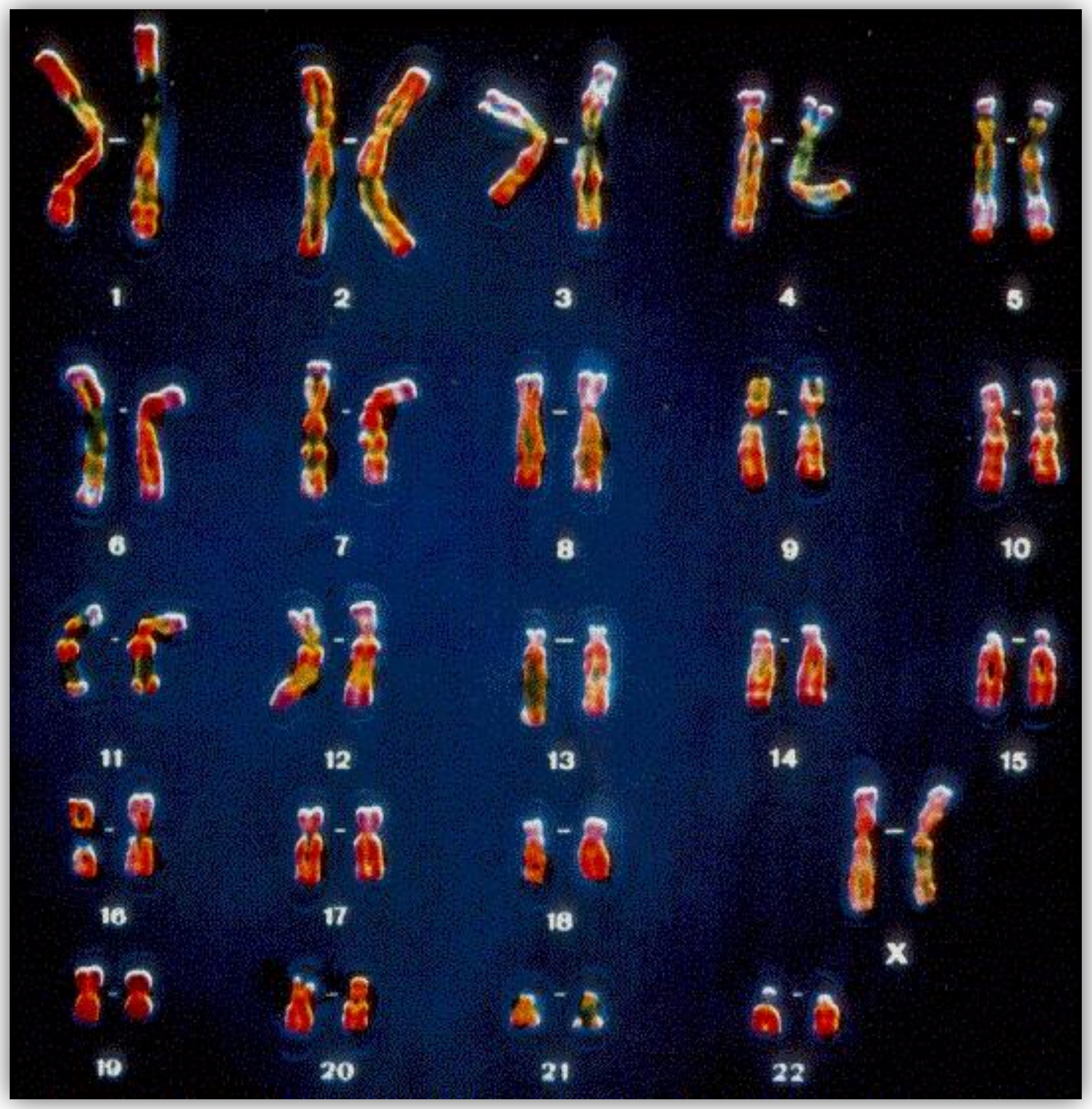
- ALL cells of a single organism have same number and types of chromosomes.
- Cells from different male or female individuals of a **single species** have the same number and types of chromosomes.

All normal Human females



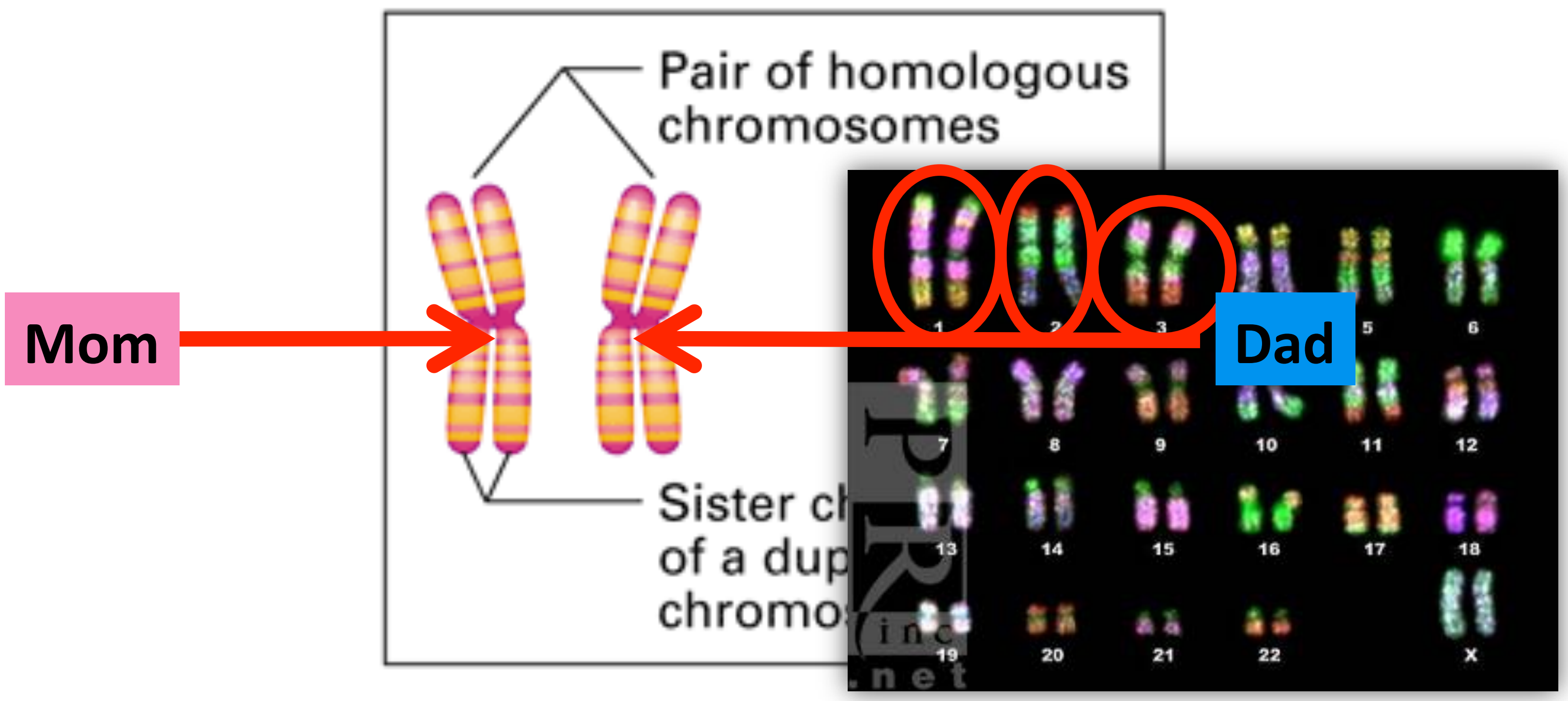
Karyotype

- A display of the chromosomes of an individual is called a karyotype.
  - Humans have 46 chromosomes in their karyotype.



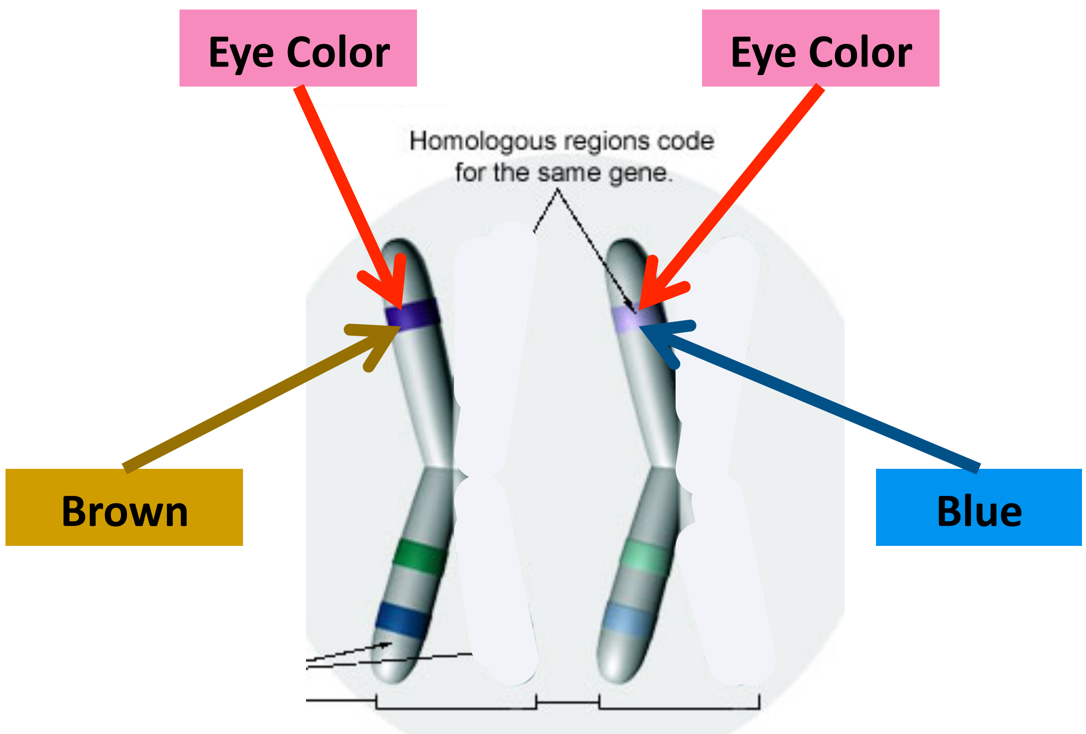
Homologous Chromosomes

- Homologous chromosomes : the two chromosomes of each matching pair.
  - Resemble each other in size and shape and genes
- Inherit one chromosome of each pair from your mother and the other from your father.



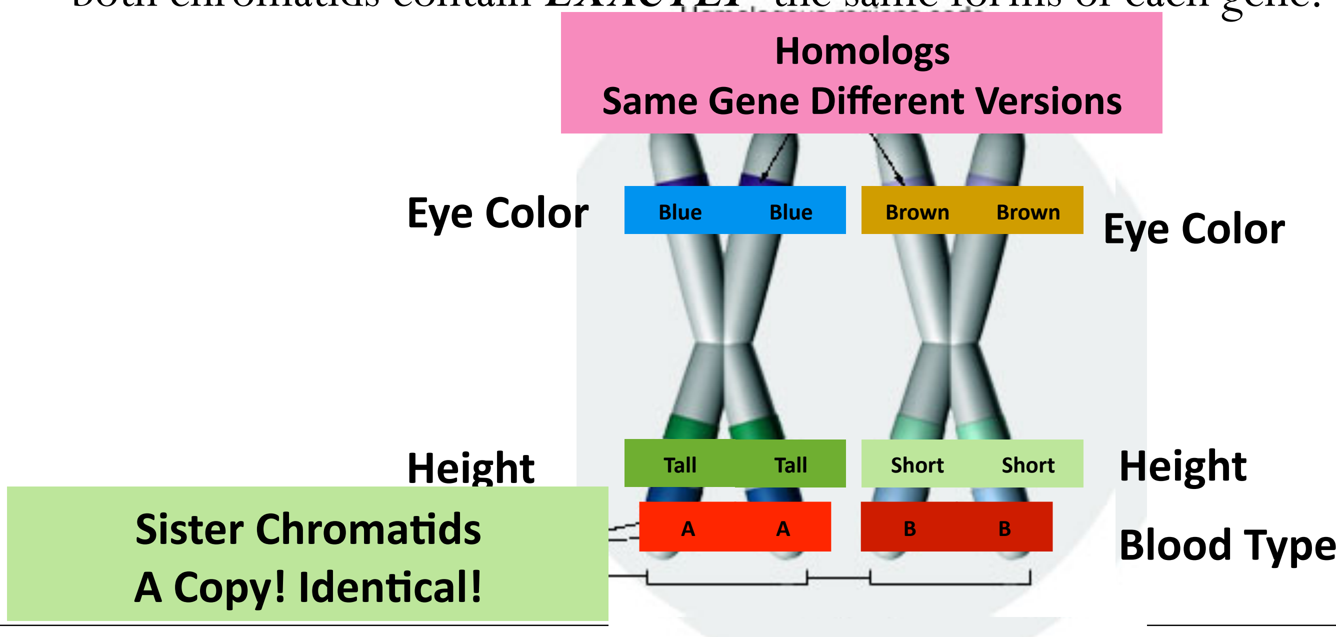
Genes on Homologous Chromosomes

- Each homologous chromosome in a pair carries the **same sequence of genes** controlling the same inherited characteristics (height, eye color).
  - However, the two genes may be different versions.
    - Ex. Gene = eye color, versions of eye color = blue, brown, green…
    - Ex. Gene = height, versions = short, tall



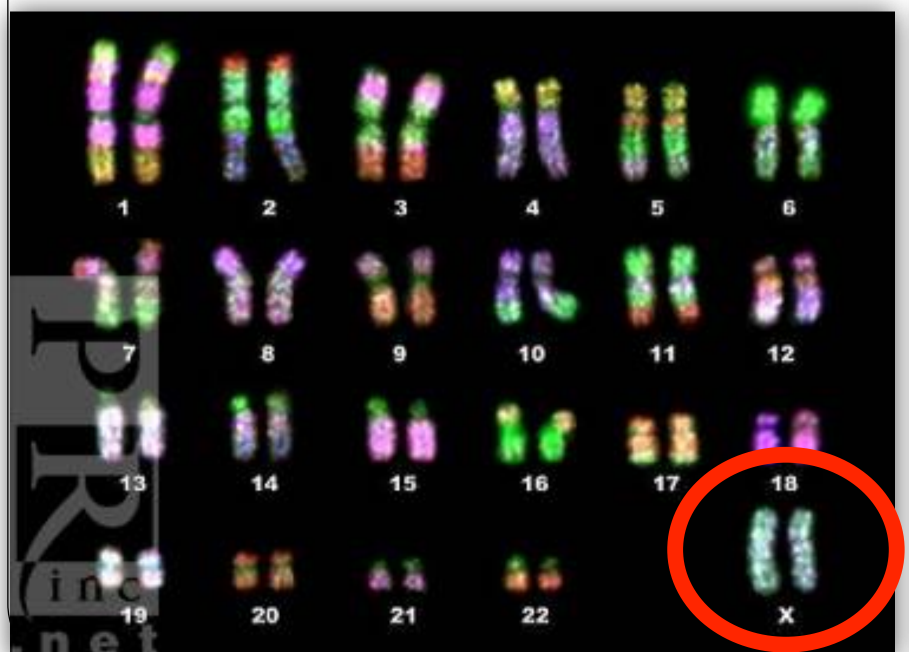
Homologous Chromosome vs. Sister Chromatid

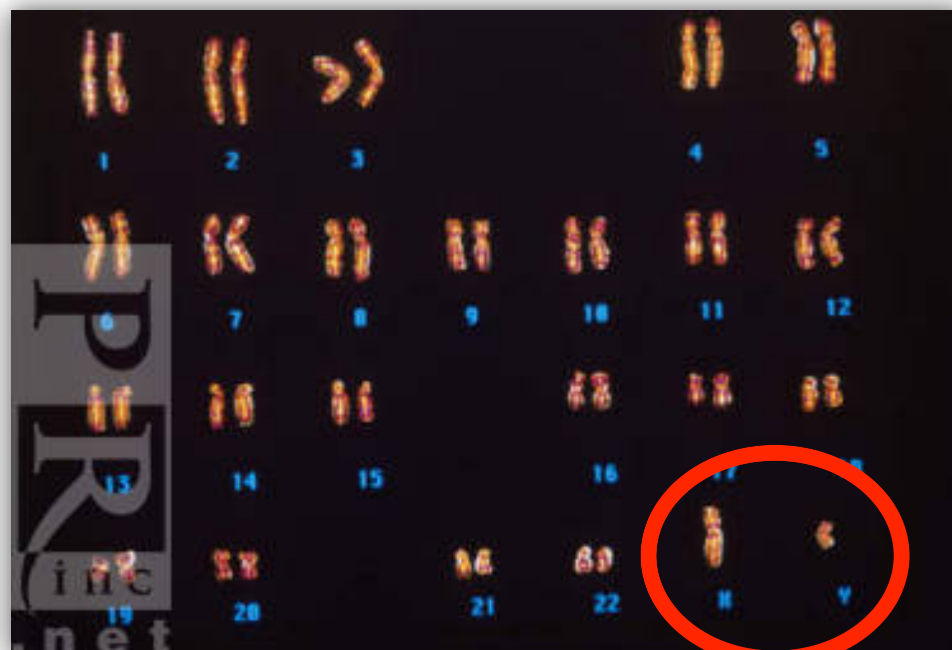
- *Homologous chromosomes are different from sister chromatids*
- **Homologous Chromosomes**
  - Have the same sequence of genes on each chromosome in the pair but may carry different versions of the same gene
- **Sister chromatids**
  - are duplicated copies of a single chromosome that are attached to each other and are **identical**
  - both chromatids contain ***EXACTLY*** the same forms of each gene.

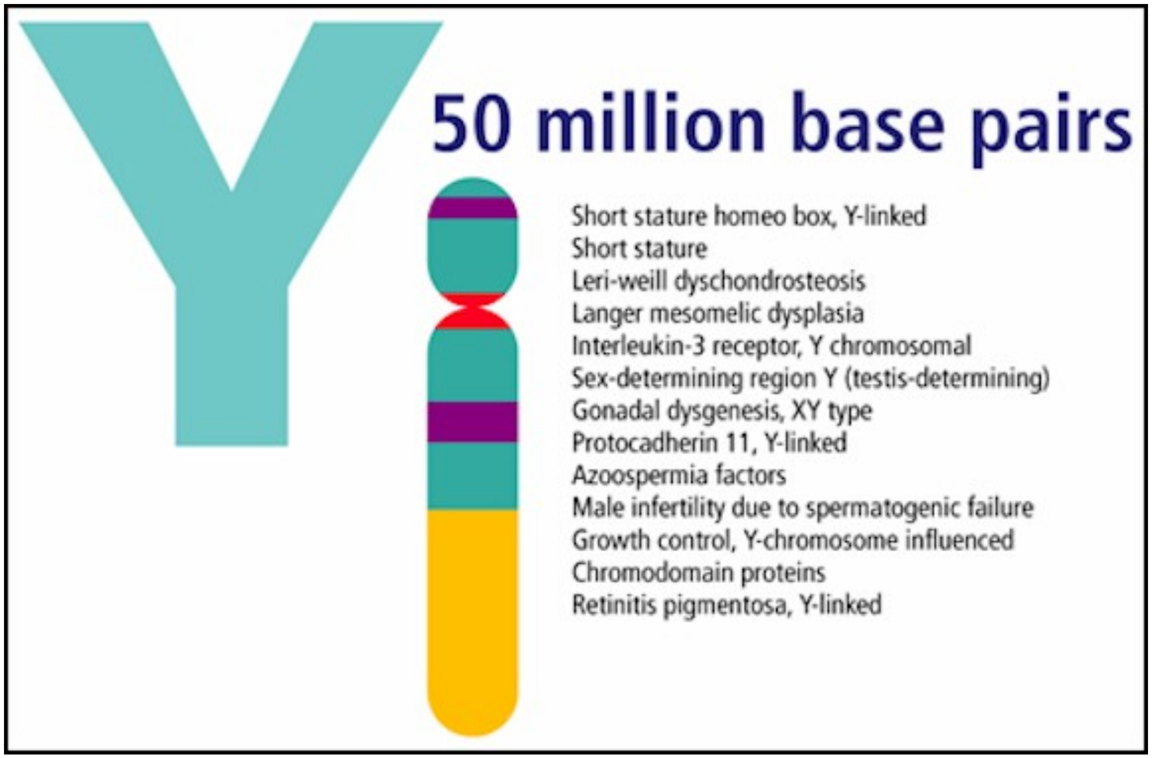


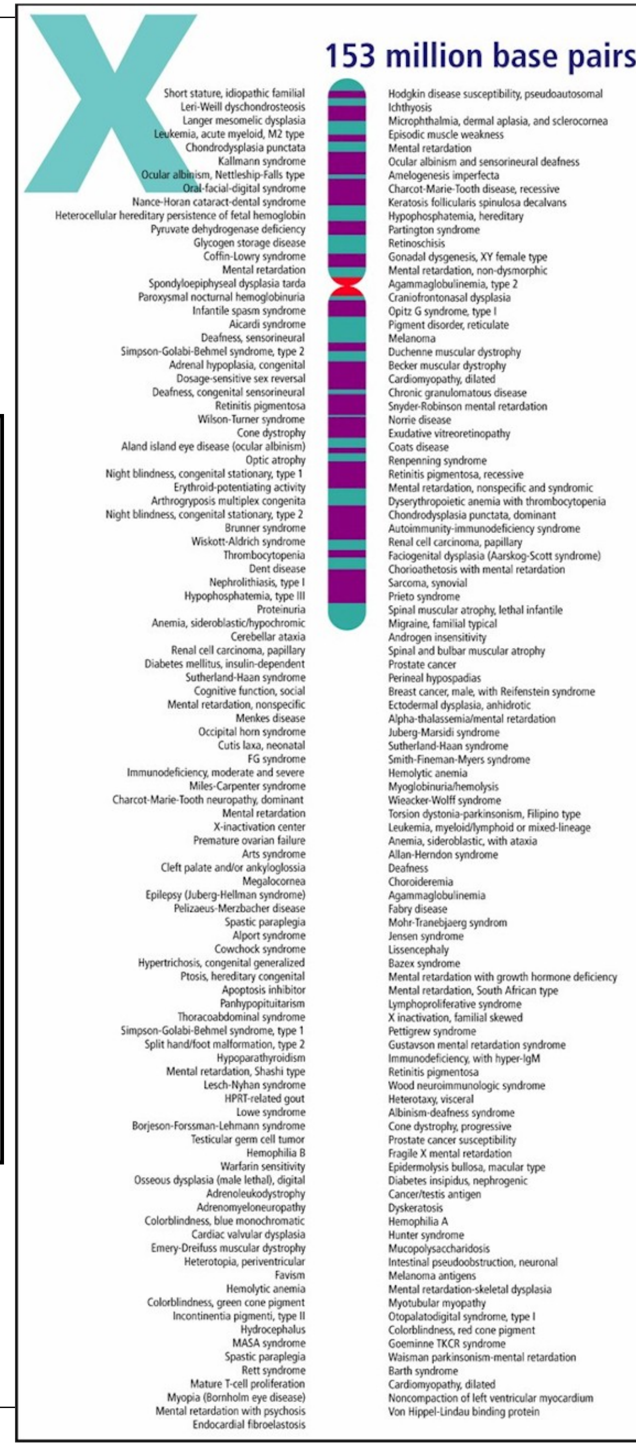
Sex Chromosomes

- Humans have 22-23 homologous pairs of chromosomes.
  - #23 determine sex → **<u>sex chromosomes</u>**
    - Females have 23 homologous chromosomes
    - Males have 22 homologous chromosomes



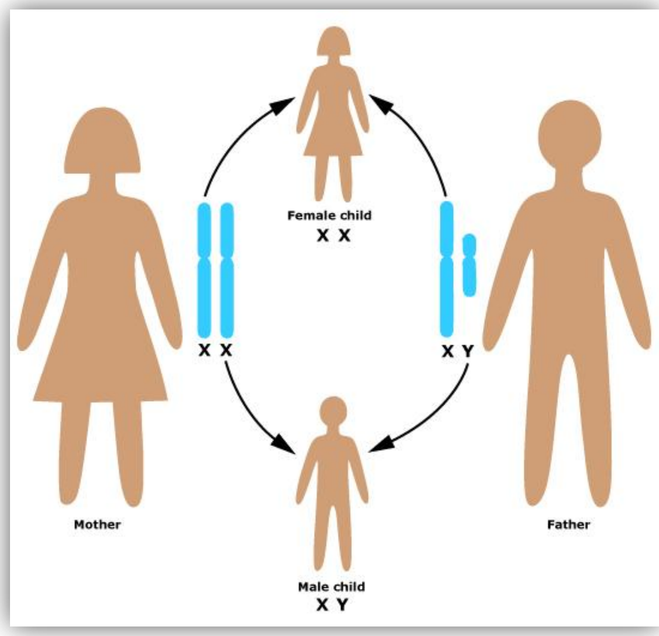



Y
50 million base pairs
Short stature homeo box, Y-linked
Short stature
Leri-weill dyschondrosteosis
Langer mesomelic dysplasia
Interleukin-3 receptor, Y chromosomal
Sex-determining region Y (testis-determining)
Gonadal dysgenesis, XY type
Protocadherin 11, Y-linked
Azoospermia factors
Male infertility due to spermatogenic failure
Growth control, Y-chromosome influenced
Chromodomain proteins
Retinitis pigmentosa, Y-linked


X
153 million base pairs
Short stature, idiopathic familial
Leri-Weill dyschondrosteosis
Langer mesomelic dysplasia
Leukemia, acute myeloid, M2 type
Chondrodysplasia punctata
Kallmann syndrome
Ocular albinism, Nettleship-Falls type
Oral-facial-digital syndrome
Nance-Horan cataract-dental syndrome
Heterocellular hereditary persistence of fetal hemoglobin
Pyruvate dehydrogenase deficiency
Glycogen storage disease
Coffin-Lowry syndrome
Mental retardation
Spondyloepiphyseal dysplasia tarda
Paroxysmal nocturnal hemoglobinuria
Infantile spasm syndrome
Aicardi syndrome
Deafness, sensorineural
Simpson-Golabi-Behmel syndrome, type 2
Adrenal hypoplasia, congenital
Dosage-sensitive sex reversal
Deafness, congenital sensorineural
Retinitis pigmentosa
Wilson-Turner syndrome
Cone dystrophy
Aland island eye disease (ocular albinism)
Optic atrophy
Night blindness, congenital stationary, type 1
Erythroid-potentiating activity
Arthrogryposis multiplex congenita
Night blindness, congenital stationary, type 2
Brunner syndrome
Wiskott-Aldrich syndrome
Thrombocytopenia
Dent disease
Nephrolithiasis, type I
Hypophosphatemia, type III
Proteinuria
Anemia, sideroblastic/hypochromic
Cerebellar ataxia
Renal cell carcinoma, papillary
Diabetes mellitus, insulin-dependent
Sutherland-Haan syndrome
Cognitive function, social
Mental retardation, nonspecific
Menkes disease
Occipital horn syndrome
Cutis laxa, neonatal
FG syndrome
Immunodeficiency, moderate and severe
Miles-Carpenter syndrome
Charcot-Marie-Tooth neuropathy, dominant
Mental retardation
X-inactivation center
Premature ovarian failure
Arts syndrome
Cleft palate and/or ankyloglossia
Megalocornea
Epilepsy (Juberg-Hellman syndrome)
Pelizaeus-Merzbacher disease
Spastic paraplegia
Alport syndrome
Cowchock syndrome
Hypertrichosis, congenital generalized
Ptosis, hereditary congenital
Apoptosis inhibitor
Panhypopituitarism
Thoracoabdominal syndrome
Simpson-Golabi-Behmel syndrome, type 1
Split hand/foot malformation, type 2
Hypoparathyroidism
Mental retardation, Shashi type
Lesch-Nyhan syndrome
HPRT-related gout
Lowe syndrome
Borjeson-Forssman-Lehmann syndrome
Testicular germ cell tumor
Hemophilia B
Warfarin sensitivity
Osseous dysplasia (male lethal), digital
Adrenoleukodystrophy
Adrenomyeloneuropathy
Colorblindness, blue monochromatic
Cardiac valvular dysplasia
Emery-Dreifuss muscular dystrophy
Heterotopia, periventricular
Favism
Hemolytic anemia
Colorblindness, green cone pigment
Incontinentia pigmenti, type II
Hydrocephalus
MASA syndrome
Spastic paraplegia
Rett syndrome
Mature T-cell proliferation
Myopia (Bornholm eye disease)
Mental retardation with psychosis
Endocardial fibroelastosis
Hodgkin disease susceptibility, pseudoautosomal
Ichthyosis
Microphthalmia, dermal aplasia, and sclerocornea
Episodic muscle weakness
Mental retardation
Ocular albinism and sensorineural deafness
Amelogenesis imperfecta
Charcot-Marie-Tooth disease, recessive
Keratosis follicularis spinulosa decalvans
Hypophosphatemia, hereditary
Partington syndrome
Retinoschisis
Gonadal dysgenesis, XY female type
Mental retardation, non-dysmorphic
Agammaglobulinemia, type 2
Craniofrontonasal dysplasia
Opitz G syndrome, type I
Pigment disorder, reticulate
Melanoma
Duchenne muscular dystrophy
Becker muscular dystrophy
Cardiomyopathy, dilated
Chronic granulomatous disease
Snyder-Robinson mental retardation
Norrie disease
Exudative vitreoretinopathy
Coats disease
Renpenning syndrome
Retinitis pigmentosa, recessive
Mental retardation, nonspecific and syndromic
Dyserythropoietic anemia with thrombocytopenia
Chondrodysplasia punctata, dominant
Autoimmunity-immunodeficiency syndrome
Renal cell carcinoma, papillary
Faciogenital dysplasia (Aarskog-Scott syndrome)
Chorioathetosis with mental retardation
Sarcoma, synovial
Prieto syndrome
Spinal muscular atrophy, lethal infantile
Migraine, familial typical
Androgen insensitivity
Spinal and bulbar muscular atrophy
Prostate cancer
Perineal hypospadias
Breast cancer, male, with Reifenstein syndrome
Ectodermal dysplasia, anhidrotic
Alpha-thalassemia/mental retardation
Juberg-Marsidi syndrome
Sutherland-Haan syndrome
Smith-Fineman-Myers syndrome
Hemolytic anemia
Myoglobinuria/hemolysis
Wieacker-Wolff syndrome
Torsion dystonia-parkinsonism, Filipino type
Leukemia, myeloid/lymphoid or mixed-lineage
Anemia, sideroblastic, with ataxia
Allan-Herndon syndrome
Deafness
Choroideremia
Agammaglobulinemia
Fabry disease
Mohr-Tranebjaerg syndrom
Jensen syndrome
Lissencephaly
Bazex syndrome
Mental retardation with growth hormone deficiency
Mental retardation, South African type
Lymphoproliferative syndrome
X inactivation, familial skewed
Pettigrew syndrome
Gustavson mental retardation syndrome
Immunodeficiency, with hyper-IgM
Retinitis pigmentosa
Wood neuroimmunologic syndrome
Heterotaxy, visceral
Albinism-deafness syndrome
Cone dystrophy, progressive
Prostate cancer susceptibility
Fragile X mental retardation
Epidermolysis bullosa, macular type
Diabetes insipidus, nephrogenic
Cancer/testis antigen
Dyskeratosis
Hemophilia A
Hunter syndrome
Mucopolysaccharidosis
Intestinal pseudoobstruction, neuronal
Melanoma antigens
Mental retardation-skeletal dysplasia
Myotubular myopathy
Otopalatodigital syndrome, type I
Colorblindness, red cone pigment
Goeminne TKCR syndrome
Waisman parkinsonism-mental retardation
Barth syndrome
Cardiomyopathy, dilated
Noncompaction of left ventricular myocardium
Von Hippel-Lindau binding protein

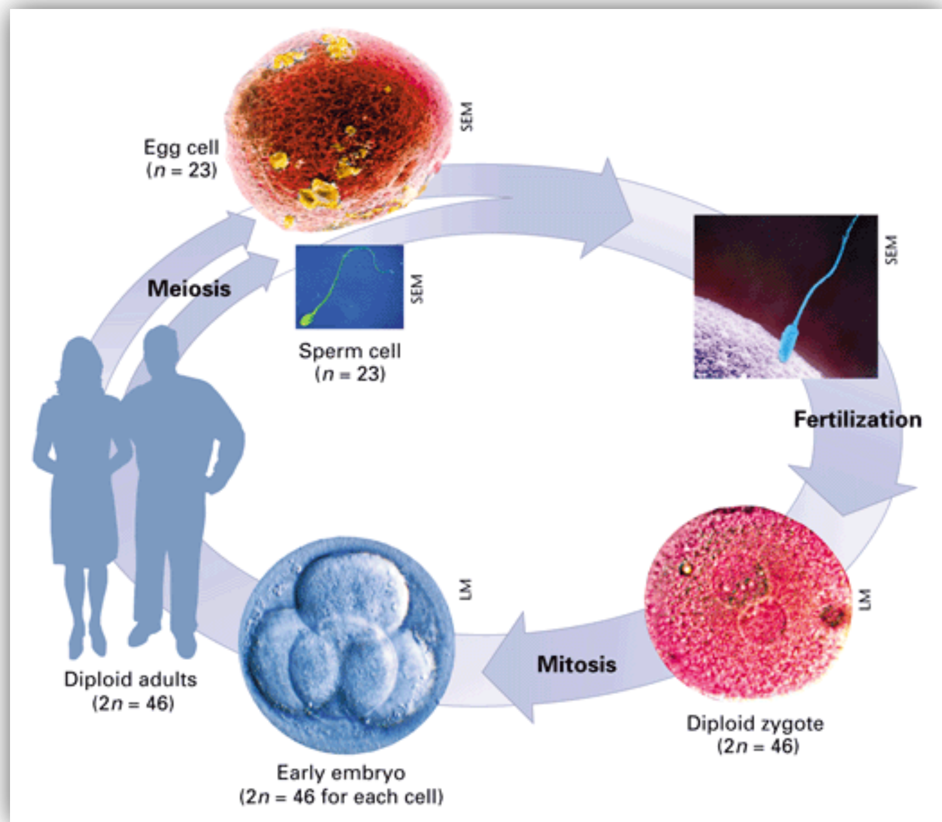
Sex Chromosomes

- 2 forms of the sex chromosome→ X & Y
  - males have one X chromosome and one Y chromosome (XY at #23)
  - females have two X chromosomes (XX at #23)
- Most genes carried on the X chromosome do not have counterparts on the tiny Y, and the Y has genes that are not on the X



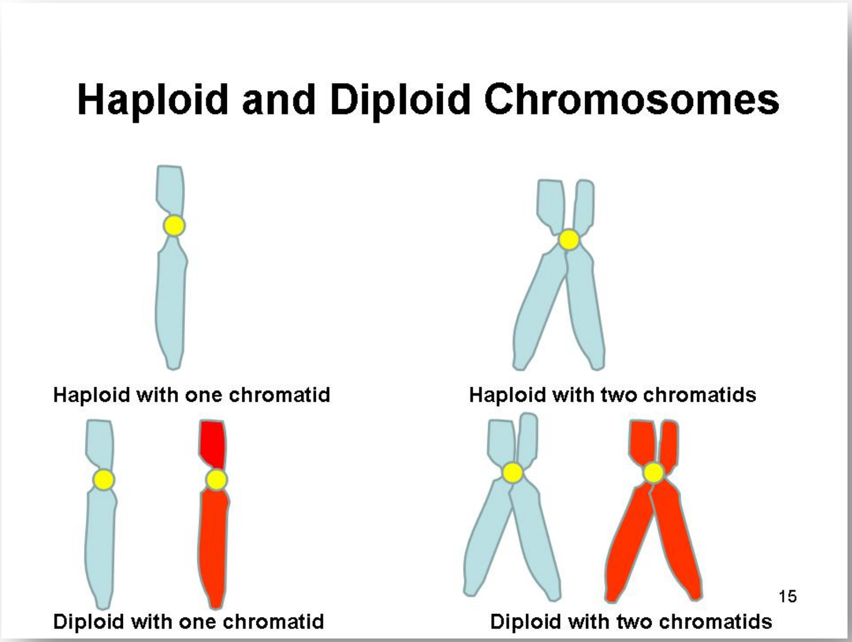
Diploid and Haploid Cells

- 2 sets of chromosomes
  - 1 inherited from each parent
  - This is a key factor in the life cycles of all sexually reproducing organisms.



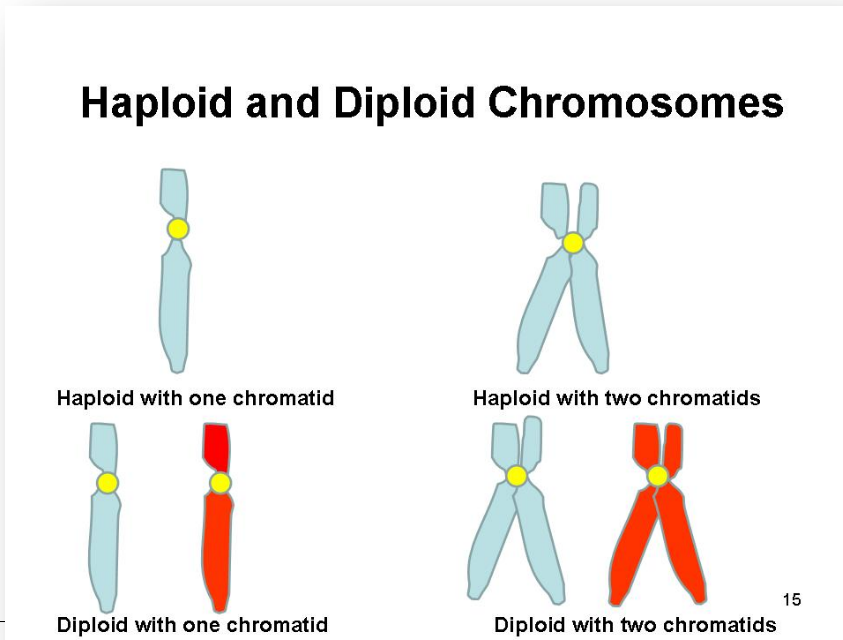
Diploid Cells

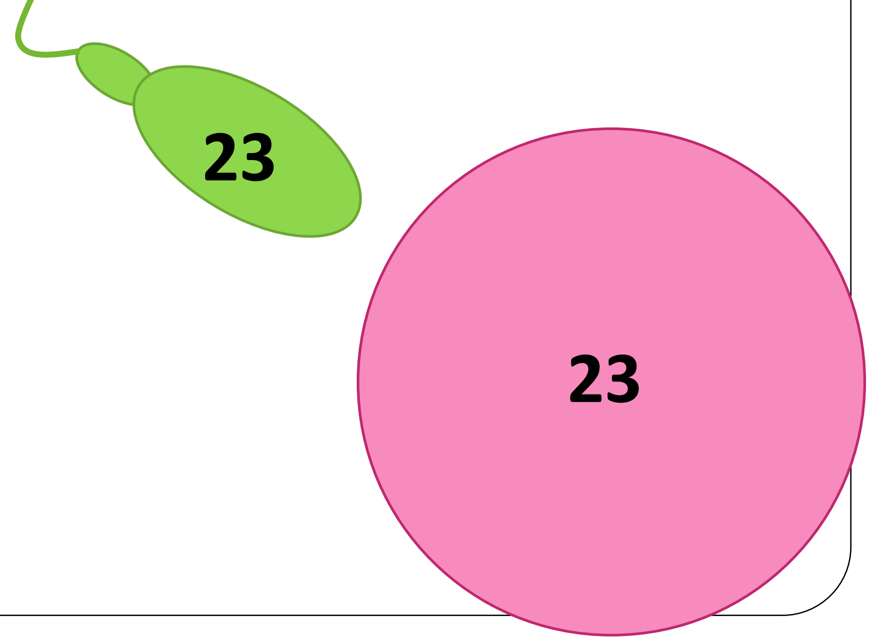
- Almost all human cells are diploid
  - diploid : the cell contains two homologous sets of chromosomes.
- The total number of chromosomes, 46 in humans, is referred to as the *diploid number*
  - abbreviated $2n$, as in $2n = 46$



Haploid Cells

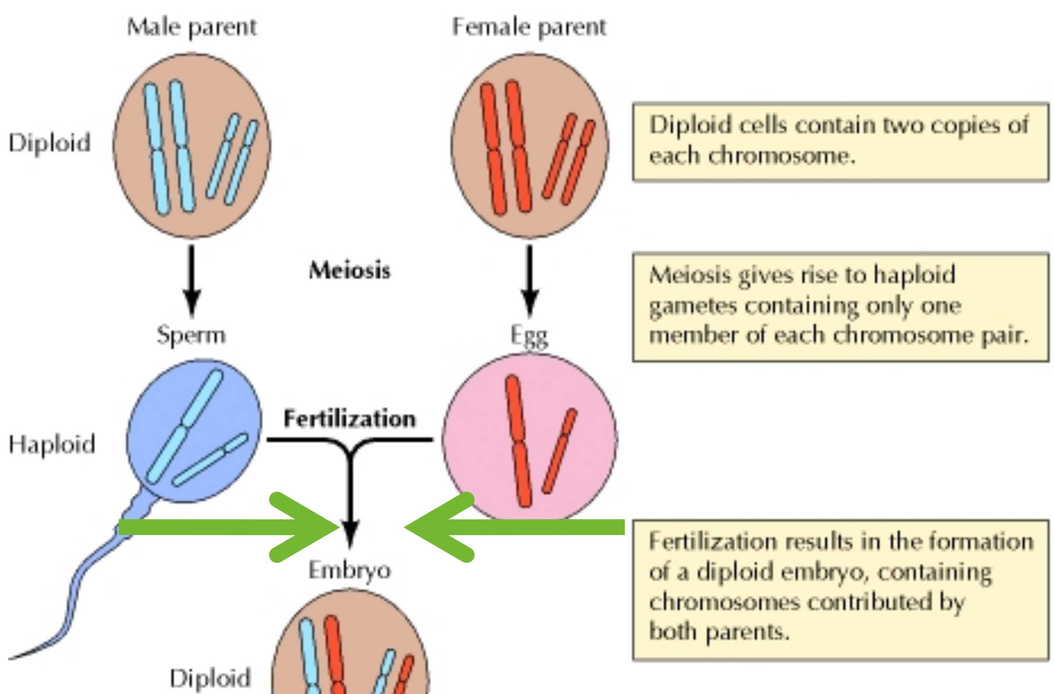
- Haploid : (half) cell with a single set of chromosomes
  - For humans, the haploid number (abbreviated *n*) is 23.
  - haploid cells are produced through the process of *meiosis*
    - Each gamete has a single set of chromosomes, one from each homologous pair.
      - Ex:gametes : sex cells , or egg and sperm cells





Haploid and Diploid cells

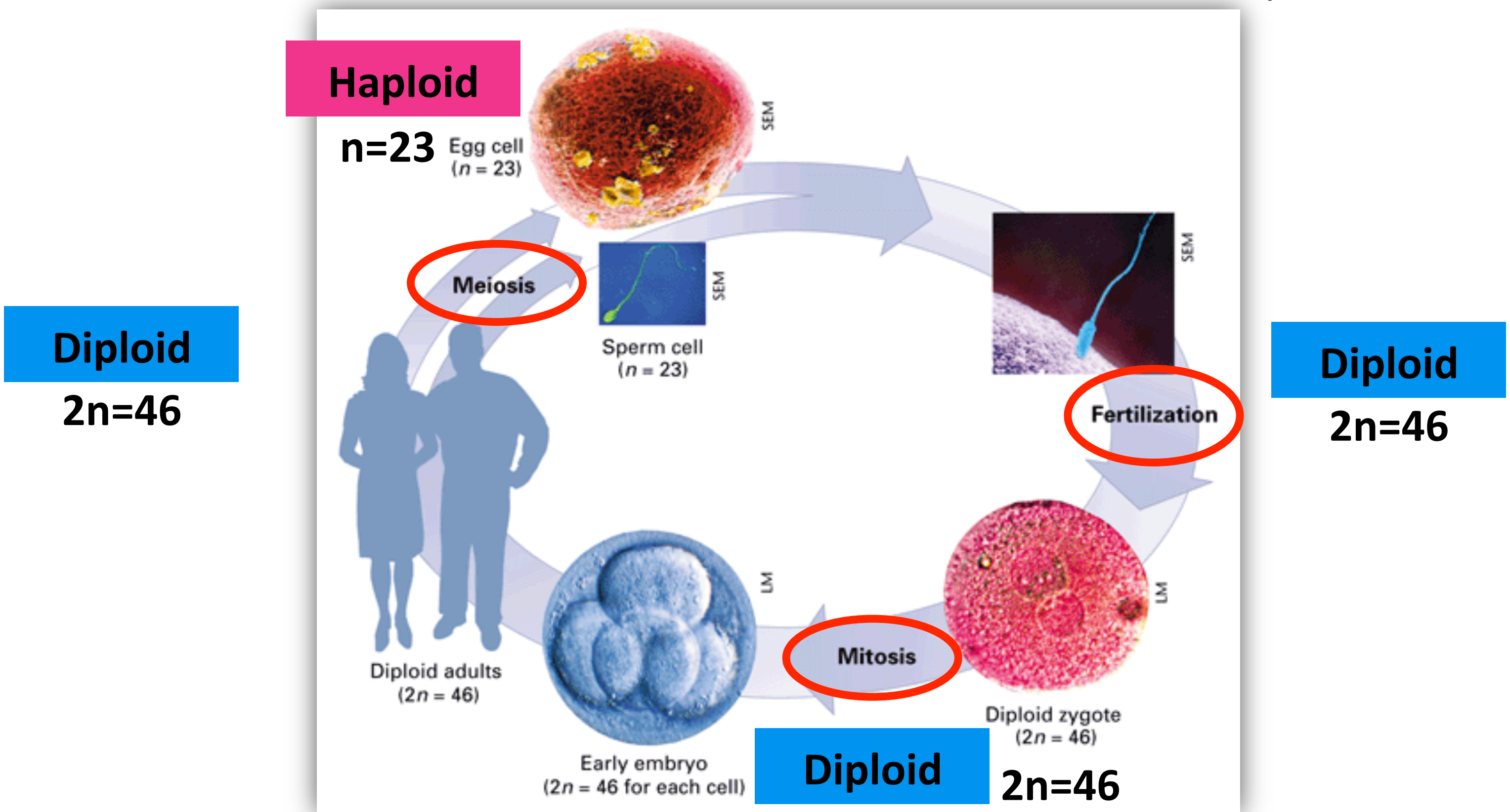
- **Fertilization -**
  - the nucleus of a haploid sperm cell from the father fuses with the nucleus of a haploid egg cell from the mother



Homologous Chromosomes!!!

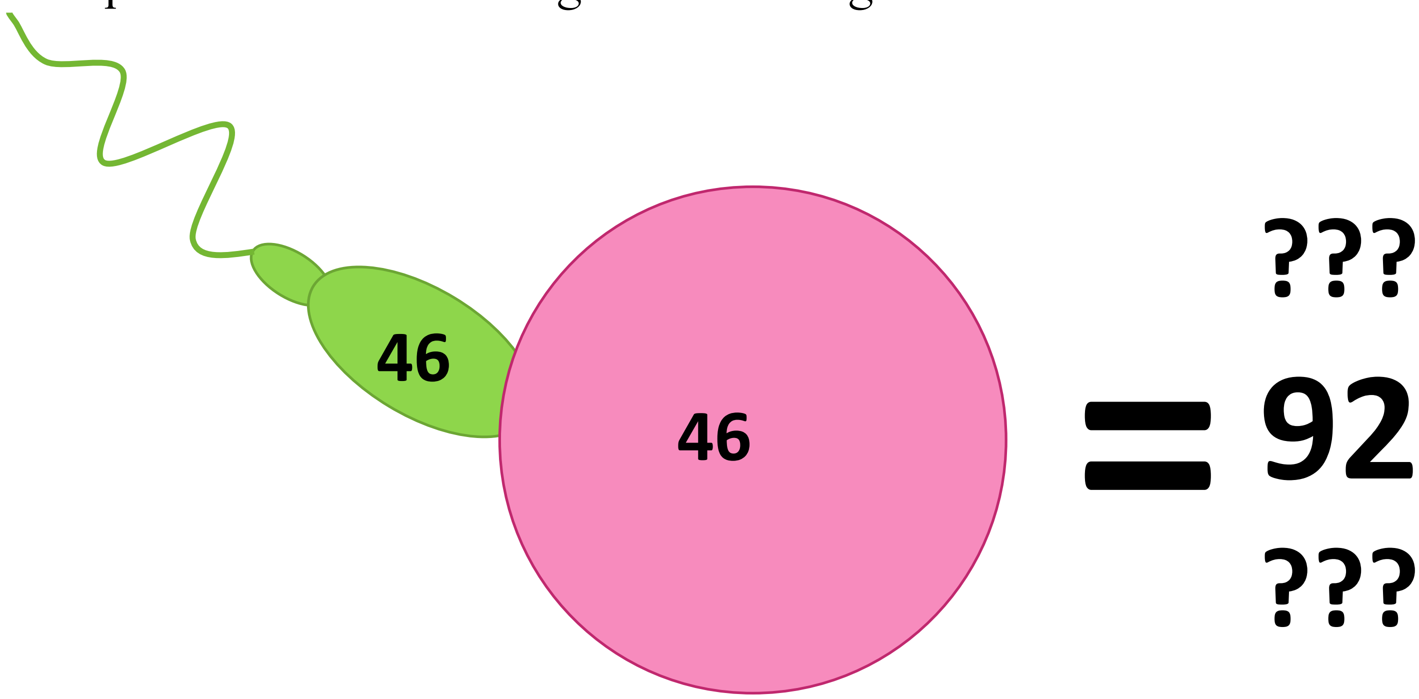
Haploid and Diploid cells

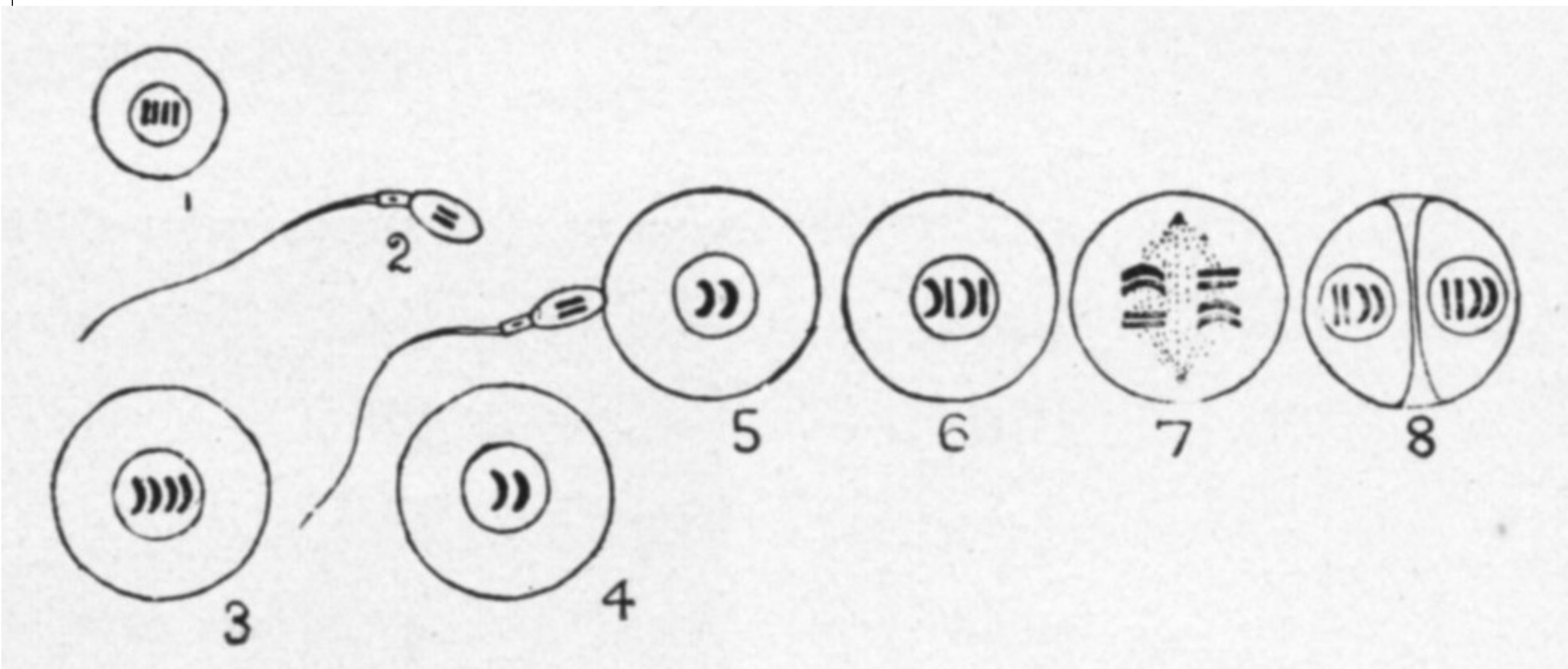
- Zygote: fertilized egg, diploid cell.
  - has two homologous sets of chromosomes, one set from each parent.
  - develops into a sexually mature adult with trillions of cells produced by mitosis.
- fertilization restores the diploid chromosome number, and the zygote's 46 chromosomes are passed on to all the other diploid body cells.



The Importance of Meiosis

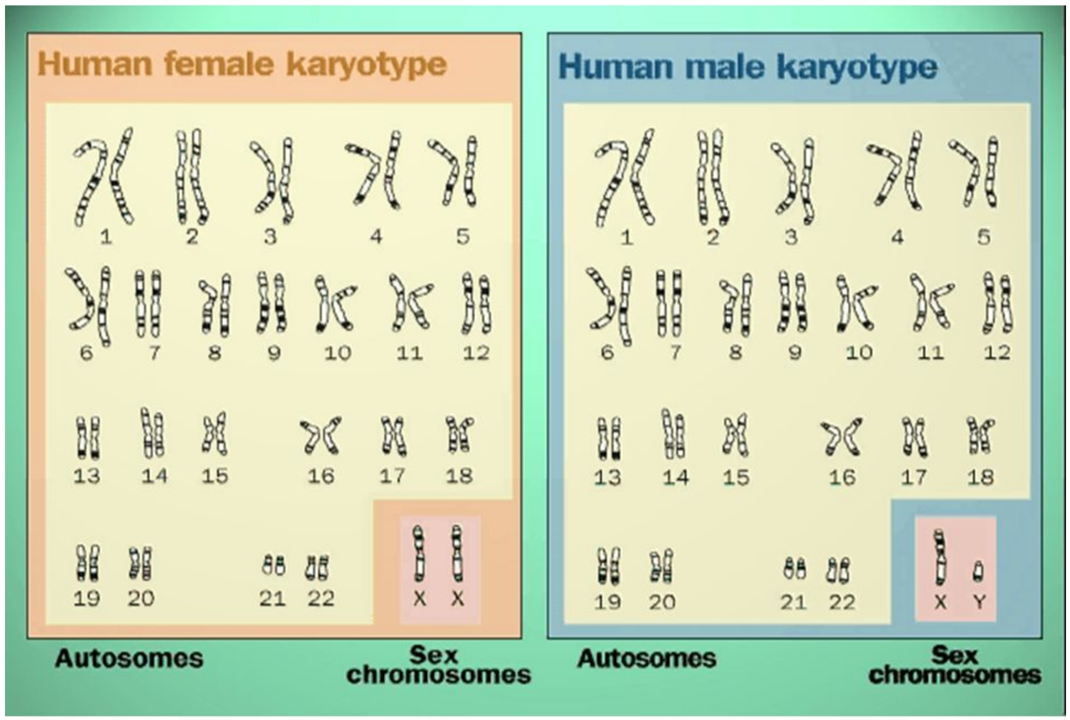
- Producing haploid gametes by meiosis keeps the chromosome number from doubling in every generation.
  - If meiosis did not occur, cells involved in fertilization would produce new organisms having twice the number of chromosomes as those in the previous generation.
  - The alternation of meiosis and fertilization keeps the number of chromosomes in a species the same from generation to generation.




1
2
3
4
5
6
7
8

Warm-up 1/17/17

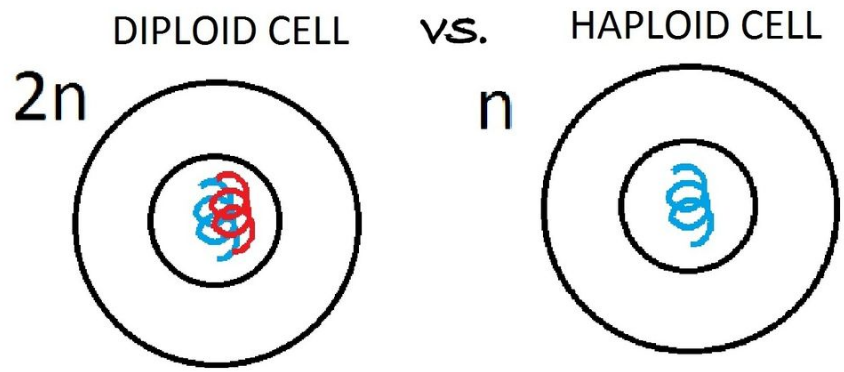
- 16. How are sister chromatids and homologous chromosomes different? Draw a picture to show the difference.



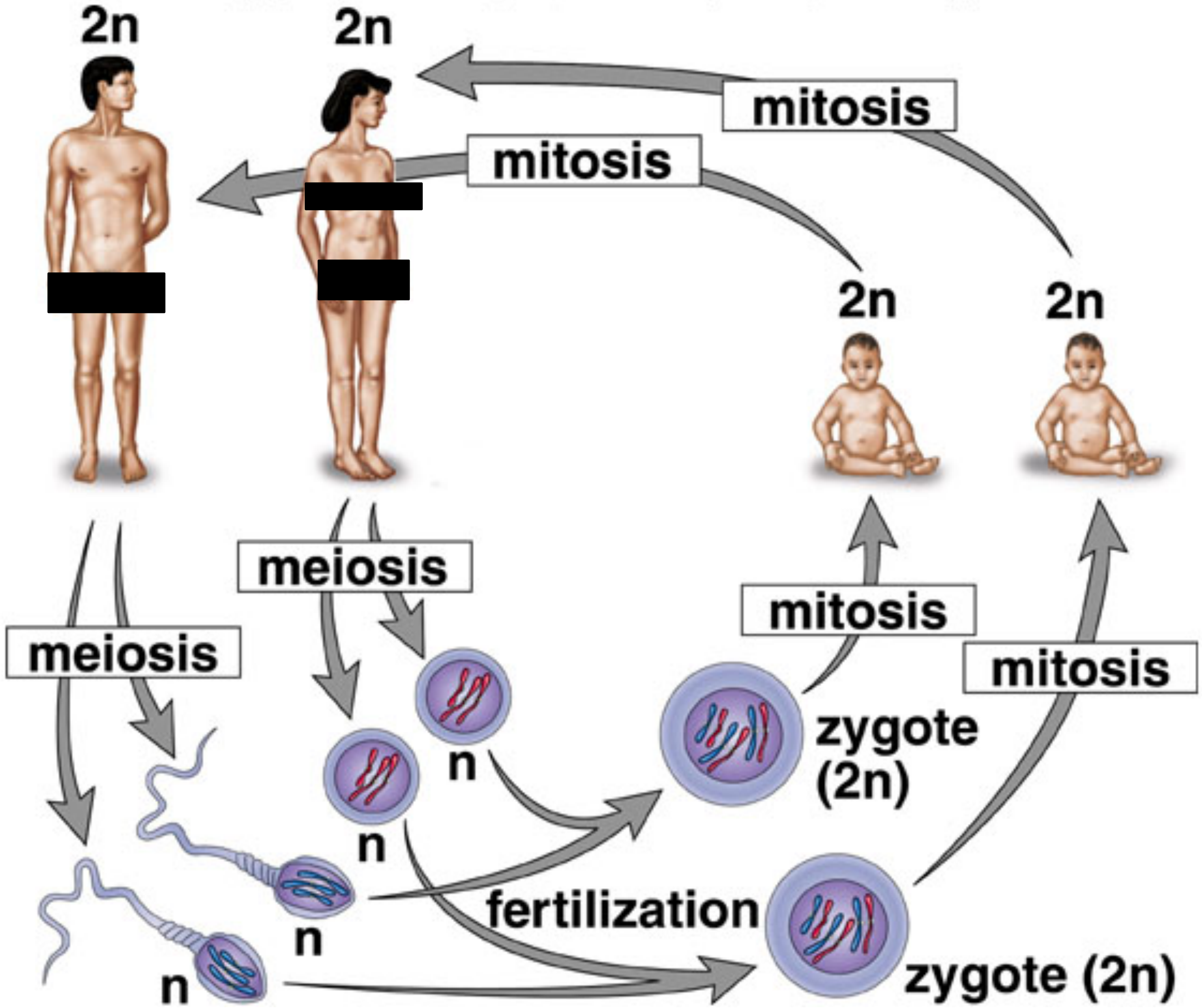
- 17. Explain why not all humans have 23 homologous pairs of chromosomes. (hint: think about the sex chromosomes).

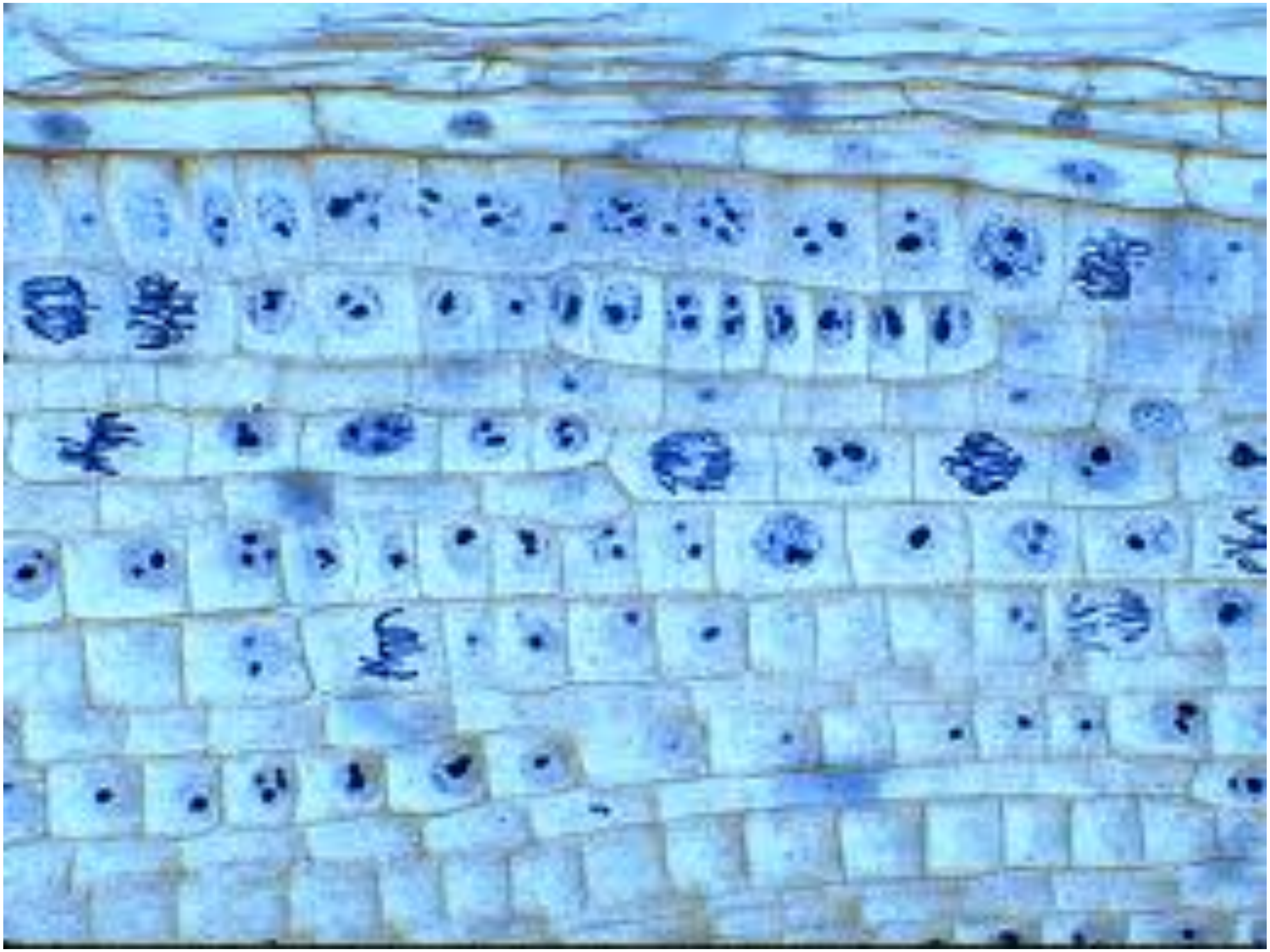
- Honors: Extension questions due Tomorrow…any questions?

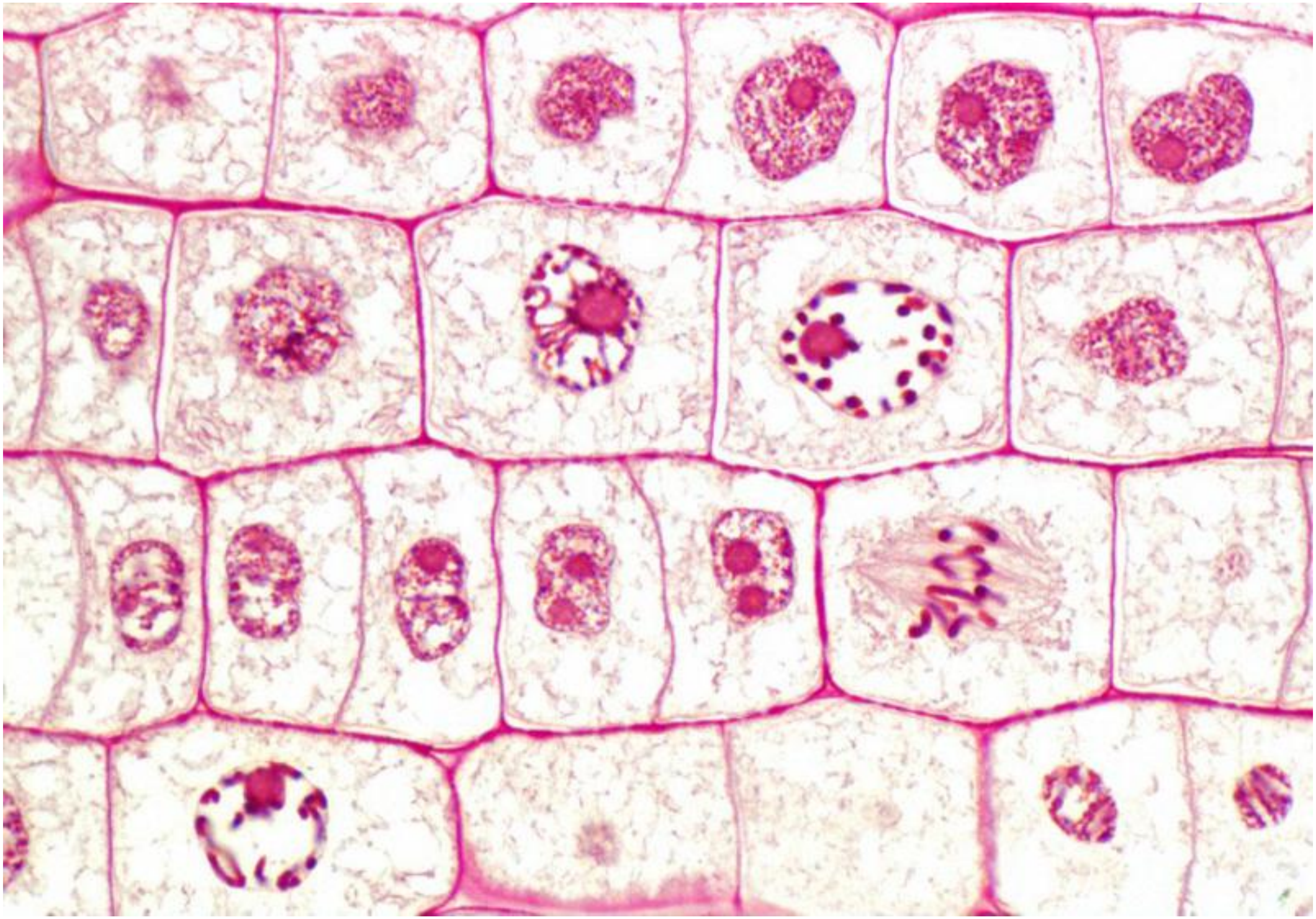
Warm-up 2/18



- **18 . What is the human diploid and haploid number of chromosomes? Give a type of cell where that number of chromosomes would be found.**
- **19.** Fill in the blanks using the following words: Interphase, S Phase, Chromosomes, Chromatin, sister chromatids, Chromosomes,
  - **The genetic material called _____________, contains DNA and other proteins. It condenses in Prophase to form ____________, which are now visible. Each ___________________ is made up of two ________________________________ that have identical information found on them. The copy of genetic material was made during the ___________ of _________________________.**

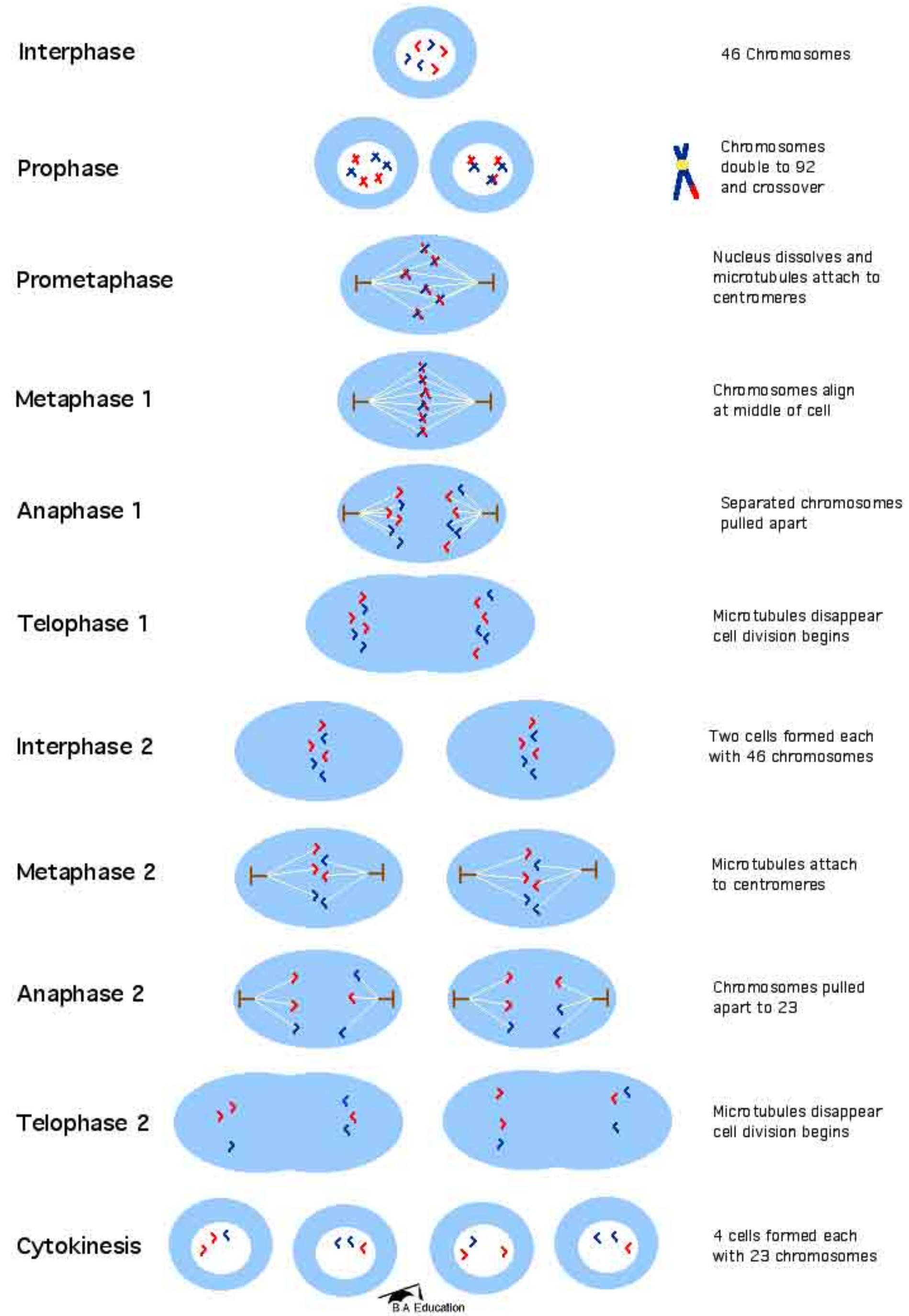

2n
2n
mitosis
mitosis
2n
2n
meiosis
meiosis
mitosis
mitosis
n
n
zygote
(2n)
n
fertilization
n
zygote (2n)





Meiosis:

The Process

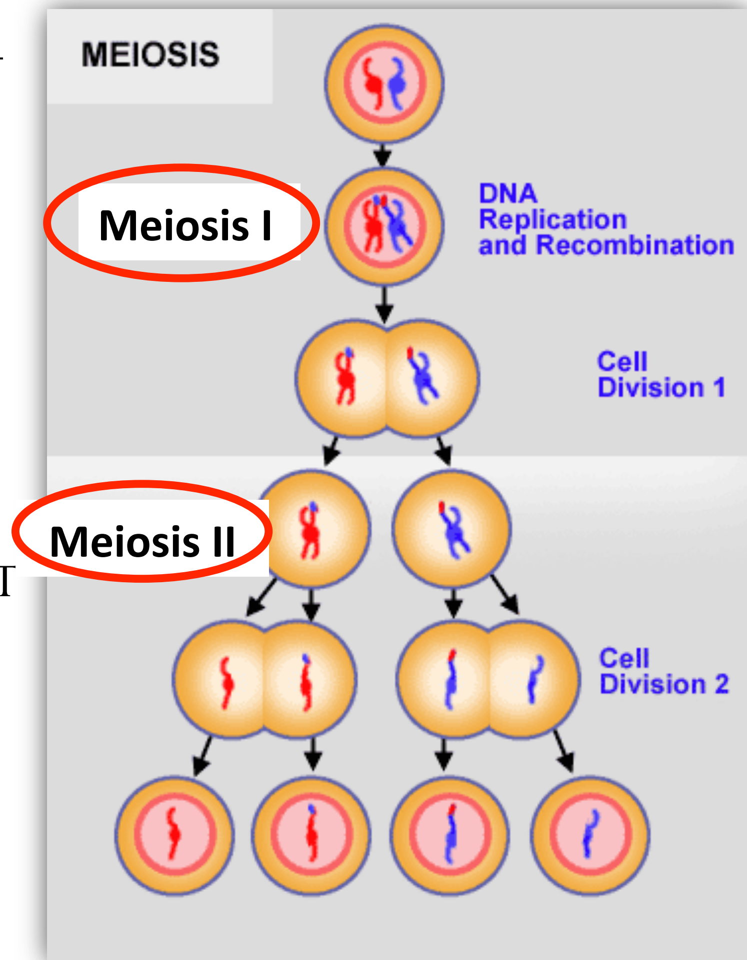


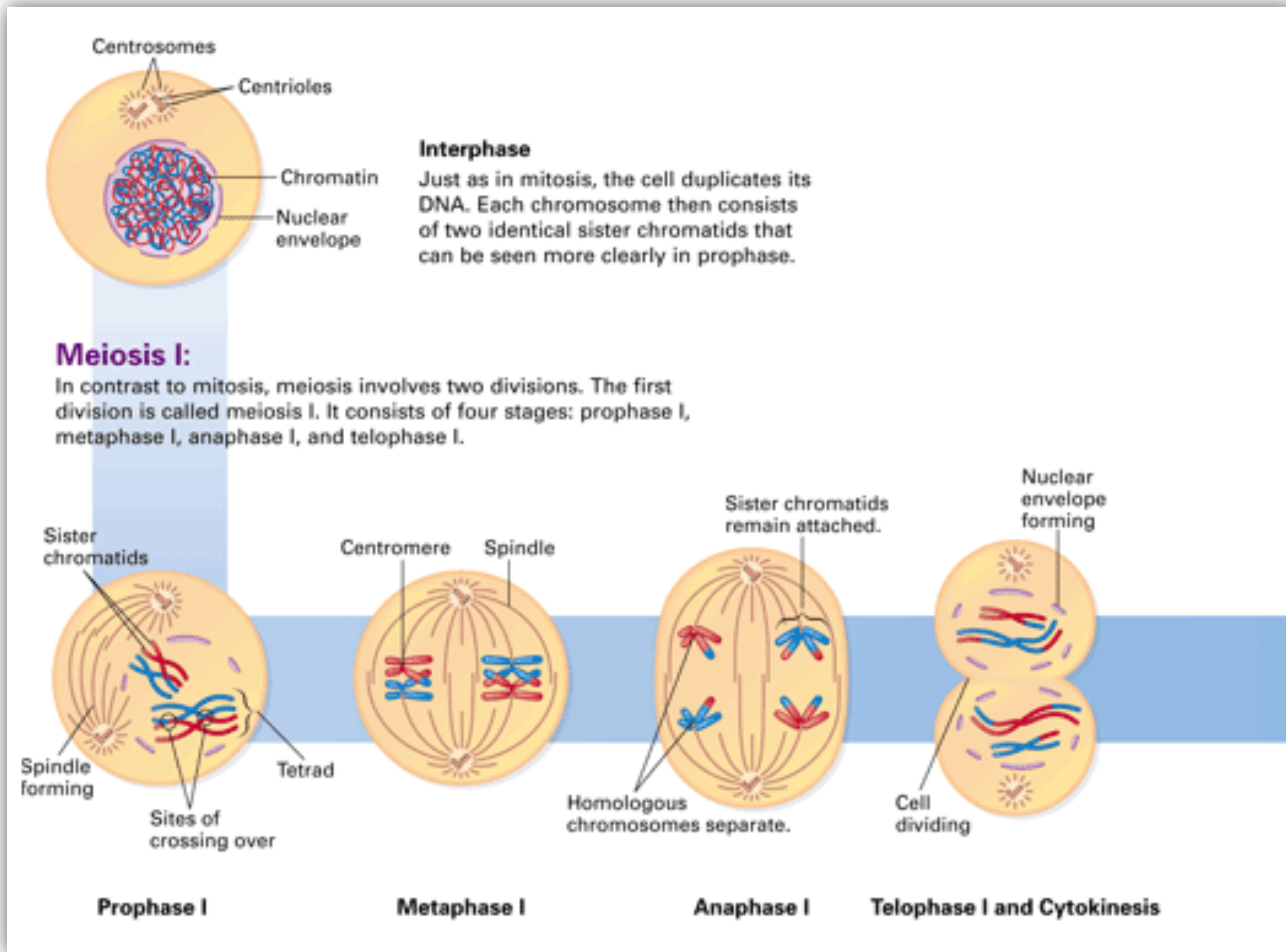
Meiosis Versus Mitosis

- MEIOSIS is different from MITOSIS in 2 major ways.
  - 1st major difference
    - **Meiosis** produces **4 new offspring cells**, each with **one set of chromosomes**— *1/2 the # of chromosomes as parent cell*
    - **Mitosis** produces **2 offspring cells**, each with the **same number of chromosomes** as the parent cell.
  - 2nd major difference
    - **Meiosis** involves the swapping of genetic material between homologous chromosomes- *crossing over*

The Two Meiotic Divisions

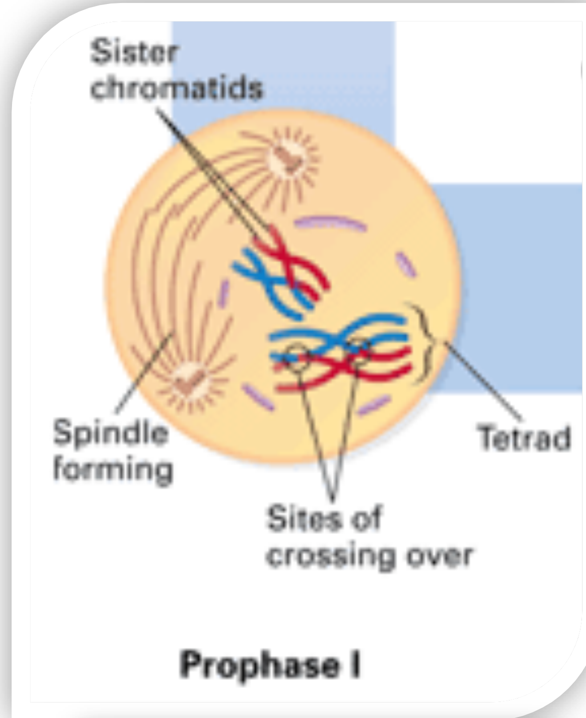
- Meiosis consists of two distinct parts—
  - **Meiosis I**
    - homologous chromosomes with sister chromatids, separate from one another
  - **Meiosis II**
    - sister chromatids are separated much as they are in mitosis.
    - However, the resulting cells are haploid, NOT diploid.

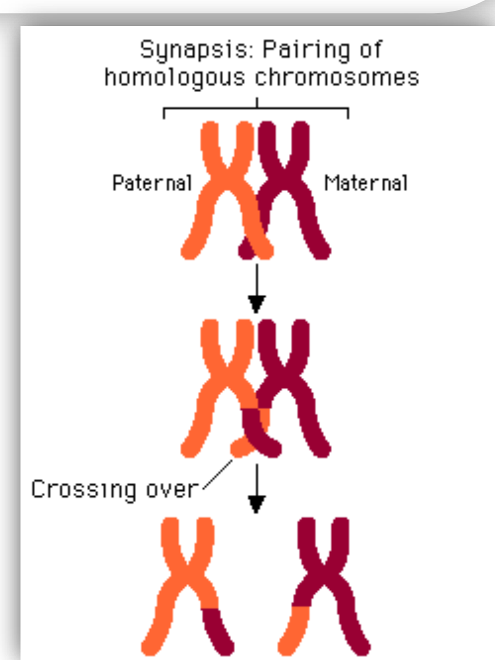



Centrosomes
Centrioles
Chromatin
Nuclear envelope
Interphase
Just as in mitosis, the cell duplicates its DNA. Each chromosome then consists of two identical sister chromatids that can be seen more clearly in prophase.
Meiosis I:
In contrast to mitosis, meiosis involves two divisions. The first division is called meiosis I. It consists of four stages: prophase I, metaphase I, anaphase I, and telophase I.
Sister chromatids
Spindle forming
Sites of crossing over
Tetrad
Centromere
Spindle
Sister chromatids remain attached.
Homologous chromosomes separate.
Nuclear envelope forming
Cell dividing
Prophase I
Metaphase I
Anaphase I
Telophase I and Cytokinesis

Prophase I

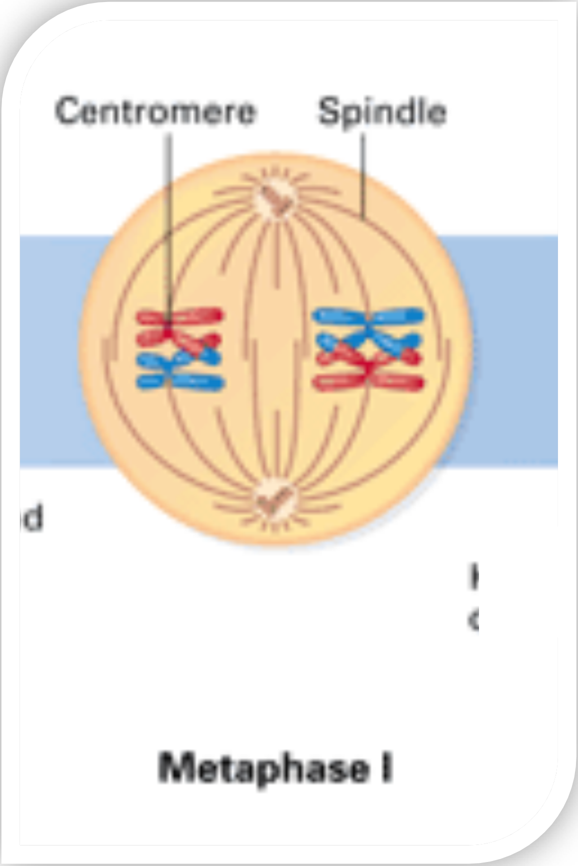
- Meiosis adds 2 new steps to the mitosis routine.
  - 1) Tetrads:
    - Homologous chromosomes to stick together along their length.
    - **Homologous chromosomes are paired, and consist of four chromatids, referred to as tetrads.**
    - The tetrads attach to the spindle.
  - 2) Crossing Over:
    - **Sister chromatids in the tetrads exchange some genetic material in the process known as crossing over.**





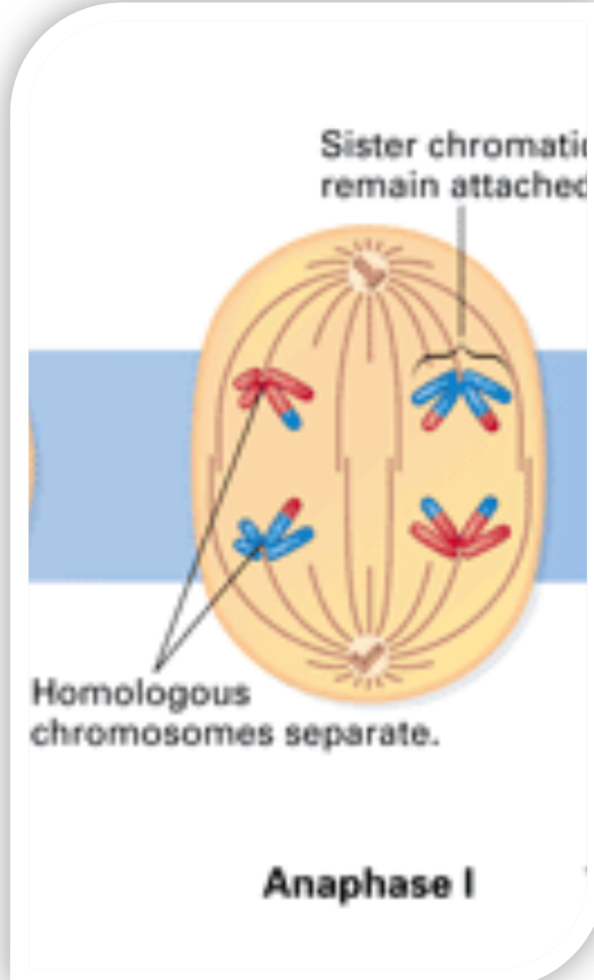
Metaphase I

- **Tetrads move to the middle of the cell and line up across the spindle.**



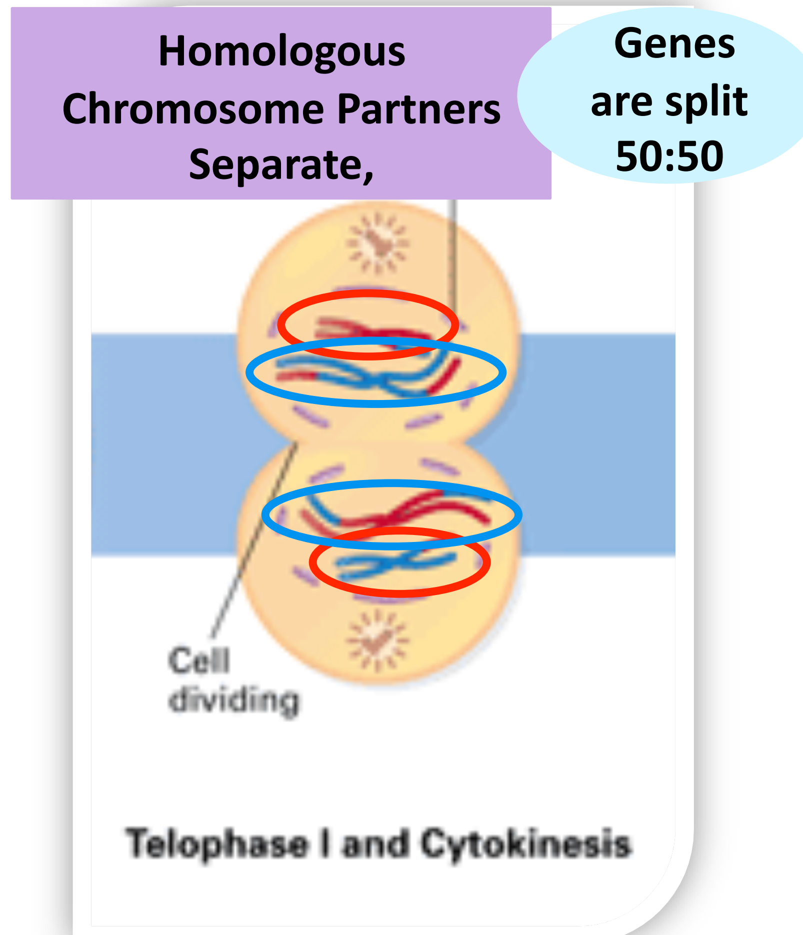
Anaphase I

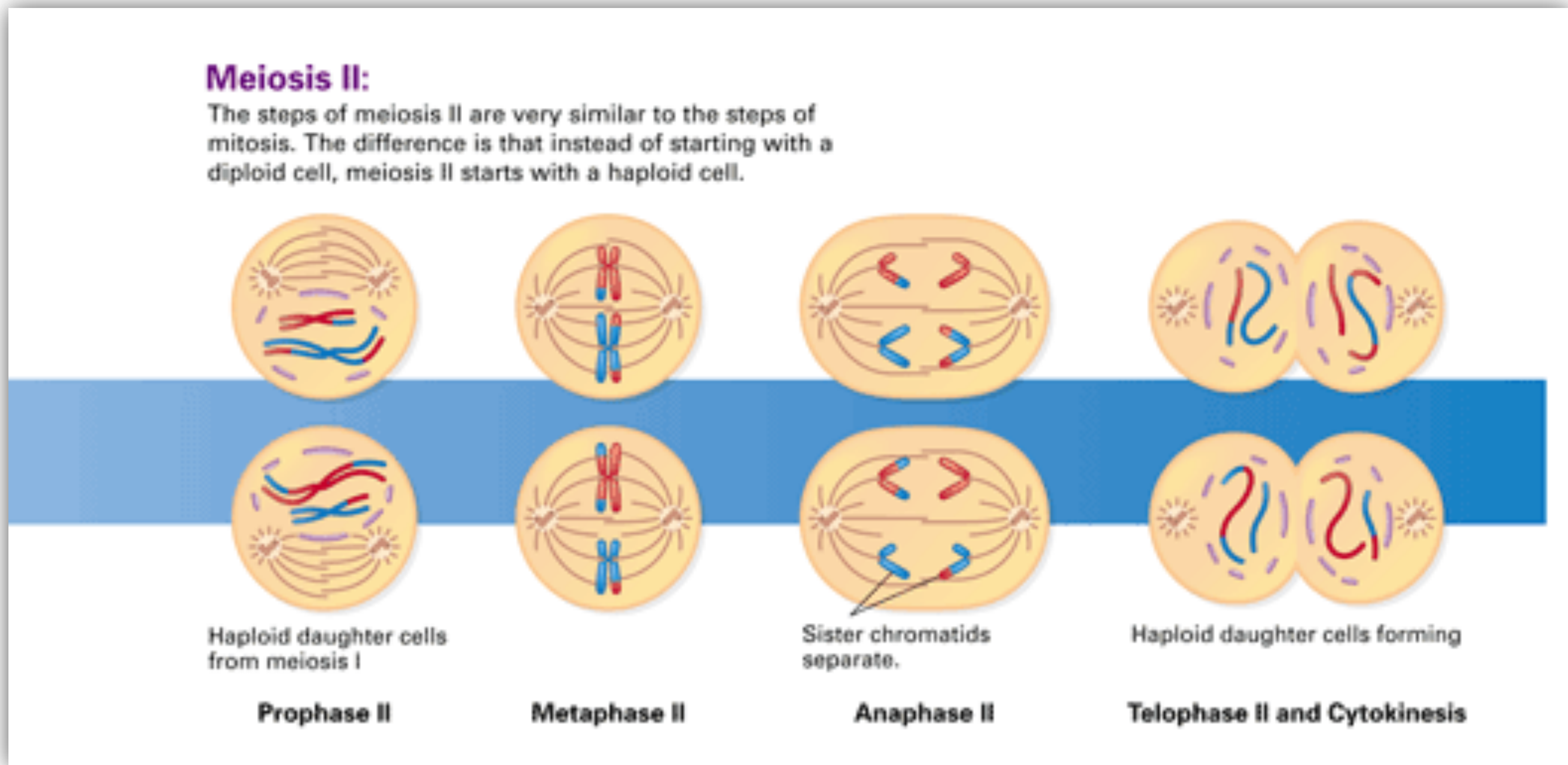
- Homologous chromosomes separate and migrate to opposite poles of the spindle.
- Sister chromatids migrate together—each chromosome is made up of two copies.
- Genes split in half.
  - This cell started with 4 chromosomes, there are only 2chromosomes (each with 2 copies) moving to each pole.



Telophase I and Cytokinesis

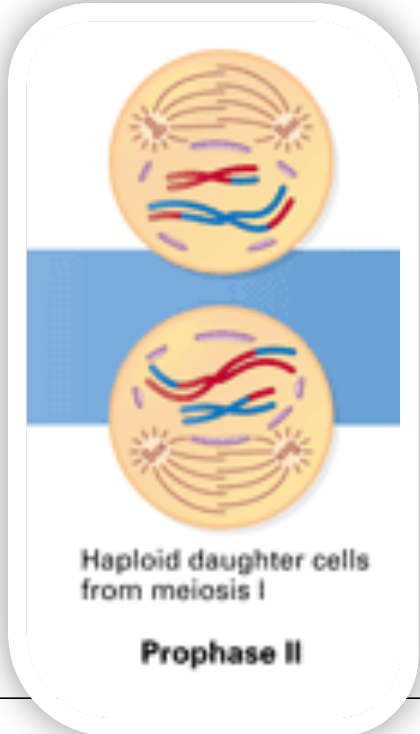
- **Chromosomes with sister chromatids arrive at the poles forming *Haploid* daughter nuclei**
  - Each has only one set of chromosomes, even though each chromosome consists of two sister chromatids
- **Cytokinesis occurs with telophase I, forming two haploid daughter cells.**
- **The chromosomes in each daughter cell are still duplicated.**




Meiosis II:
The steps of meiosis II are very similar to the steps of mitosis. The difference is that instead of starting with a diploid cell, meiosis II starts with a haploid cell.
Haploid daughter cells from meiosis I
Sister chromatids separate.
Haploid daughter cells forming
Prophase II
Metaphase II
Anaphase II
Telophase II and Cytokinesis

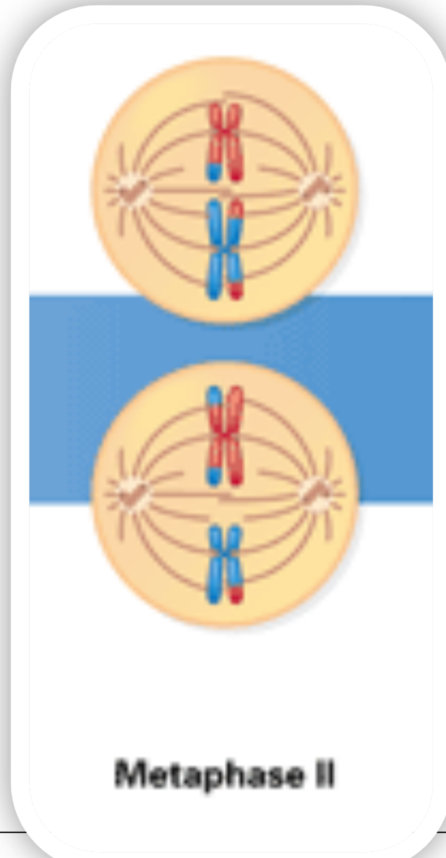
Prophase II:

- **<u>In each haploid daughter cell, a spindle forms, attaches to the centromeres, and moves the individual chromosomes to the middle of the cell.</u>**



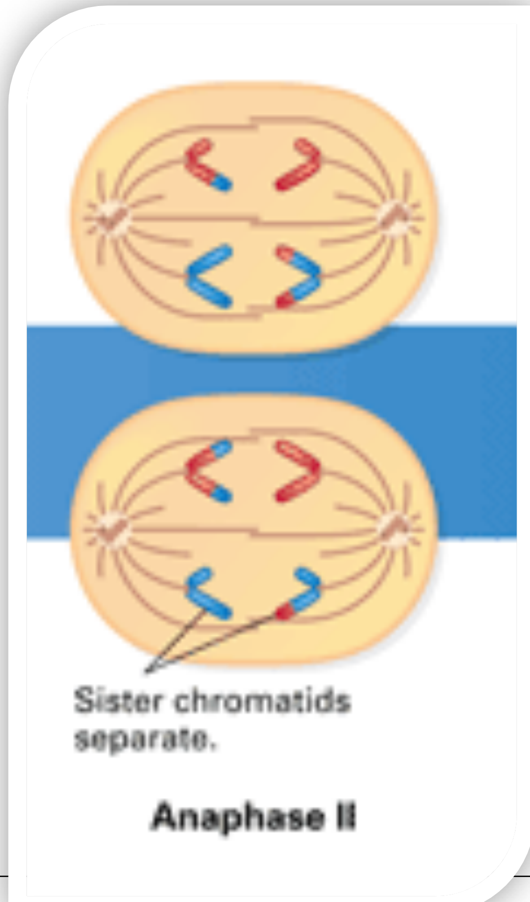
Metaphase II:

- The chromosomes line up in the middle of the cell with spindle microtubules attached to each sister chromatid.



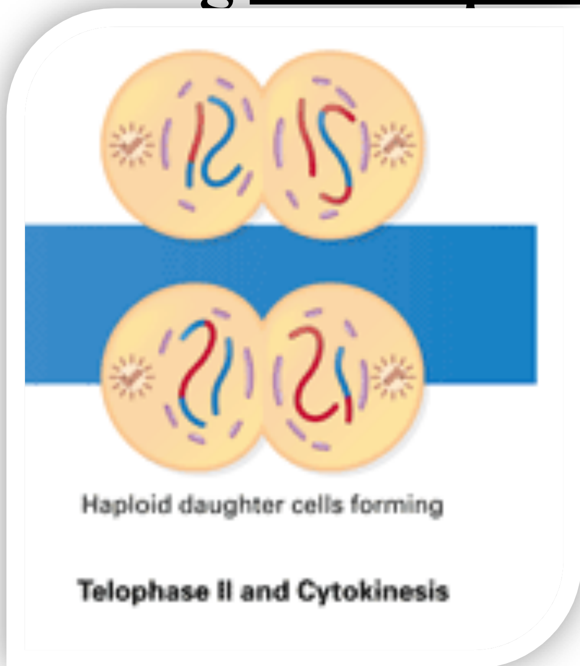
Anaphase II:

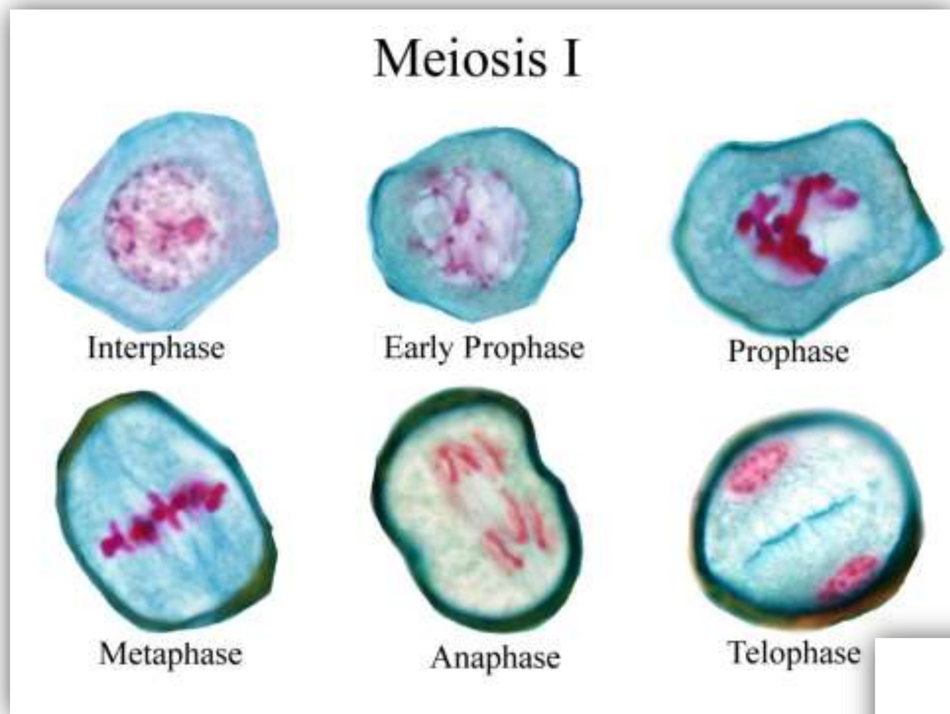
- **<u>The sister chromatids separate and move to opposite poles</u>.**

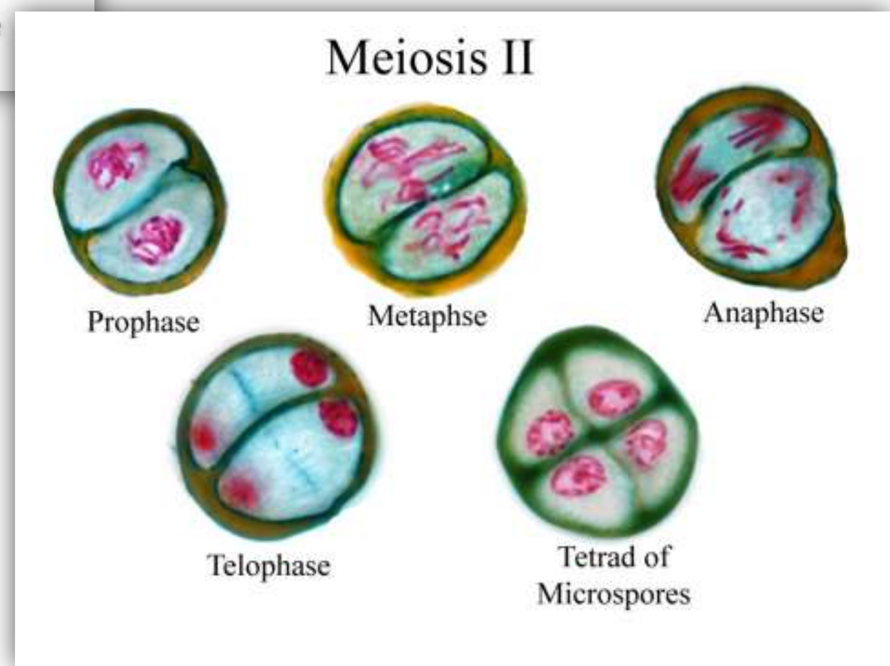


Telophase II and Cytokinesis:

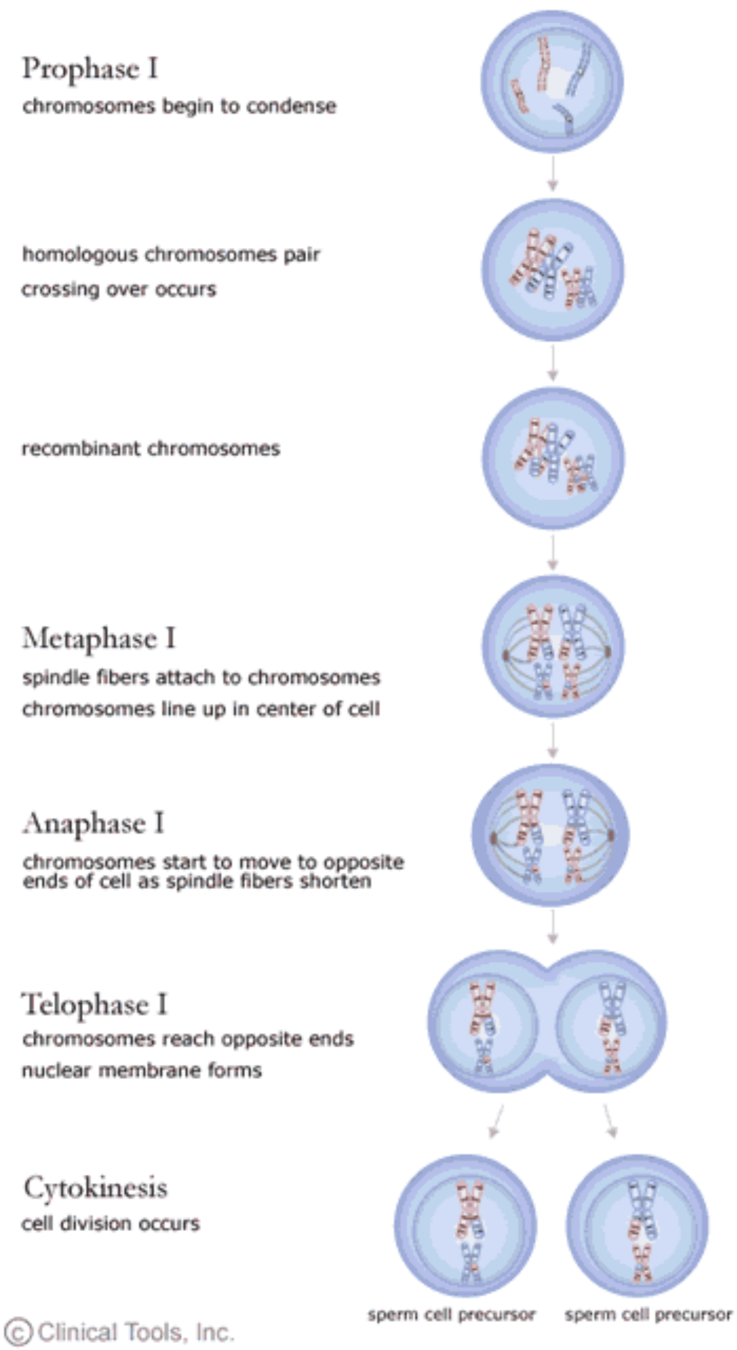
- **<u>The chromatids, now considered individual chromosomes, arrive at the poles.</u>**
- **<u>Cytokinesis splits the cells one more time</u>.**
- The process of meiosis is completed**, producing <u>four haploid daughter cells as a final result.</u>**



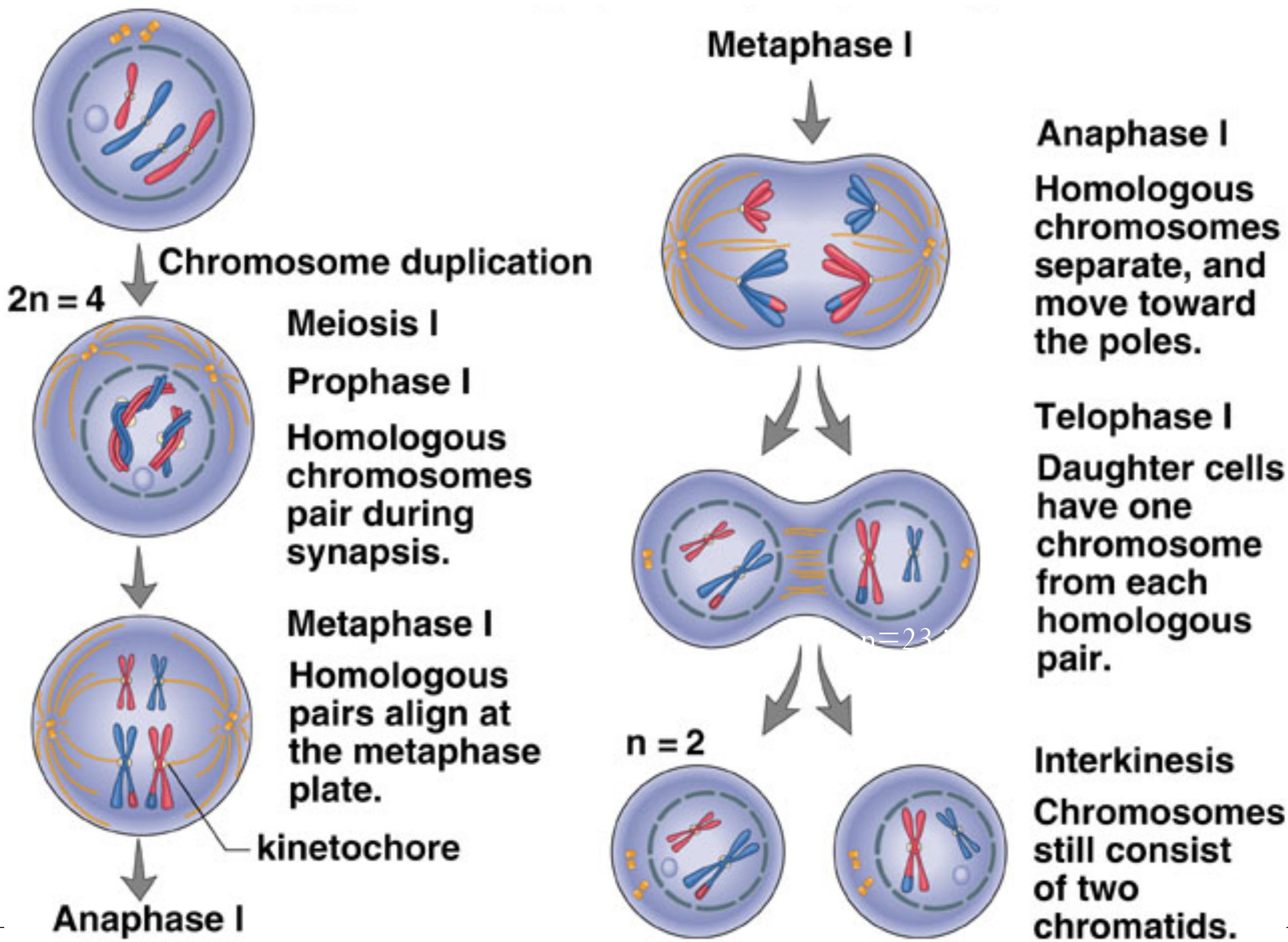

Meiosis I
Interphase
Early Prophase
Prophase
Metaphase
Anaphase
Telophase


Meiosis II
Prophase
Metaphse
Anaphase
Telophase
Tetrad of
Microspores

Meiosis I in Males



Steps of Meiosis I



Steps of Meiosis II

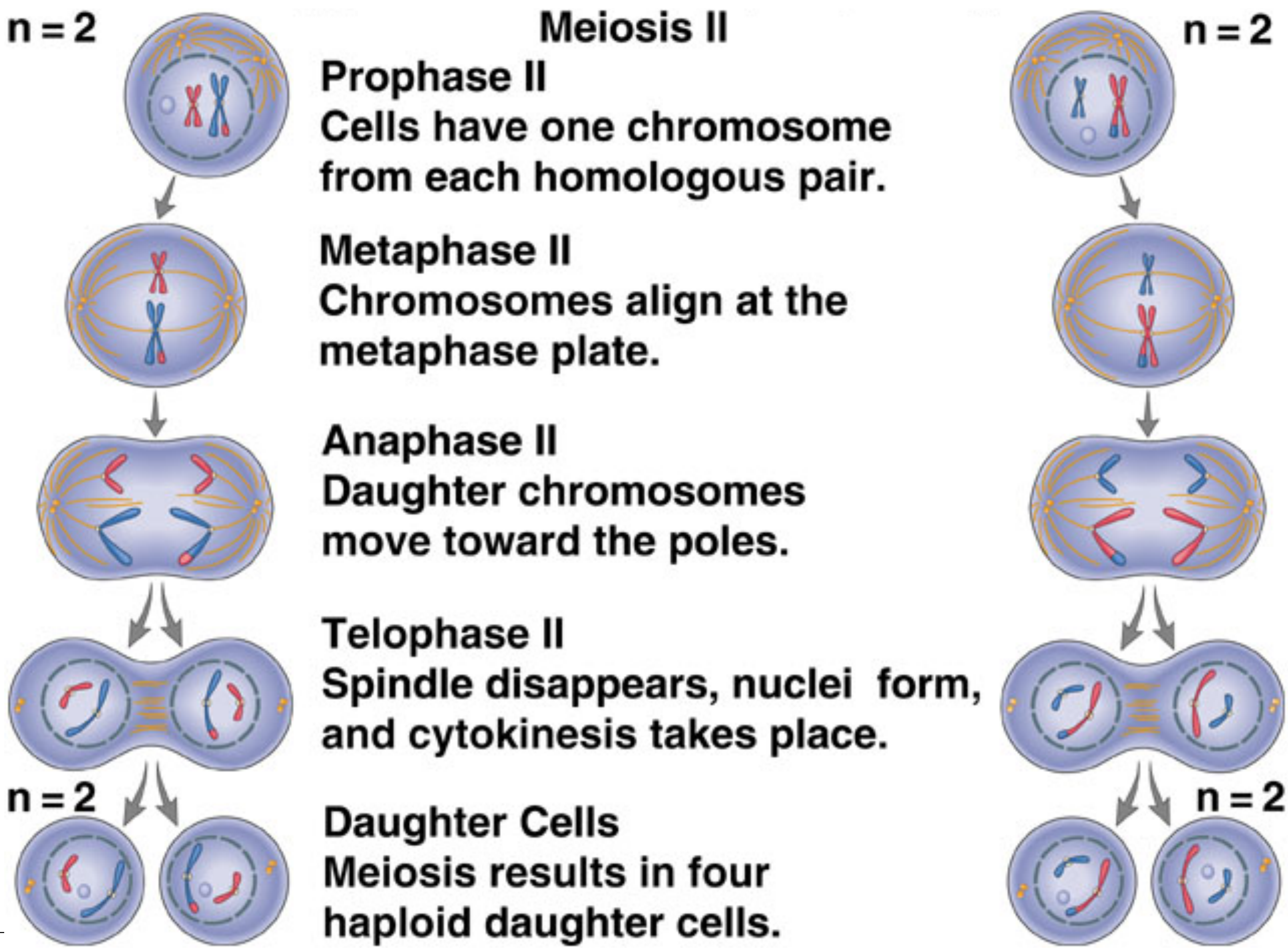


Table 10.1

Comparison of Meiosis I with Mitosis

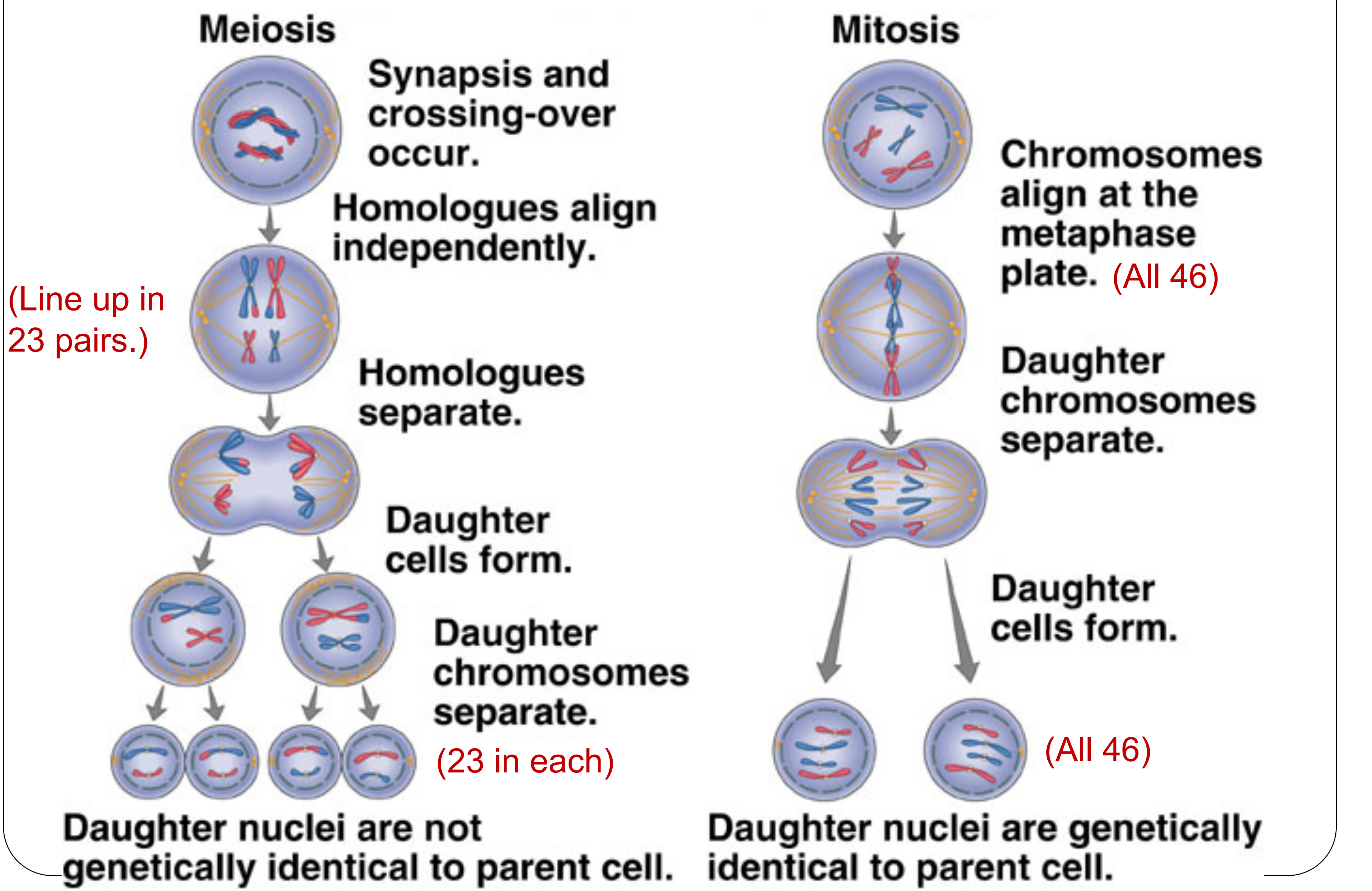
Meiosis I	Mitosis
Prophase I	***Prophase***
Pairing of homologous chromosomes	No pairing of chromosomes
Metaphase I	***Metaphase***
Bivalents at metaphase plate	Duplicated chromosomes at metaphase plate
Anaphase I	***Anaphase***
Homologues of each bivalent separate and duplicated chromosomes move to poles.	Sister chromatids separate, becoming daughter chromosomes that move to the poles.
Telophase I	***Telophase***
Two haploid daughter cells	Two daughter cells, identical to the parent cell

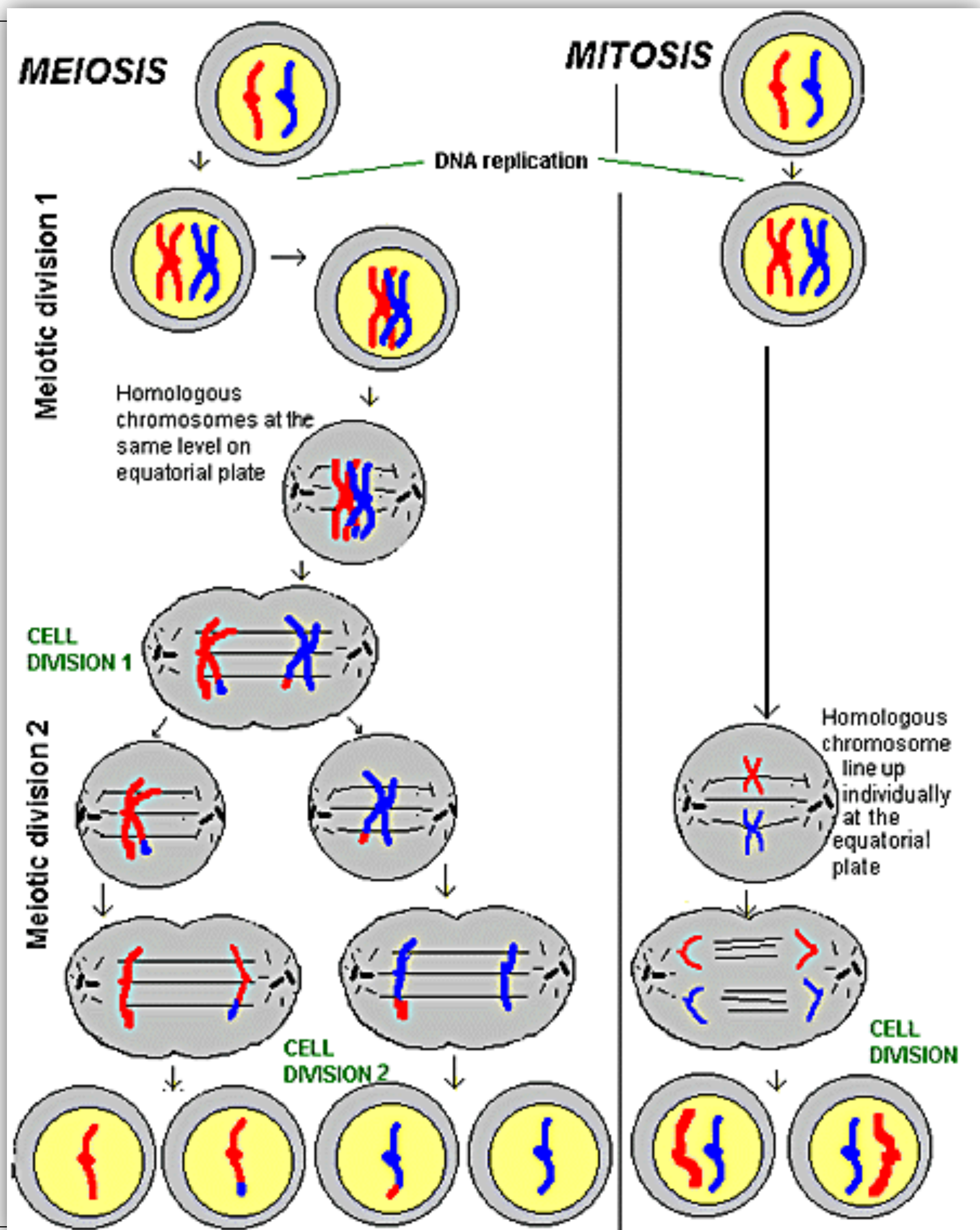
Table 10.2

Comparison of Meiosis II with Mitosis

Meiosis II	Mitosis
Prophase II	***Prophase***
No pairing of chromosomes	No pairing of chromosomes
Metaphase II	***Metaphase***
Haploid number of duplicated chromosomes at metaphase plate	Diploid number of duplicated chromosomes at metaphase plate
Anaphase II	***Anaphase***
Sister chromatids separate, becoming daughter chromosomes that move to the poles.	Sister chromatids separate, becoming daughter chromosomes that move to the poles.
Telophase II	***Telophase***
Four haploid daughter cells, not genetically identical	Two daughter cells, genetically identical to the parent cell

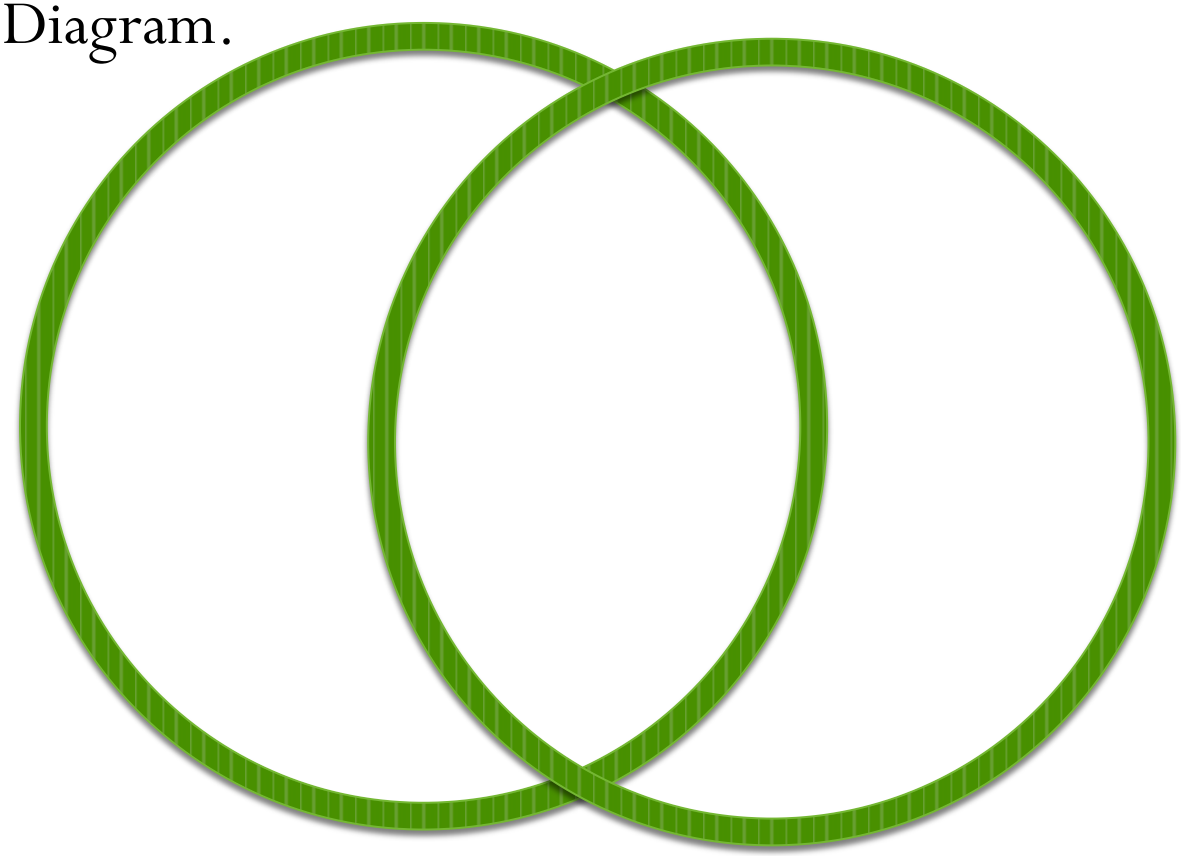
Meiosis vs. Mitosis



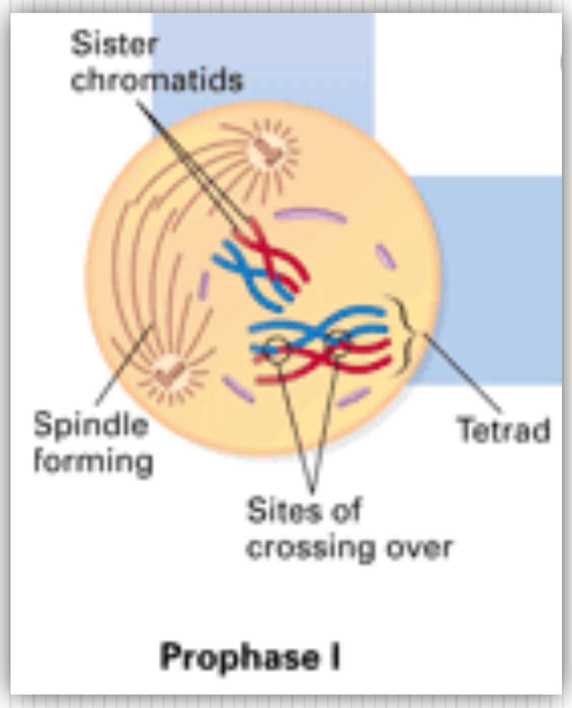

MEIOSIS
MITOSIS
DNA replication
Meiotic division 1
Homologous chromosomes at the same level on equatorial plate
CELL DIVISION 1
Meiotic division 2
CELL DIVISION 2
Homologous chromosome line up individually at the equatorial plate
CELL DIVISION

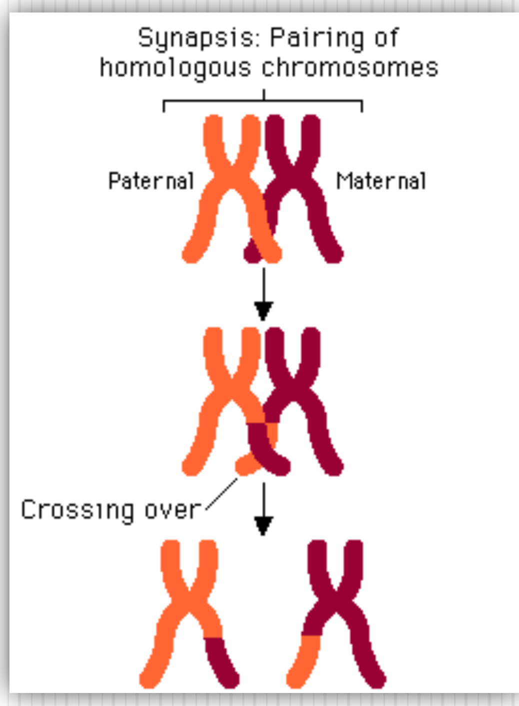
Warm-up

- 21. Compare and Contrast Meiosis and Mitosis in a Venn Diagram.



Meiosis increases genetic variation among offspring.

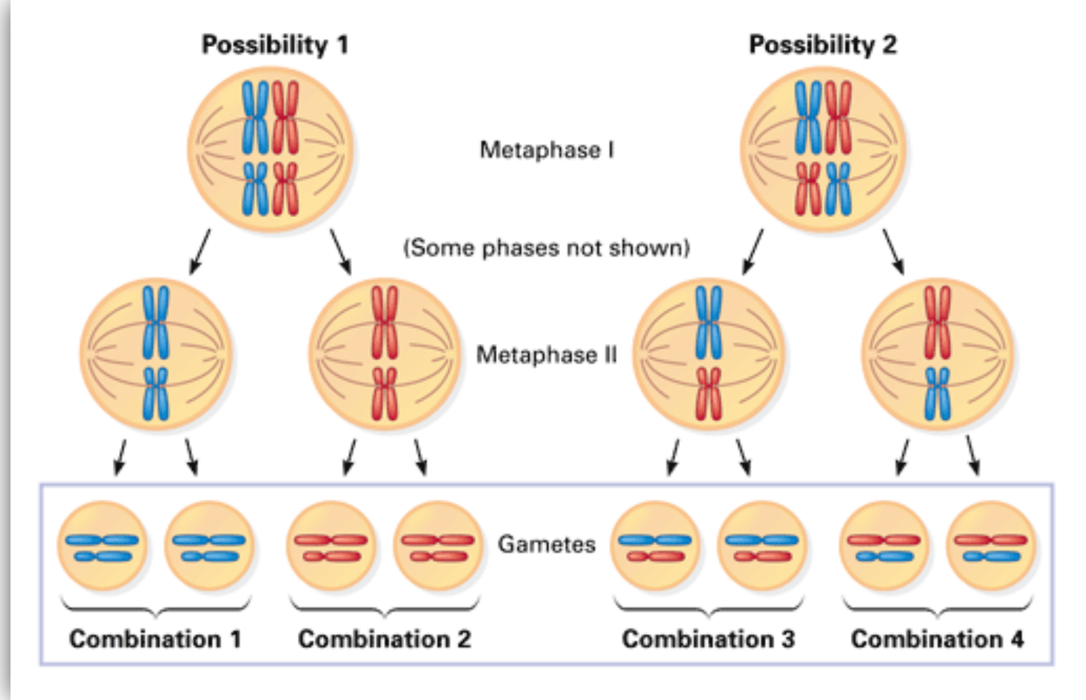




Assortments of Chromosomes

- Assortment of chromosomes is completely random
  - Metaphase I:
    - chromosomes in each homologous pair (tetrads) line up and separate at random (by chance)
  - Resulting cells:
    - the assortment of chromosomes that end up in the resulting cells occurs randomly.

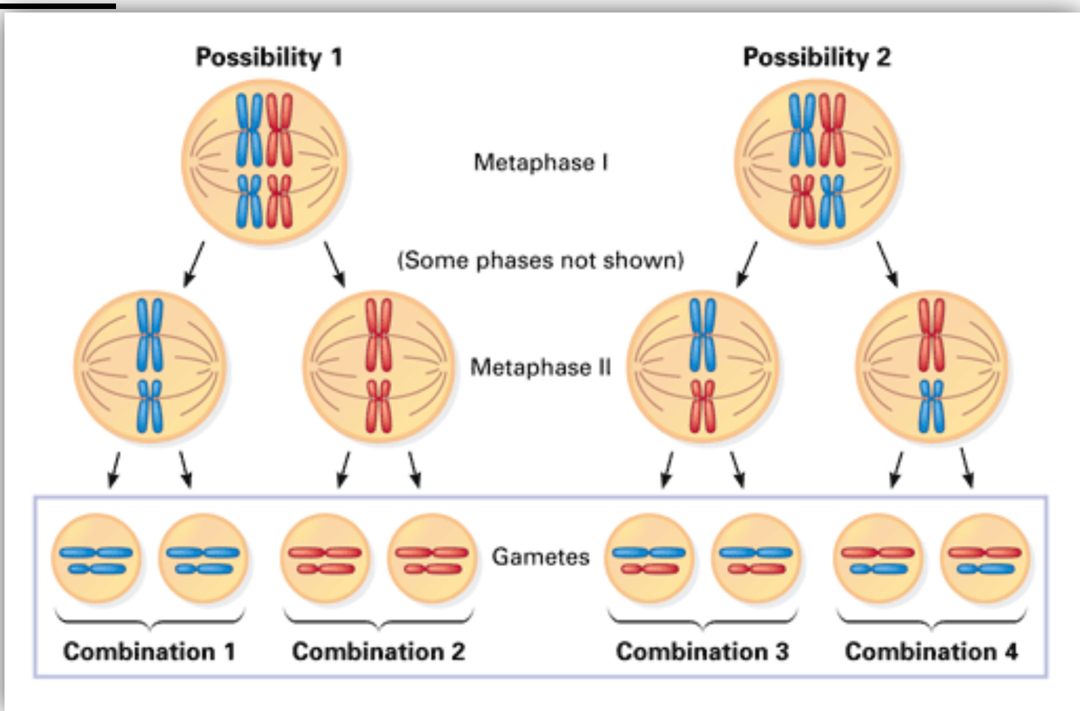
In this example, 4 combinations are possible. Diploid chromosome number of four ($2n = 4$)



Assortment and Probability

- With haploid number, you can calculate the number of possible combinations in the gametes.
- 2^n = # of possible combinations
  - *n* is the haploid number.

For the organism in the example, $n = 2$, so the number of chromosome combinations is 2^2, or 4. For a human, $n = 23$, so there are 2^{23}, or about 8 million, possible chromosome combinations!

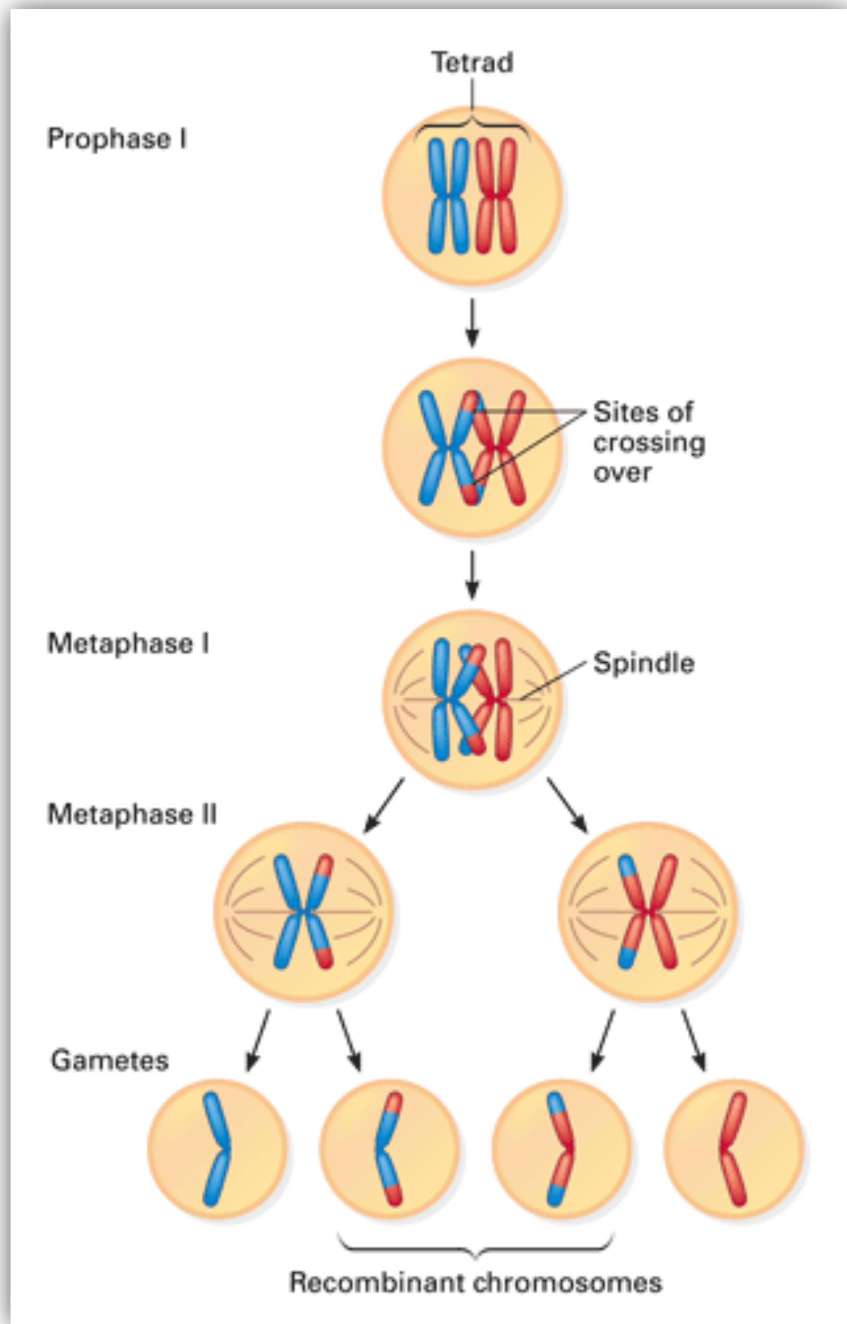


Genetic Variation

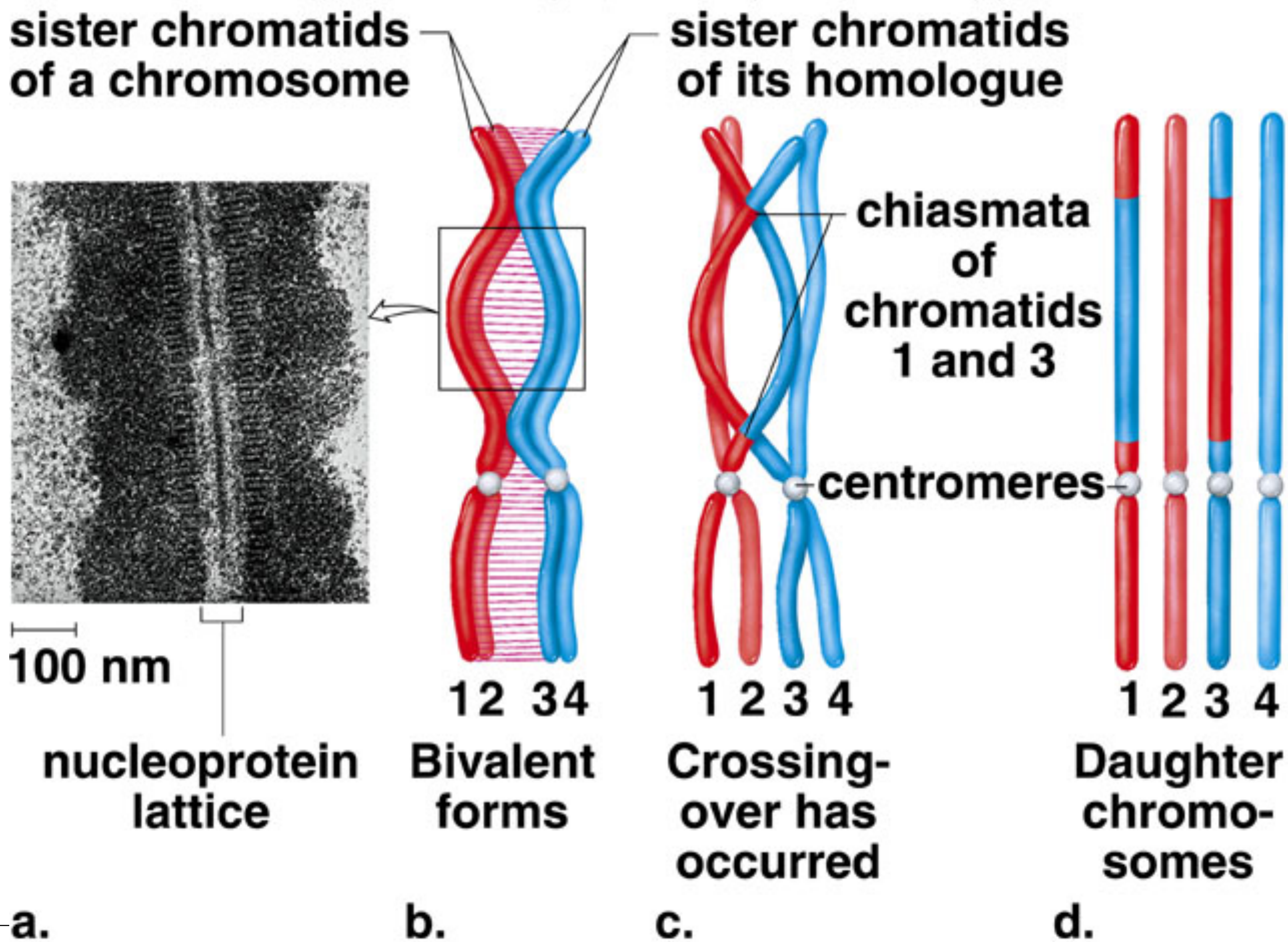
- 3 Chromosomal factors that contribute to genetic variation
  - 1. crossing over
  - 2. The number of different chromosome combinations in gametes
  - 3. Fertilization

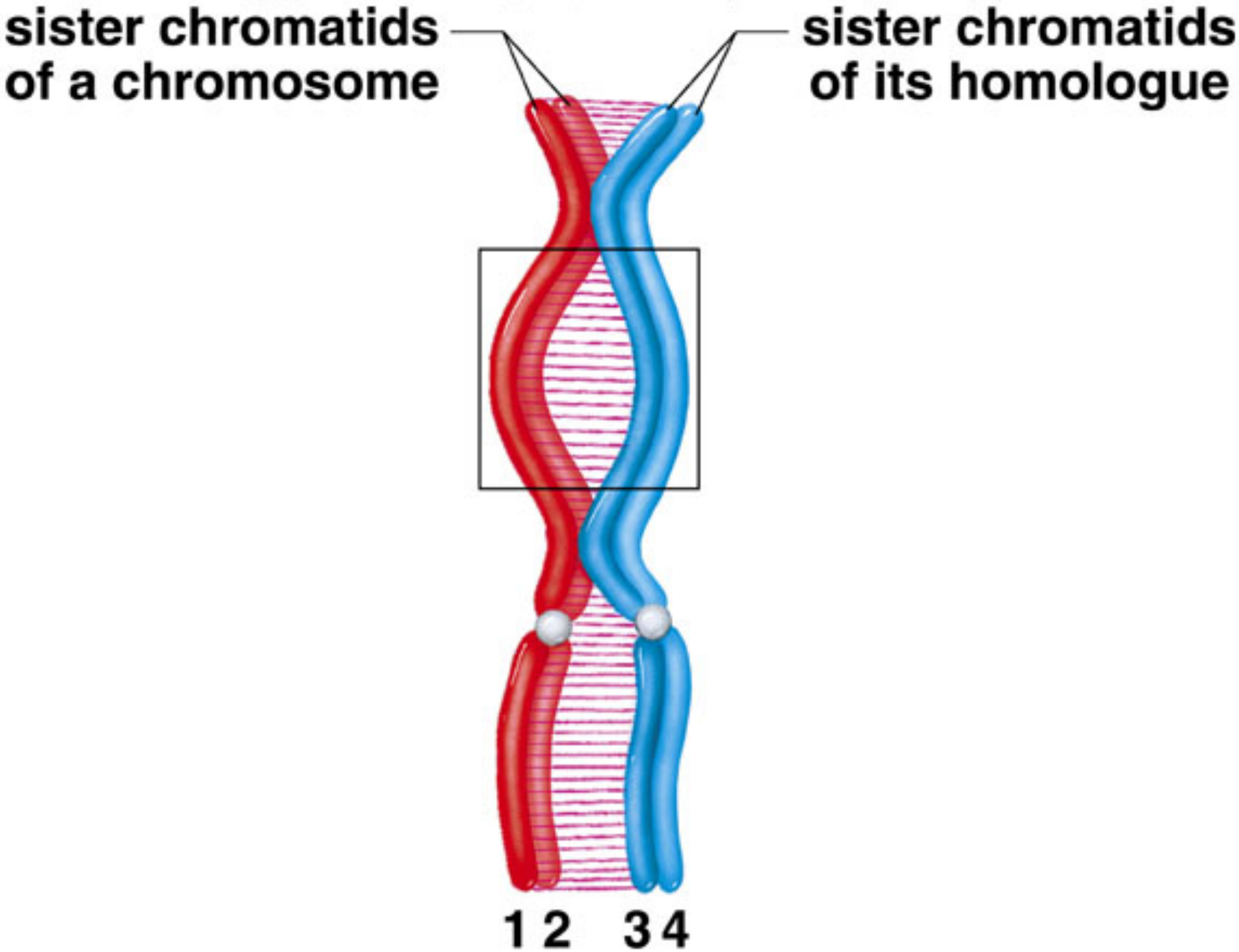
Crossing Over

- Crossing over—the exchange of genetic material between homologous chromosomes
  - occurs during prophase I of meiosis
- Crossing over process
  - homologous chromosomes closely paired along their lengths.
  - precise gene-by-gene alignment between adjacent chromatids of the two chromosomes.
  - Segments of the two chromatids can be exchanged at one or more sites.

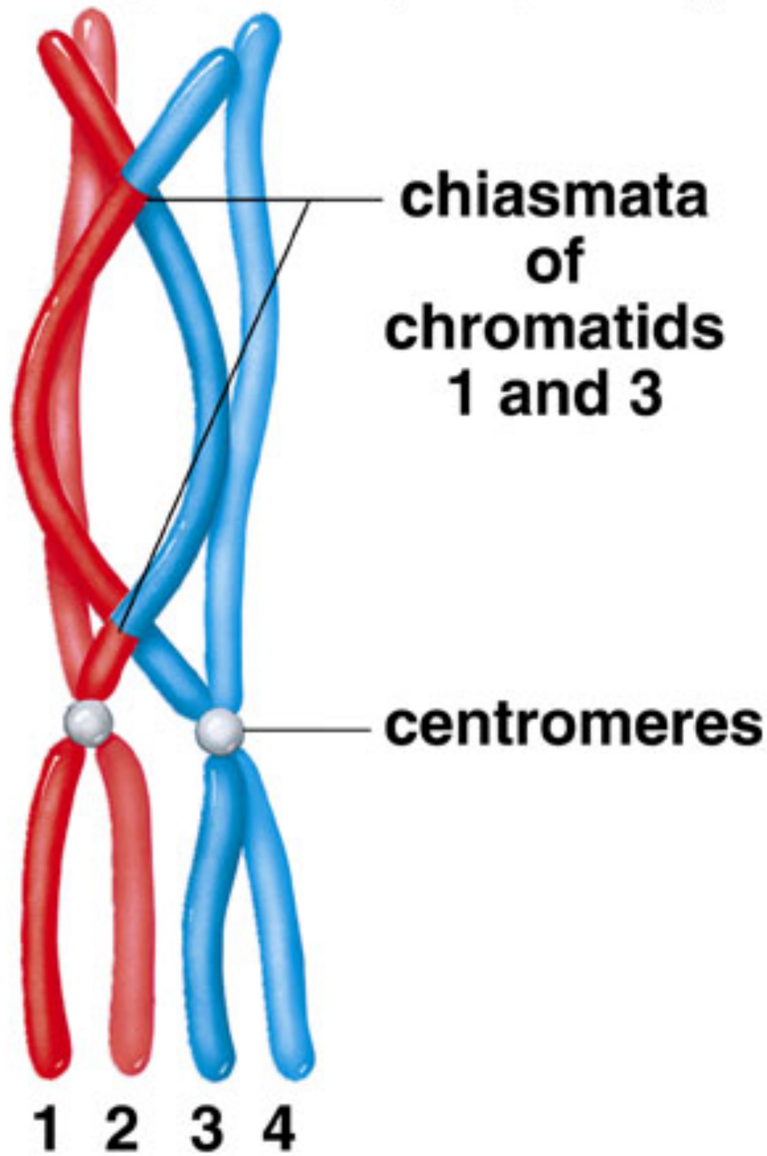


Methods of genetic recombination:
1. Crossing over

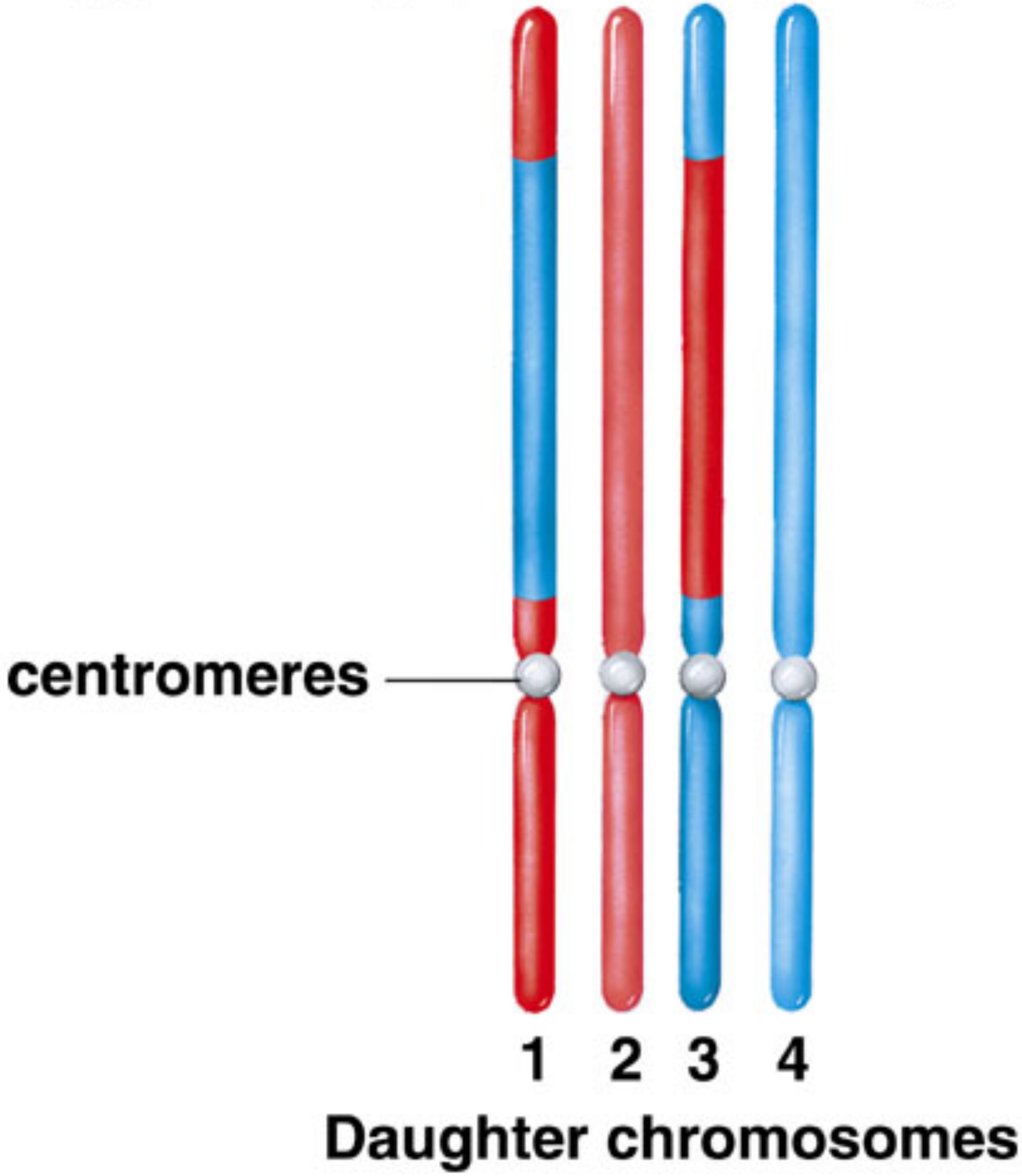




Bivalent forms

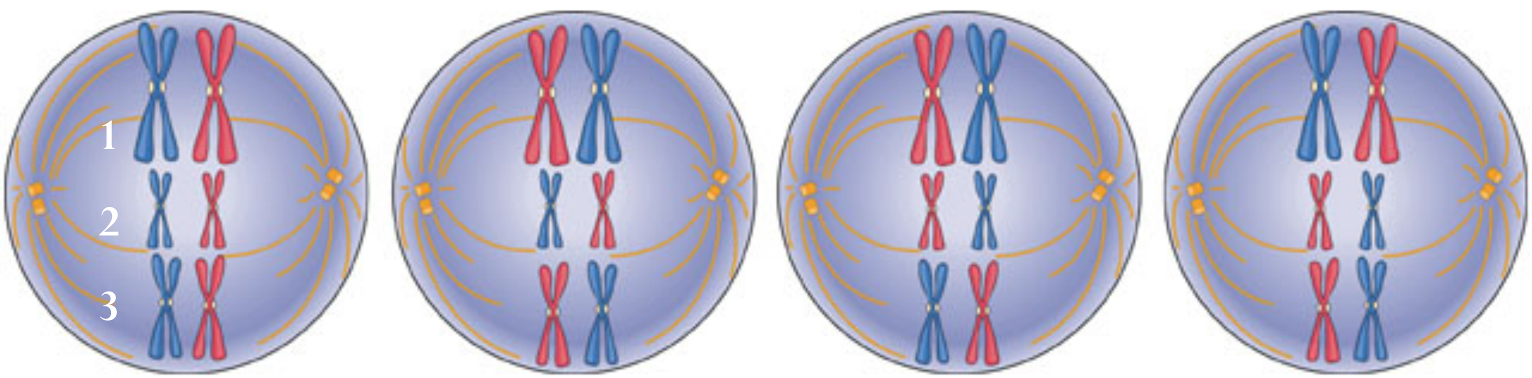


Crossing-over has occurred



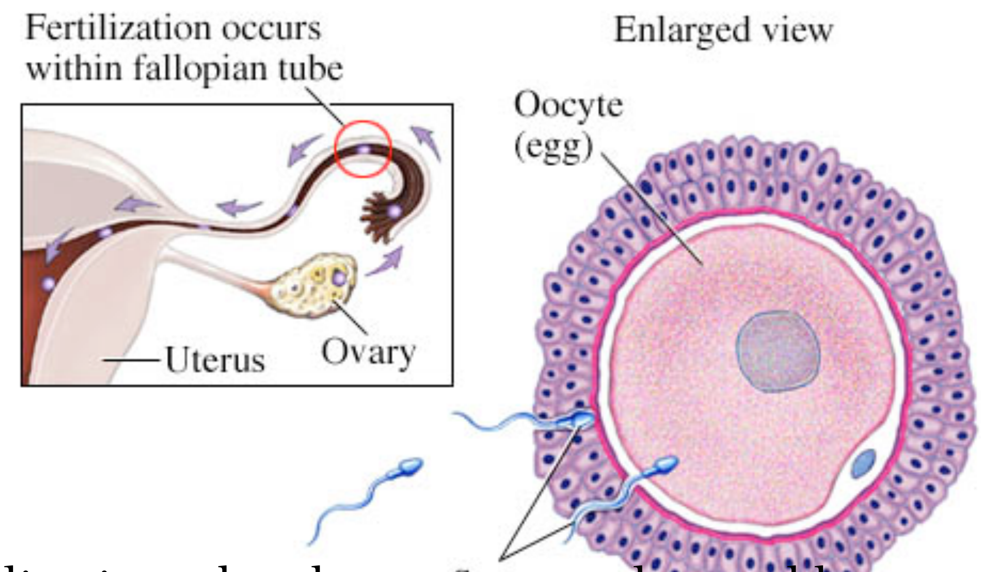
centromeres
1
2
3
4
Daughter chromosomes

Methods of genetic recombination: <u>2. Independent assortment of chromosomes.</u>



Methods of genetic recombination:

3. Fertilization



- When the gametes fuse at fertilization, the chromosomes donated by each parent are combined. In humans, this means that $(2^{23})^2$, or 70,368,744,000,000 chromosomally different zygotes are possible for every couple, if no crossing over occurs.
- If crossing over occurs *only once*, then $(4^{23})^2$, or 4,951,760,200,000,000,000,000,000,000 genetically different zygotes are possible for every couple.

Round Robin Review Stations

- Cell Organelles
- Prokaryotes vs Eukaryotes
- Microscopes
- Cell Membranes and Transport
- Mitosis
- Meiosis
- Photosynthesis
- Cellular Respiration
- ATP

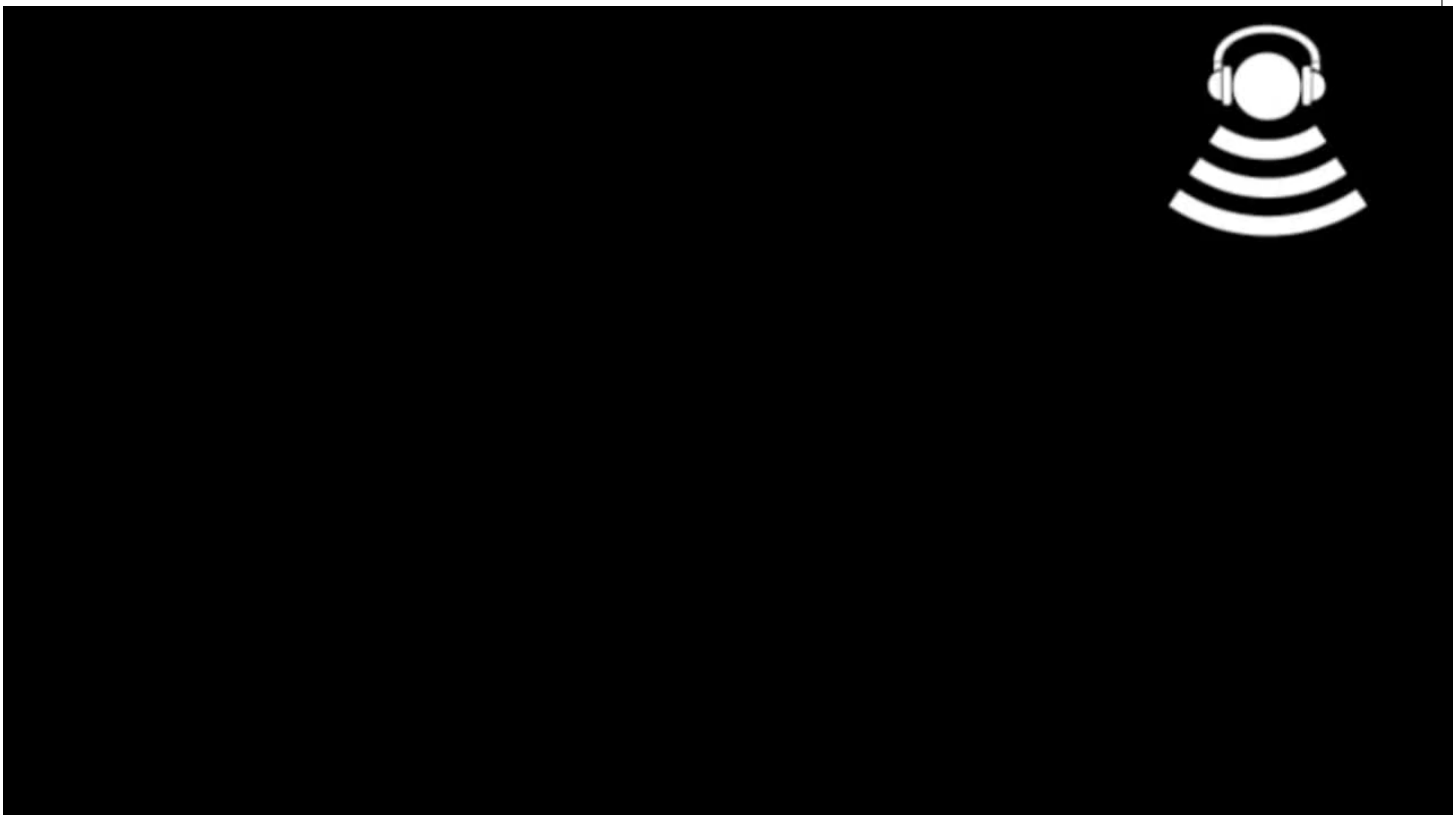
Round Robin Review

- Round 1 –
  - 2 minutes: Put as much as you can remember about each topic on the sheet.
- Round 2
  - 4 minutes to read other groups contribution, correct any mistakes, and add any additional information.
- Round 3
  - 3 minutes to read other groups contribution, correct any mistakes, and add any additional information.
- Round 4
  - 4 minutes to read other groups contribution, correct any mistakes, and add any additional information using your notes.
- Round 5
  - 4 minutes to read other groups contribution, correct any mistakes, and add any additional information using your notes.

Round Robin Review

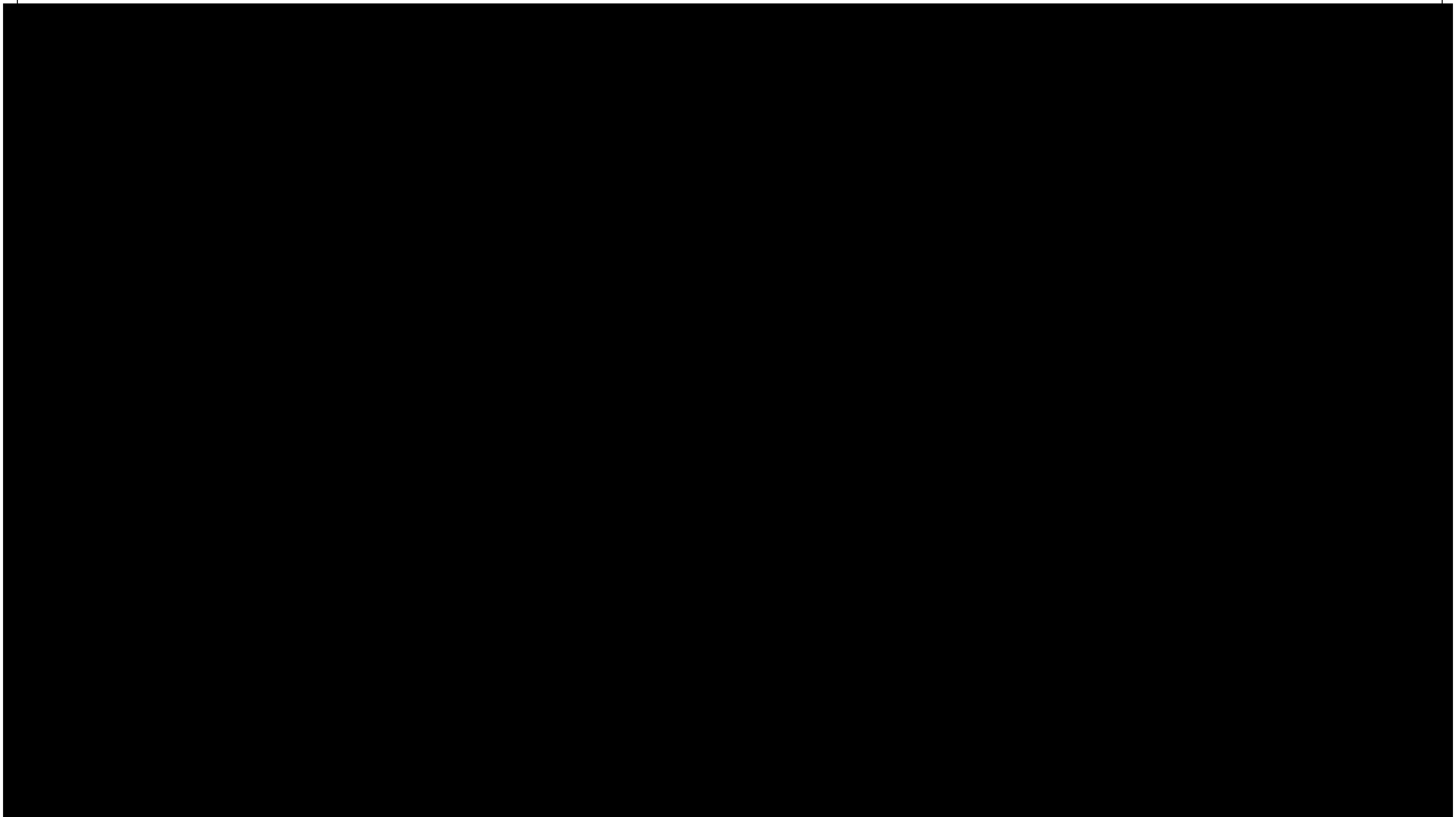
- Round 7
  - 4 minutes to read other groups contribution, correct any mistakes, and add any additional information using your notes.
- Round 8
  - 3 minutes to read other groups contribution, correct any mistakes, and add any additional information using your notes.
- Round 9
  - 2 minutes to read other groups contribution, correct any mistakes, and add any additional information using your notes.

Cell Organelle Review with Mr. Anderson



Crash Course - Mitosis Review

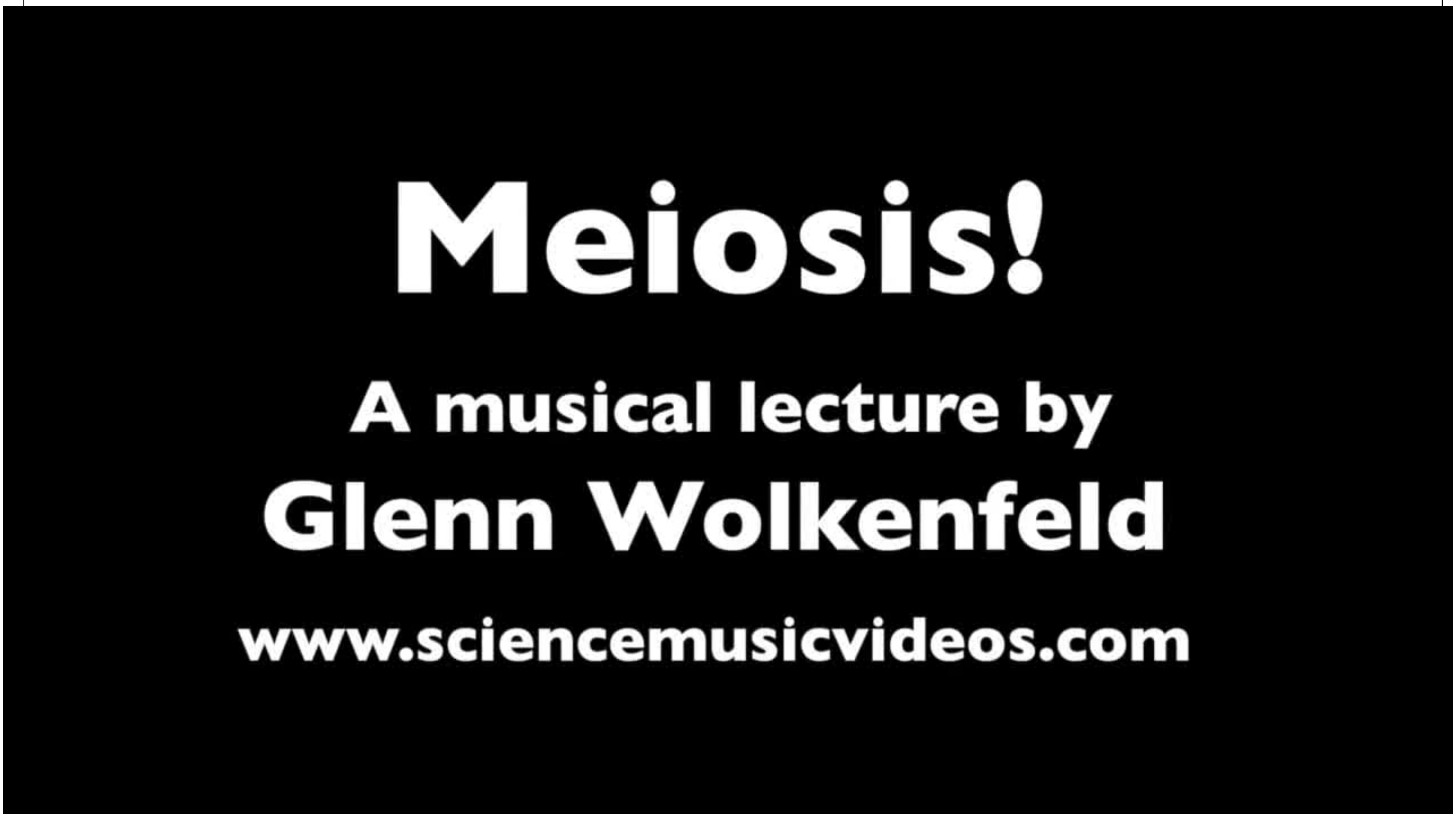
Mr. W's Mitosis Rap



Meiosis Hoedown

Crash Course Meiosis Review

Meiosis Rap with Mr. W



Organelle Review