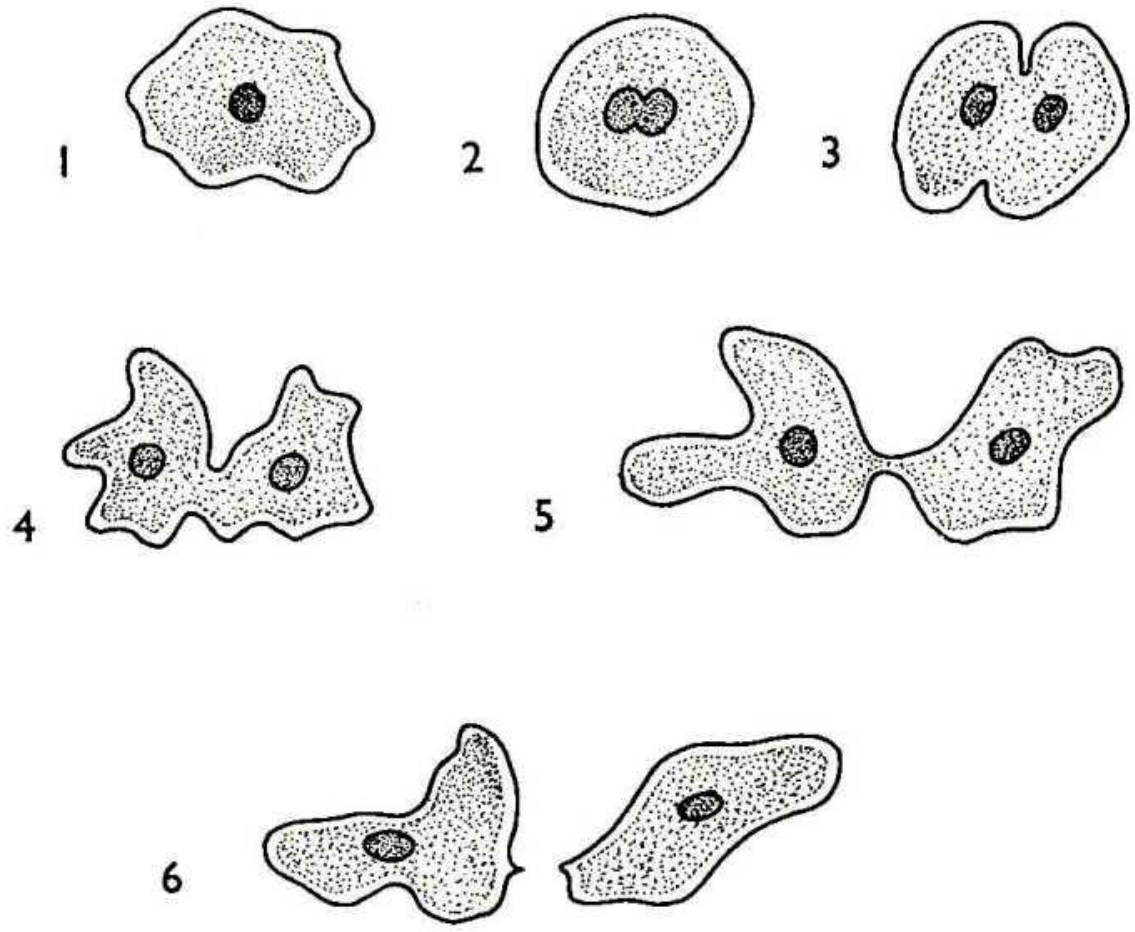
Lesson 1

- Asexual Reproduction

Asexual Reproduction

- Produces genetically identical offspring from only one single

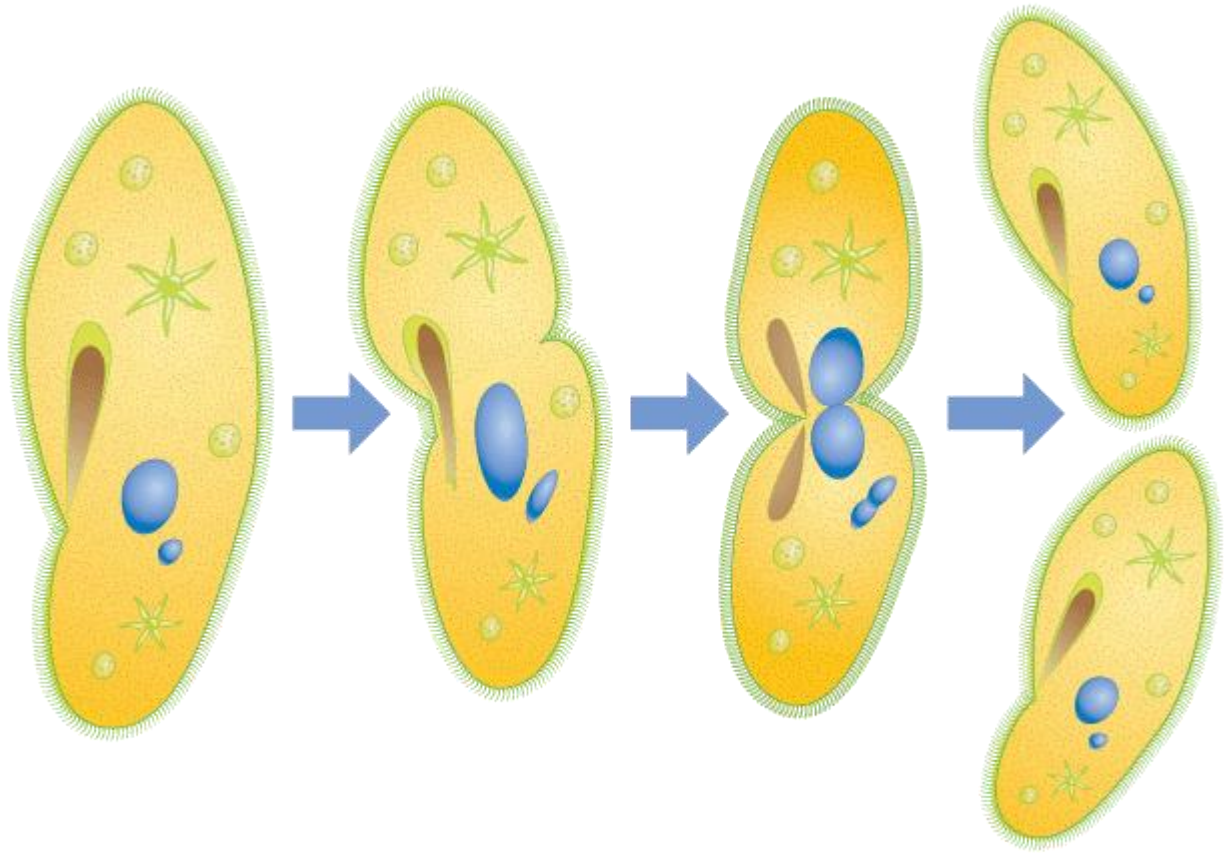


Types of Asexual Reproduction

- Vegetative Propagation
- Parthenogenesis
- Sporulation
- Binary Fission
- Regeneration
- Budding

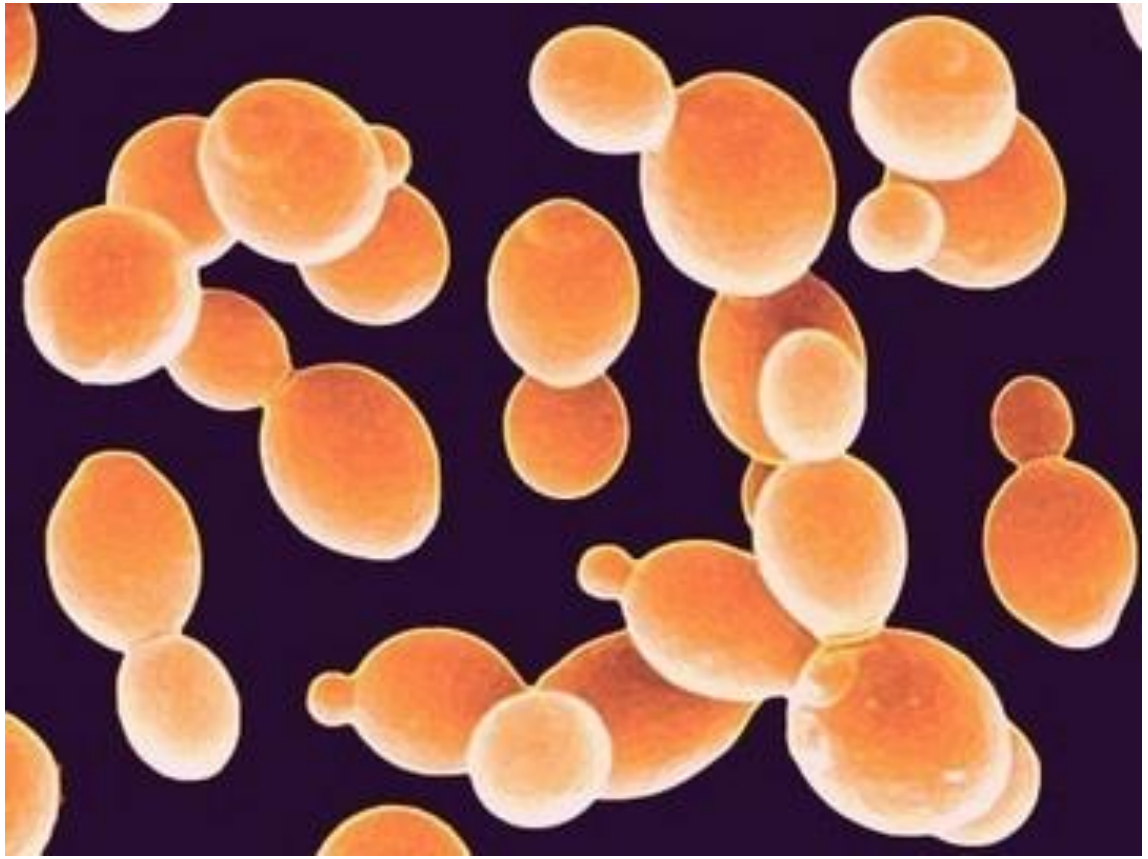
1.Binary Fission

- Organism divides in half (EQUALLY), resulting in 2 new organisms
- Ex. Unicellular organisms (Paramecia, Amoeba, Bacteria)



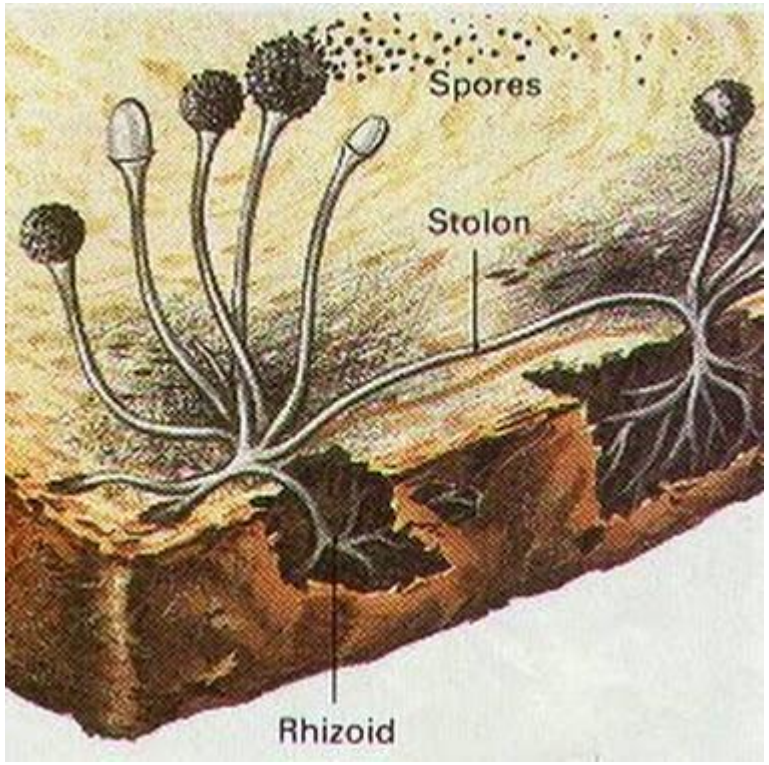
2.Budding

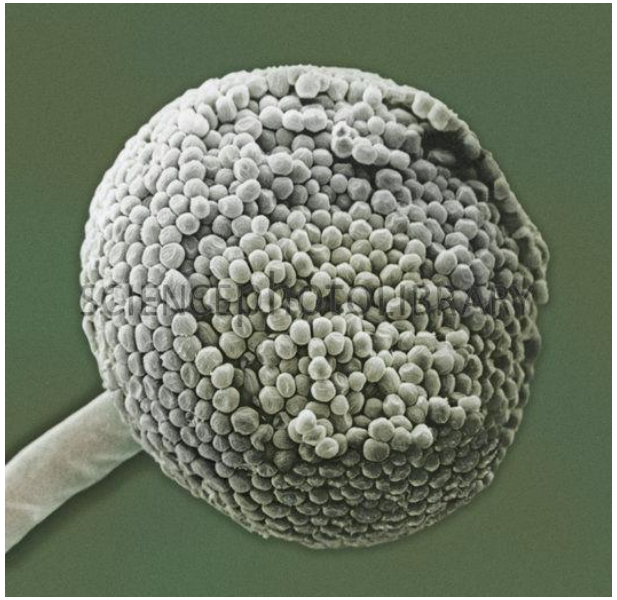
- Similar to fission but cytoplasmic division is unequal
- Ex. Unicellular (yeast) & multicellular(hydra)



3.Sporulation

- Parent releases microscopic spores (reproductive cells)
- New offspring develop with right temp & moisture
- Ex: Bread mold, mushrooms, some plants

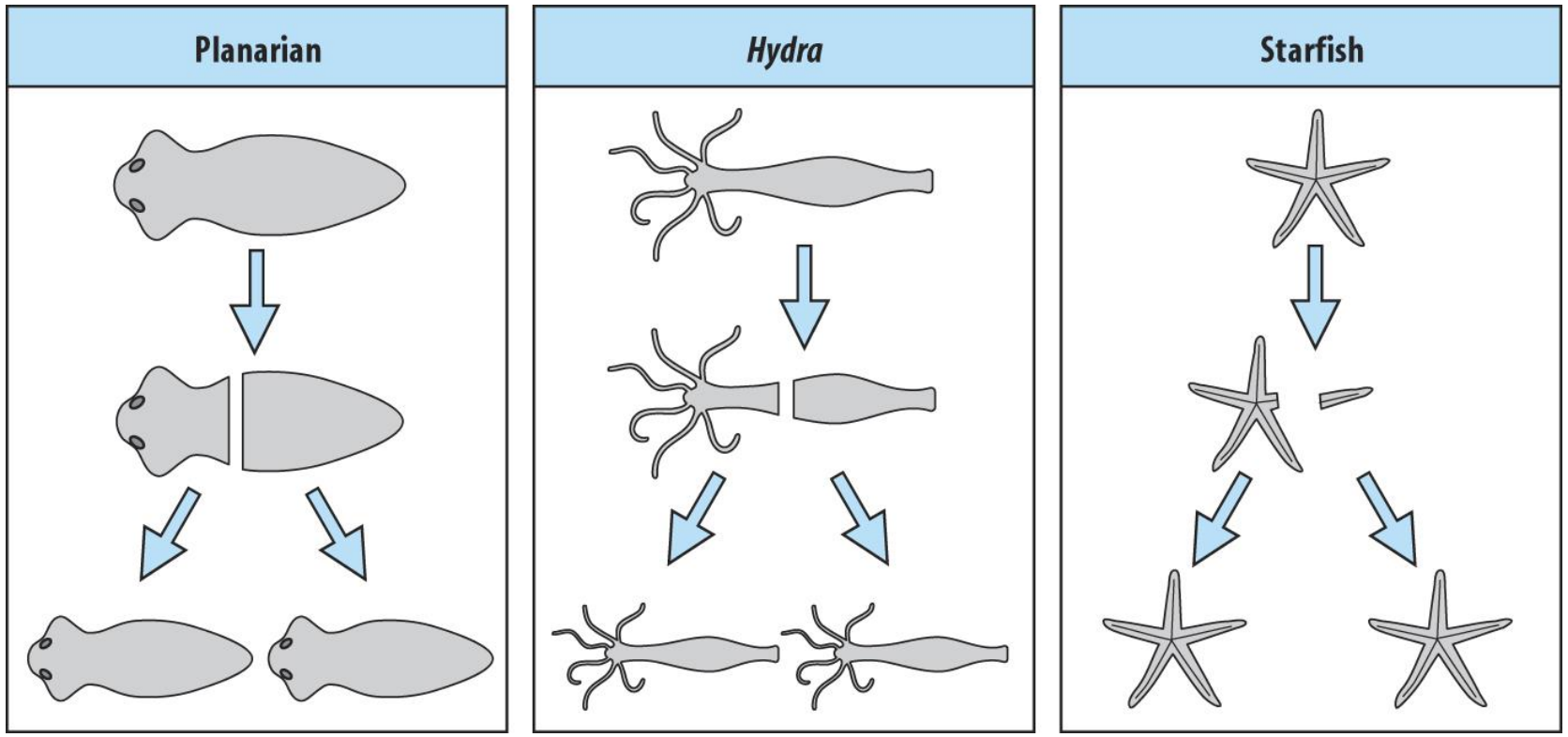




Video - Fern Spores

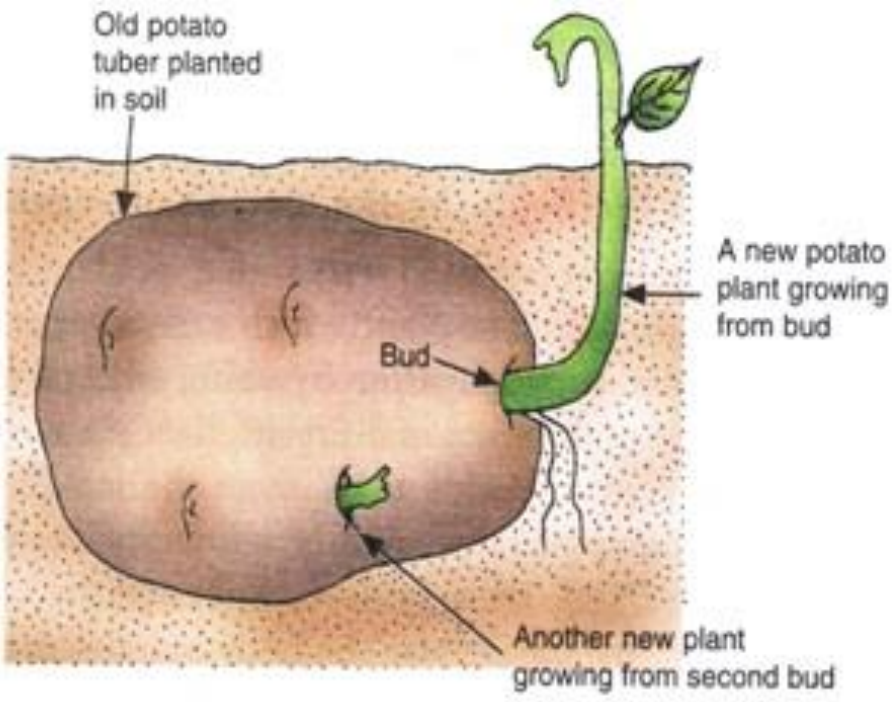
4.Regeneration

- Development of entire new organism from part of original organism
- Also refers to replacement of lost structure
- Ex. Starfish



5.Vegetative Propagation

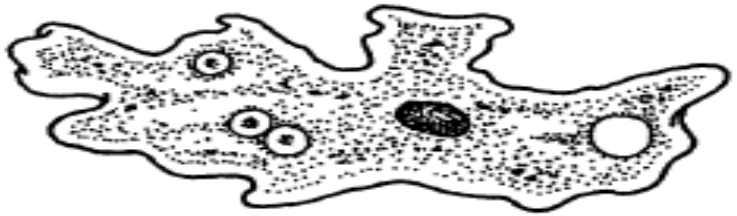
- New plants can develop from roots, stems, or leaves of the parent plant
- Ex: Cuttings of a plant, tubers of a potato, runners of strawberry pants, bulbs of onions



6.Parthenogenesis

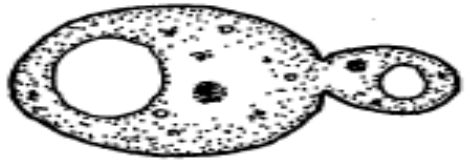
- An unfertilized egg develops into a new individual
- Occurs in some insects and arthropods (daphnia), some reptiles & fish

Video - Shark Virgin Birth



Type Binary fission

Examples Bacteria, amoeba

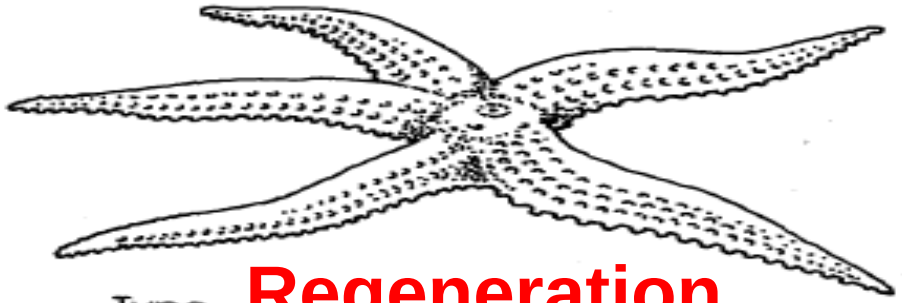


Type Budding

Examples Yeast, hydra

Type Sporulation

Examples Bread mold



Type Regeneration

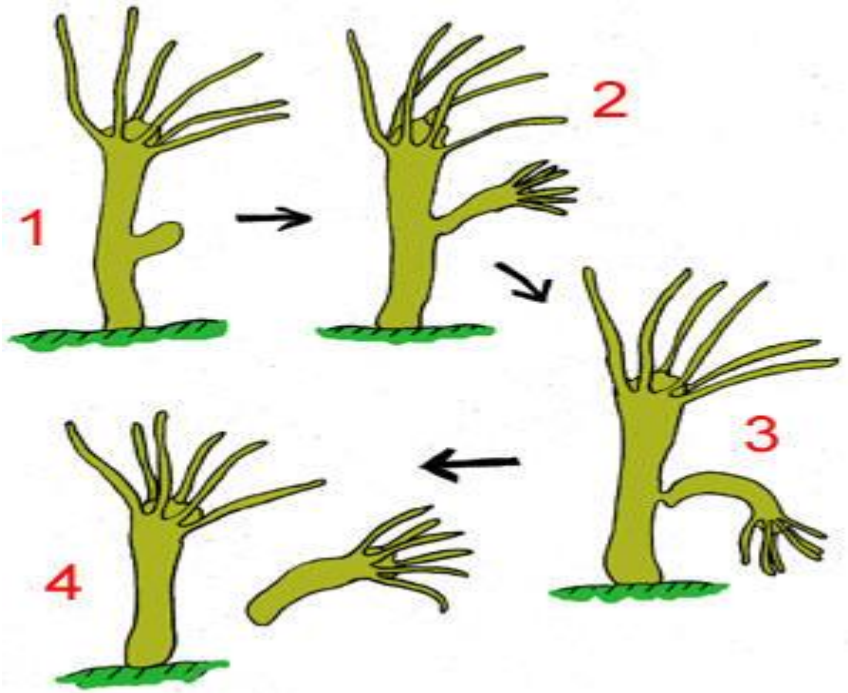
Examples Starfish, sponge

Type Parthenogenesis

Examples Daphnia

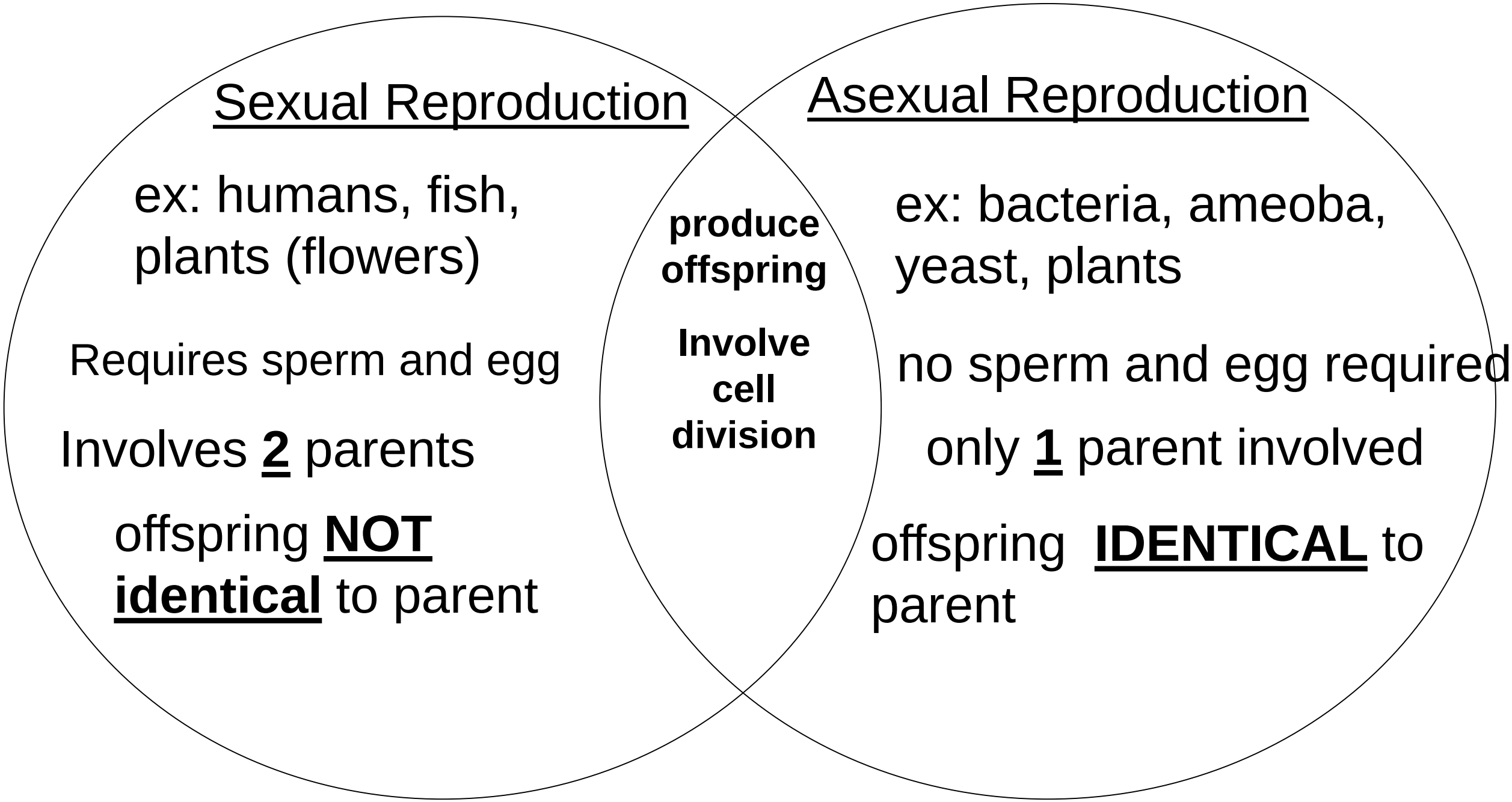
Type Vegetative propagation

Examples Runners, cuttings, tubers



What type of asexual development is this?

Budding


Sexual Reproduction
ex: humans, fish, plants (flowers)
Requires sperm and egg
Involves 2 parents
offspring NOT identical to parent
produce offspring
Involve cell division
Asexual Reproduction
ex: bacteria, ameoba, yeast, plants
no sperm and egg required
only 1 parent involved
offspring IDENTICAL to parent

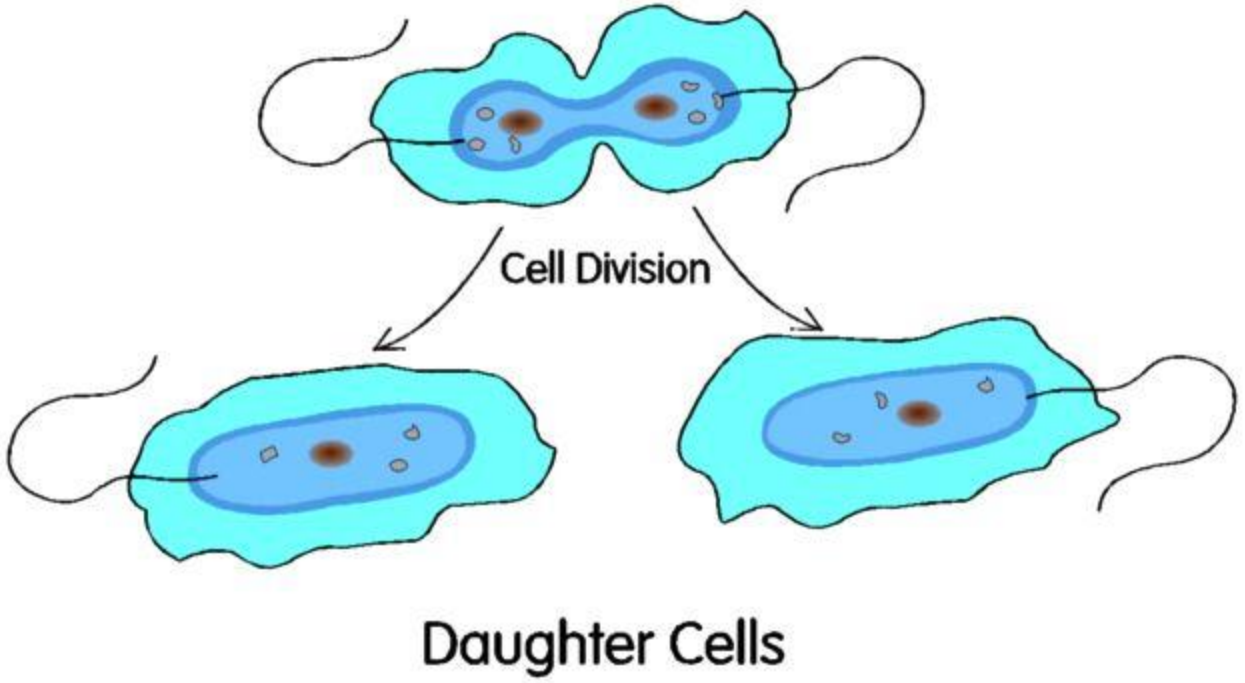
Lesson 2

Chromosome Structure

Cell Cycle

Mitosis Stages

Cell Division



Why do it?

VIDEO- cell division overview

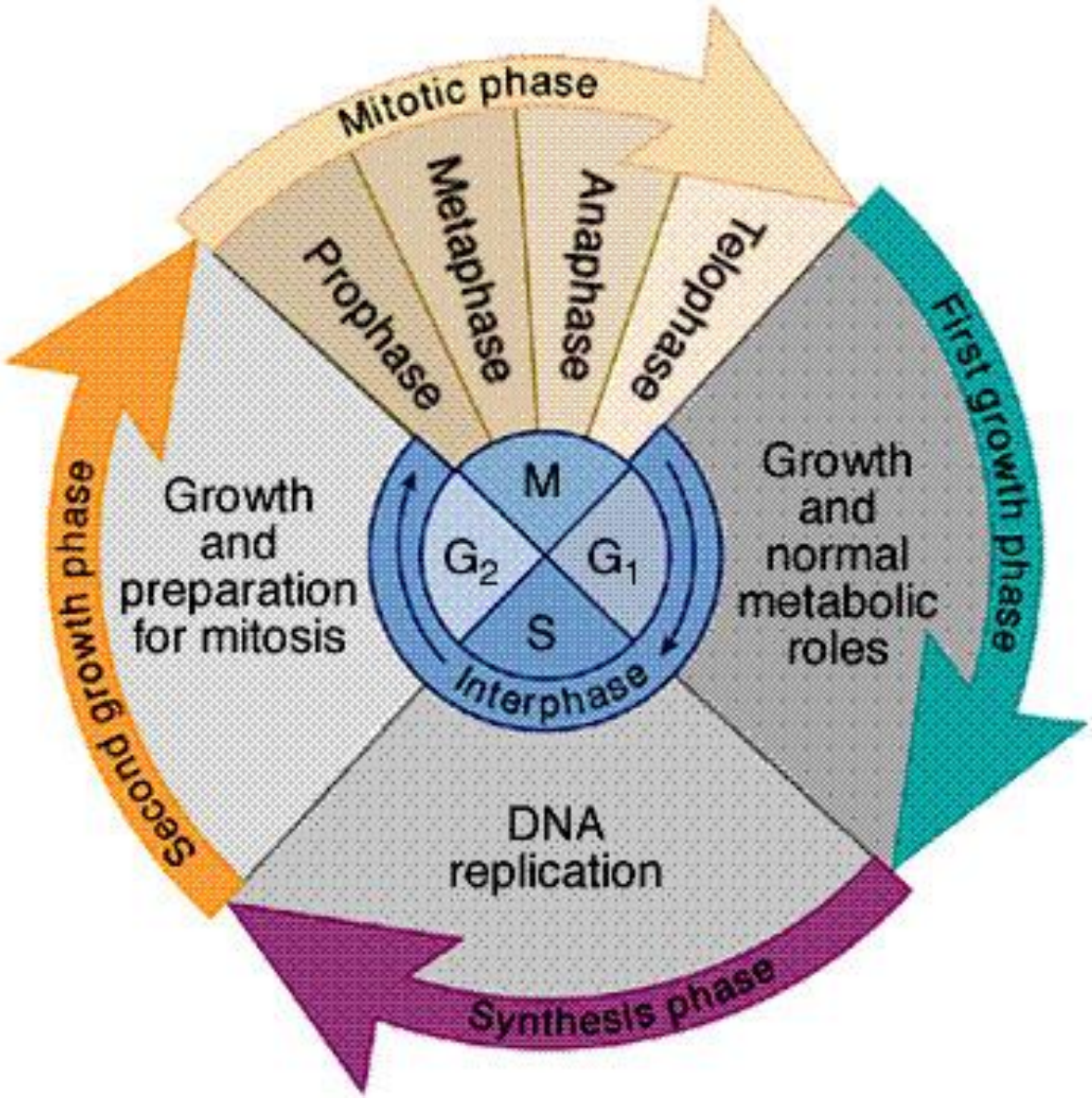
Video - Mitosis under a microscope (short)

The Cell Cycle (the "life" of a cell)

Is mostly in INTERPHASE

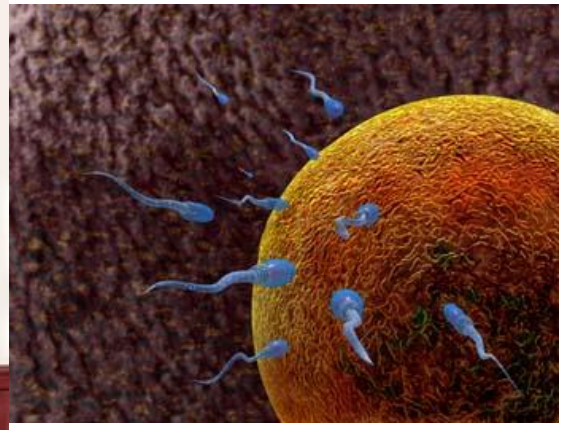
the time when a cell…

- Grows (G1)
- Replicates its DNA & organelles (S)
- Prepares for division (G2)



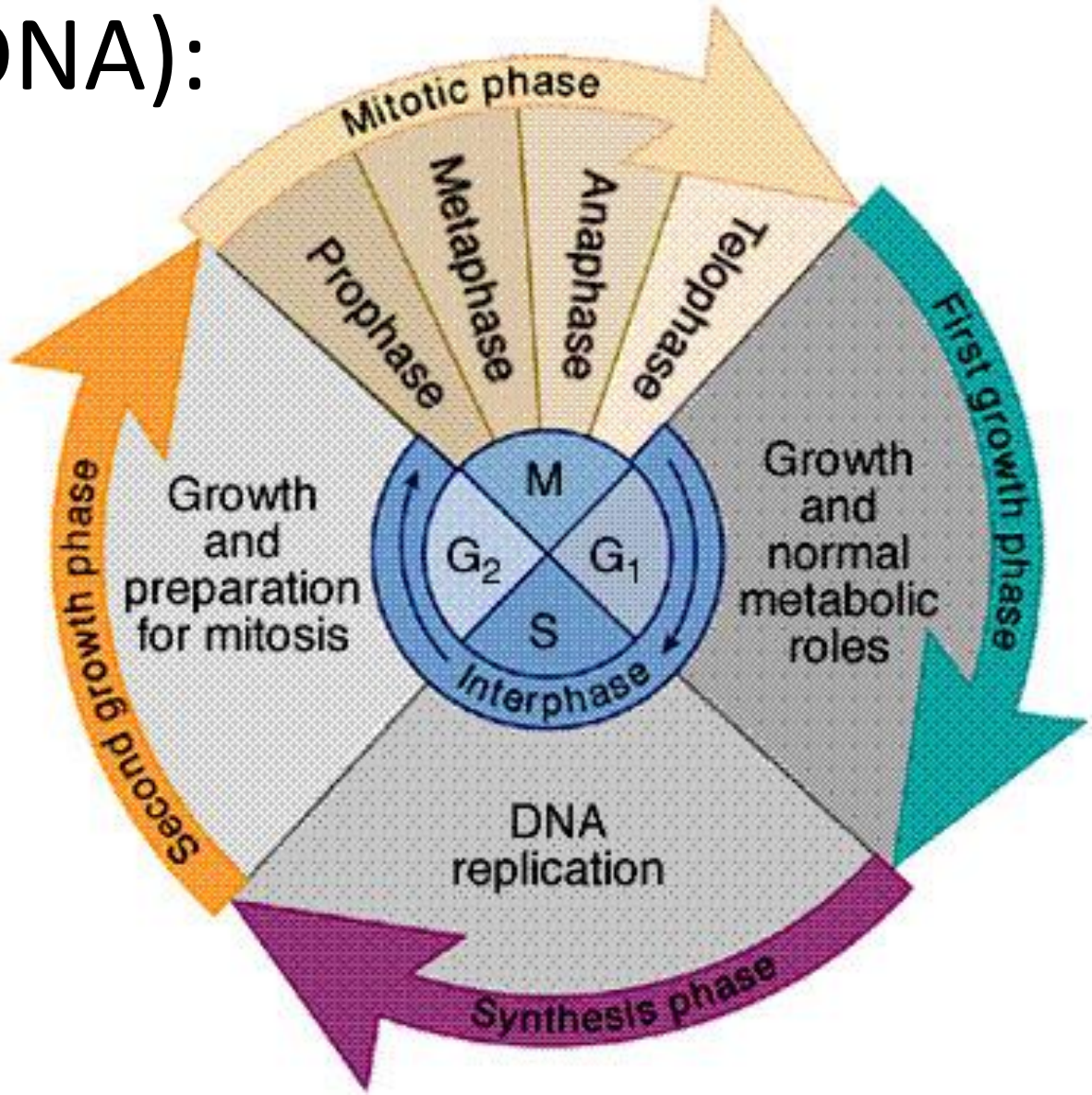
Cell division is needed for…

- <u>Growth</u> of the organism (Mitosis)
- <u>Repair</u> of damaged cells (Mitosis)
- <u>Reproduction</u> (Mitosis or Meiosis)



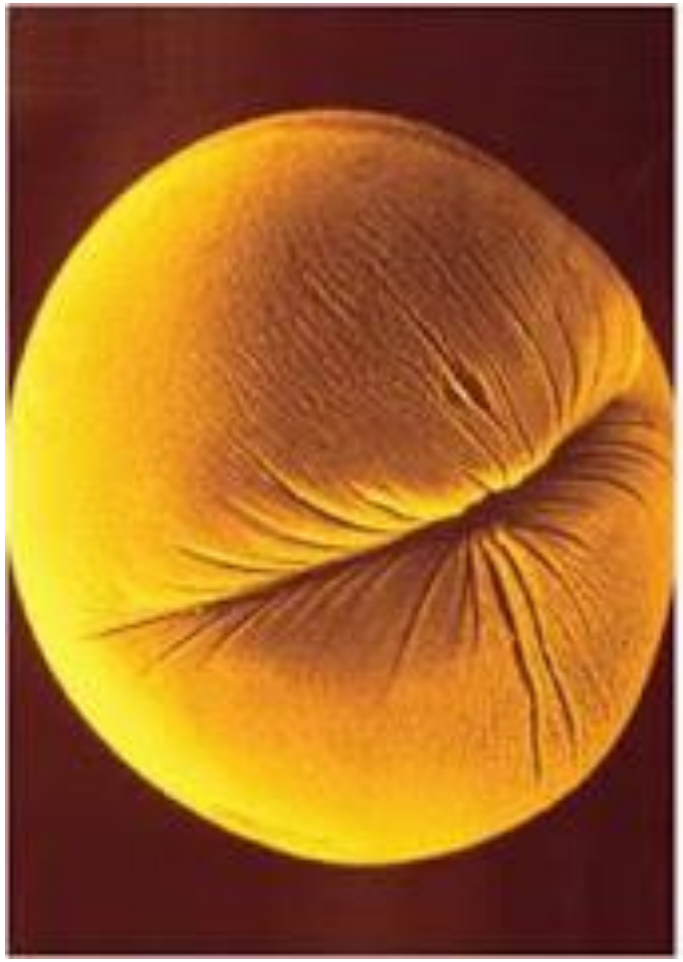
Mitosis consists of <u>4 phases</u> (division of the nuclear DNA):

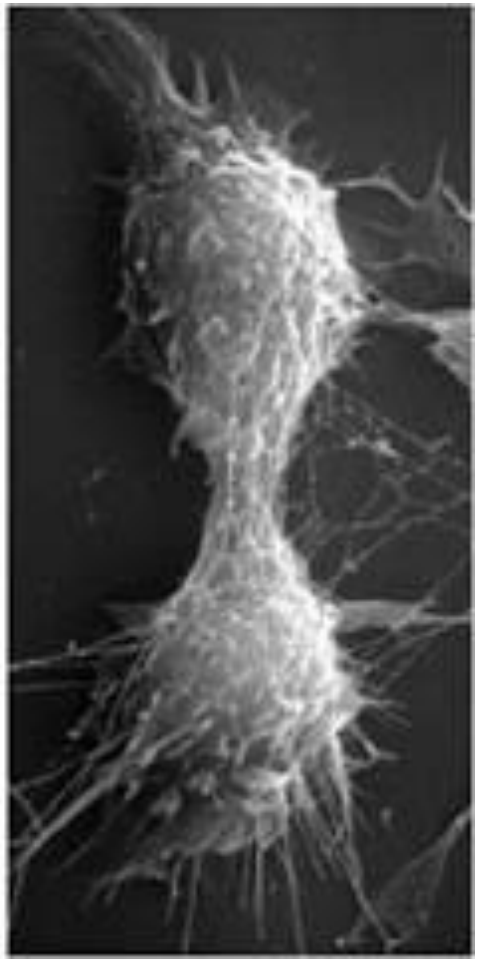
- **P**rophase
- **M**etaphase
- **A**naphase
- **T**elophase



Mitosis is followed by CYTOKINESIS

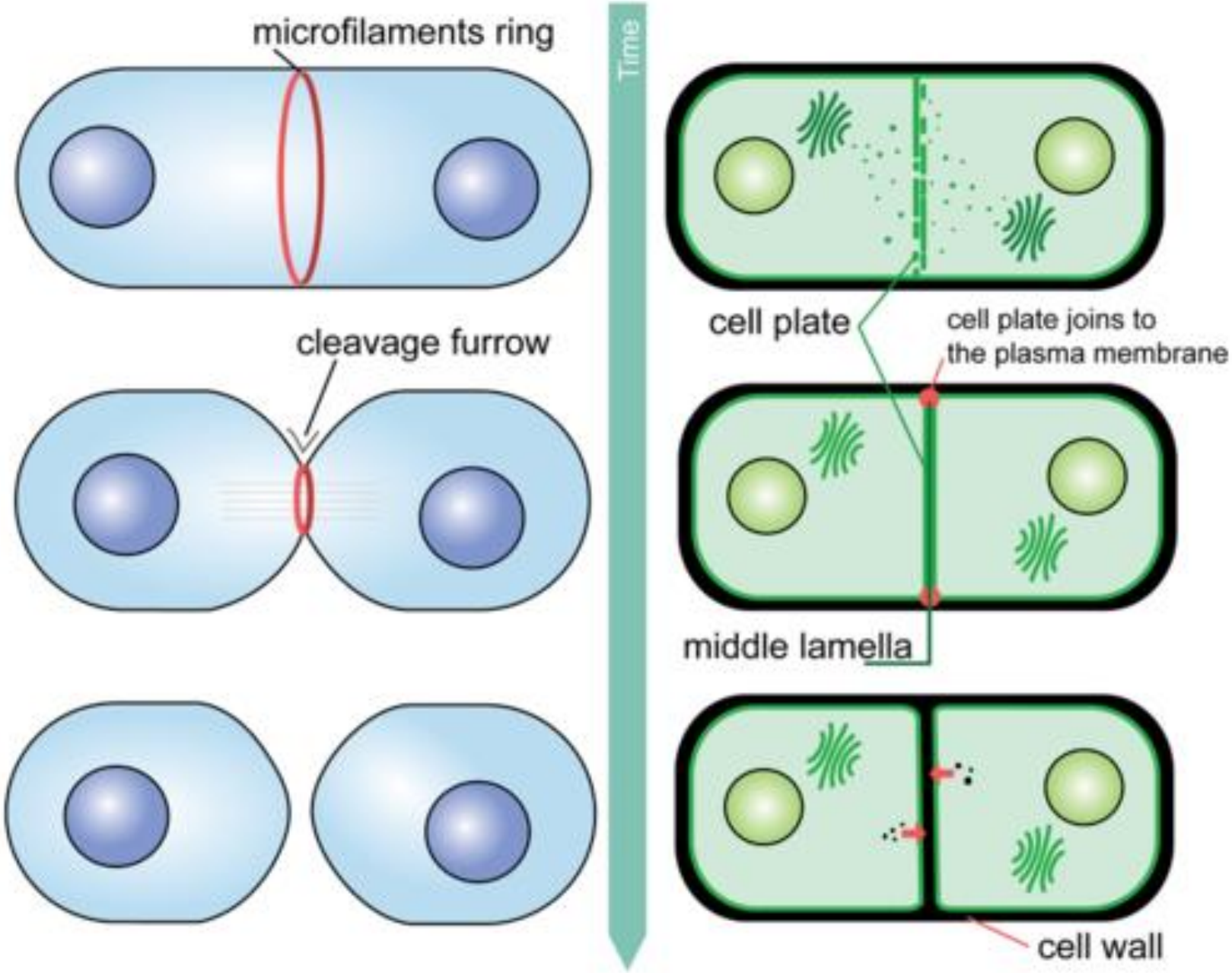
- division of the cytoplasm & cell membrane



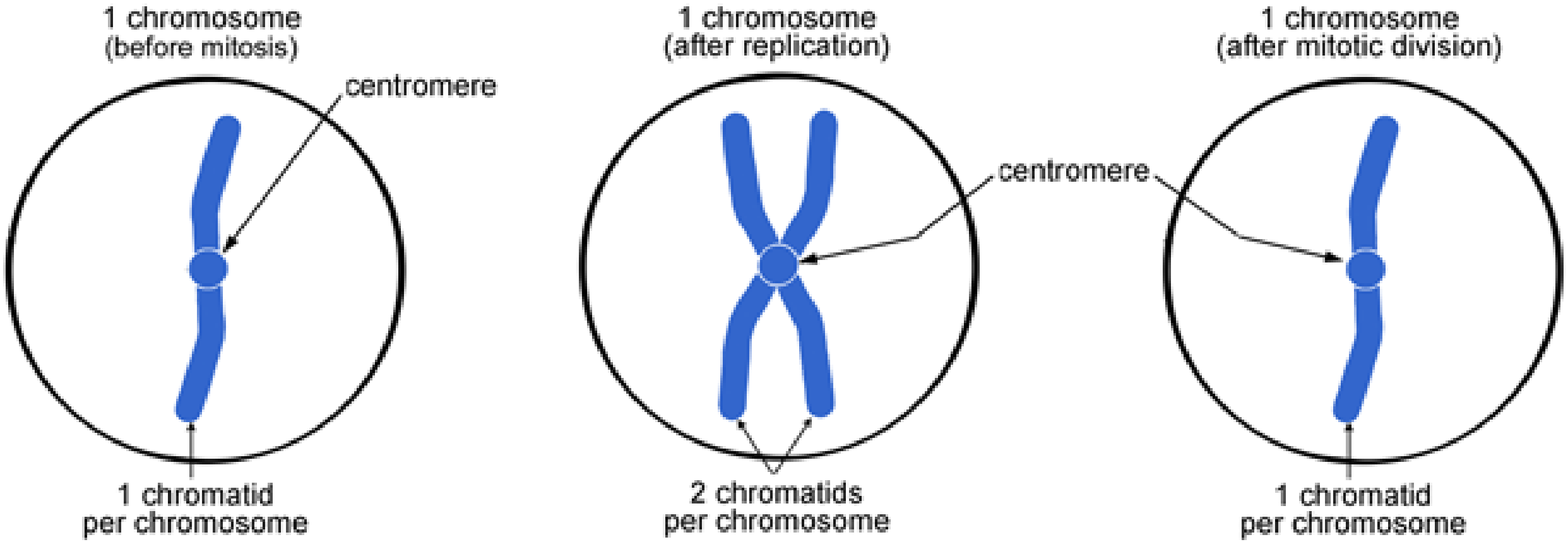


Animal cell

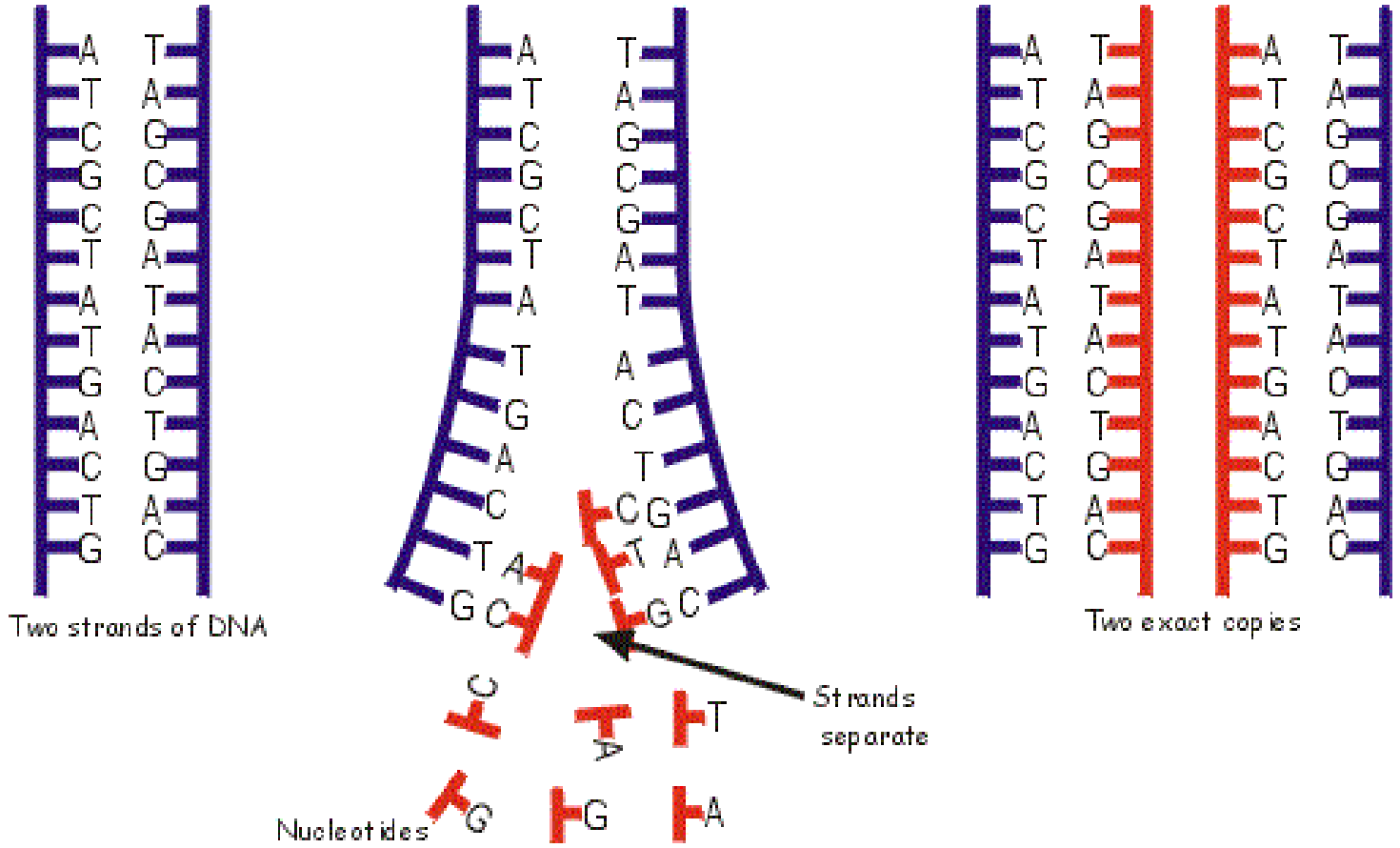
Plant cell



Chromosome Replication

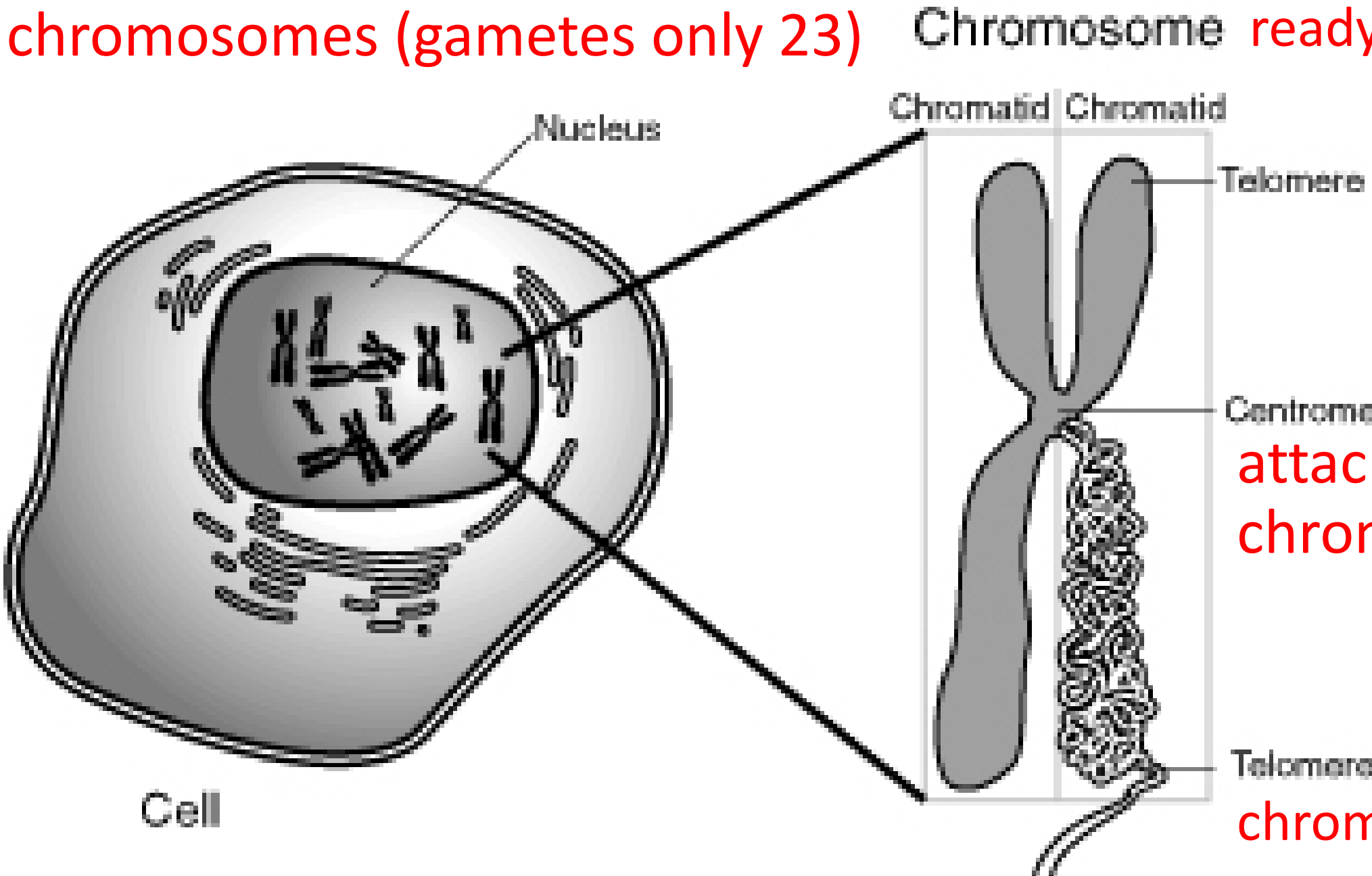


The most important step of cell division is the **REPLICATION / DUPLICATION** of chromosomes and the equal separation of DNA between daughter cells!



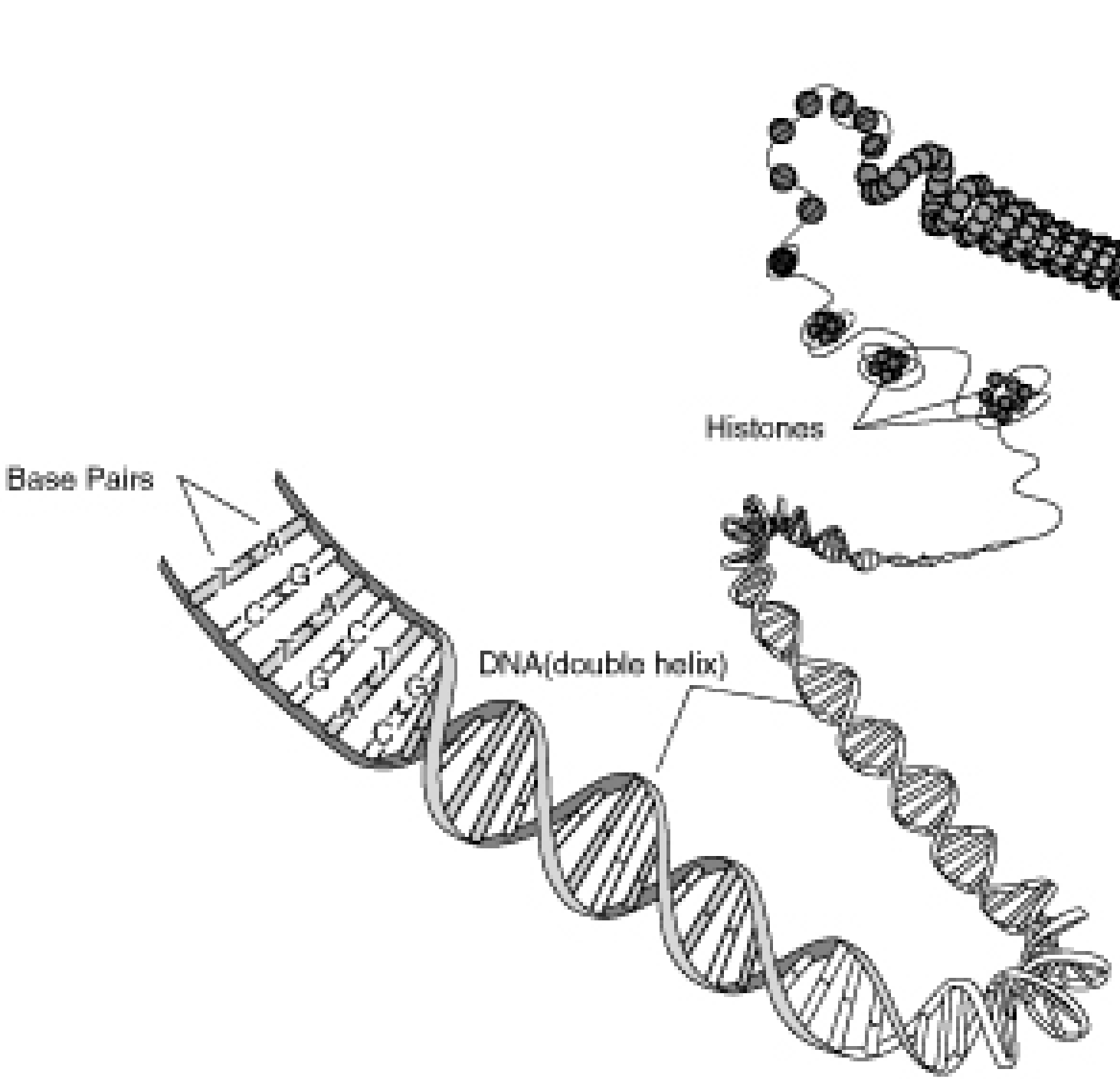
A human cell nucleus contains 46 chromosomes (gametes only 23)

double stranded is ready for division



attaches 2 sister chromatids

ends of chromosome

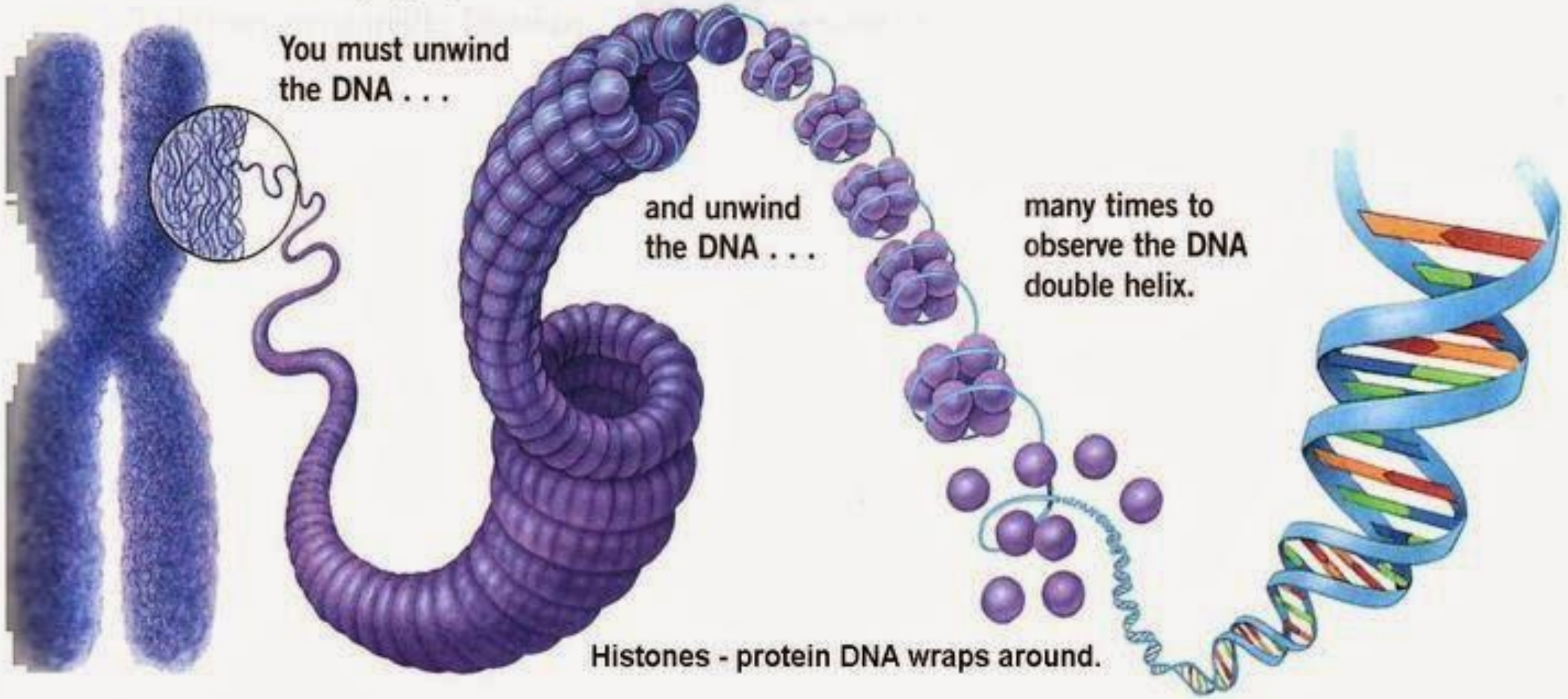


Chromosome

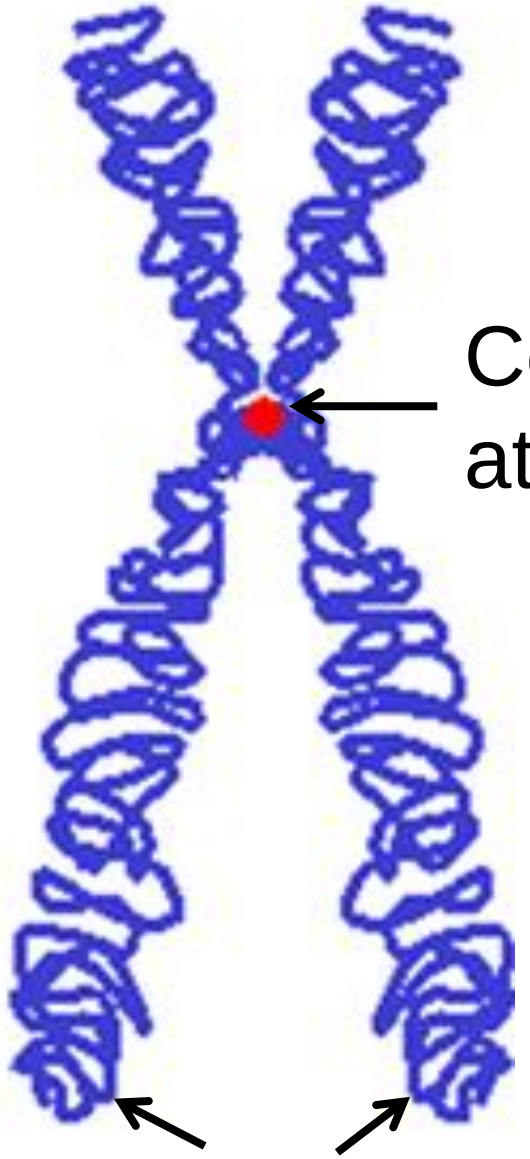
- long tightly coiled DNA molecule
- replicates to form 2 identical sister chromatids

FIGURE 7.7 **Chromosome Structure**

Chromosome contain very tightly wound DNA



Chromosome Structure

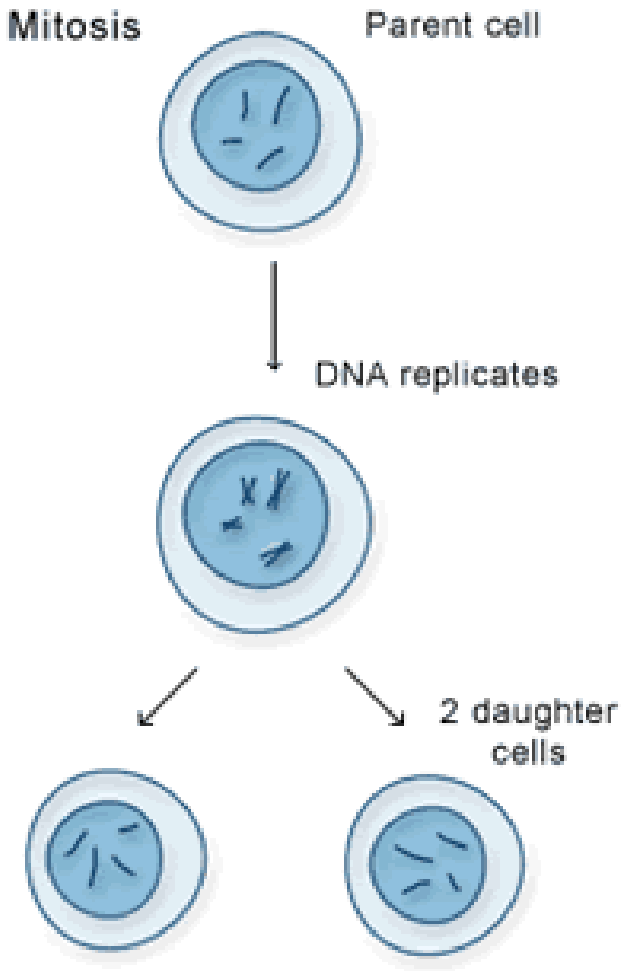


Centromere
attaches 2 chromatids

Identical Sister Chromatids

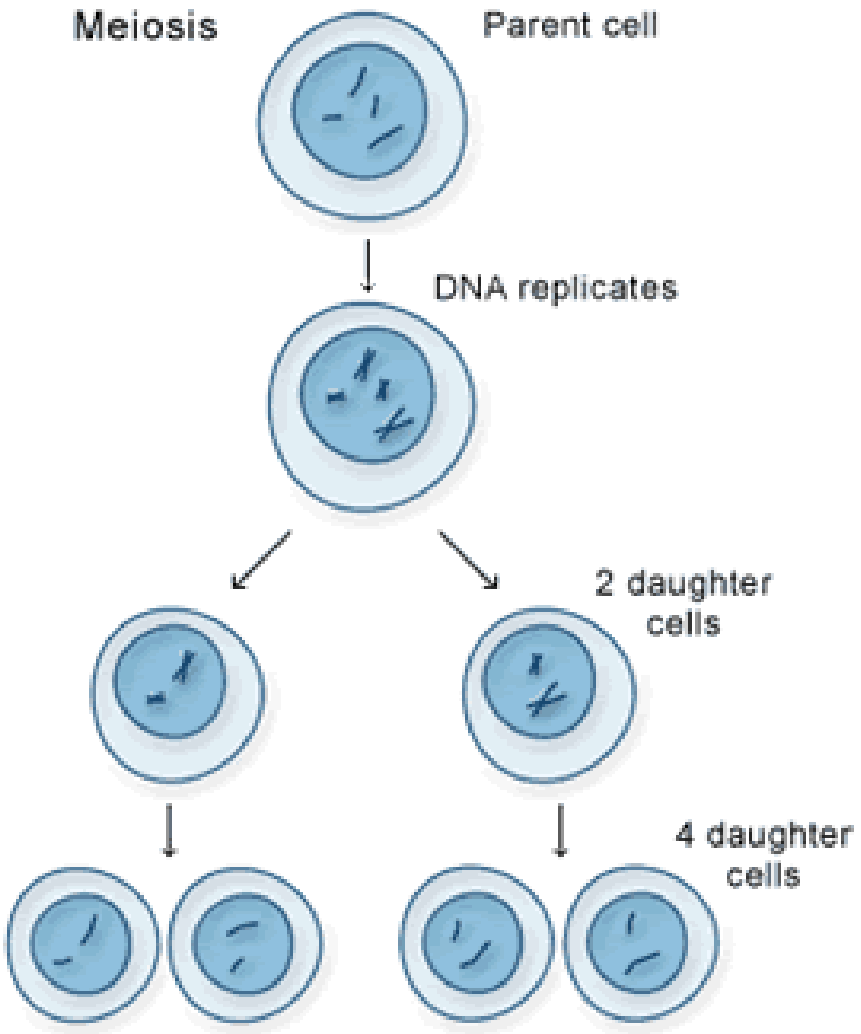
Cells can divide in two different ways…

MITOSIS



U.S. National Library of Medicine

MEIOSIS

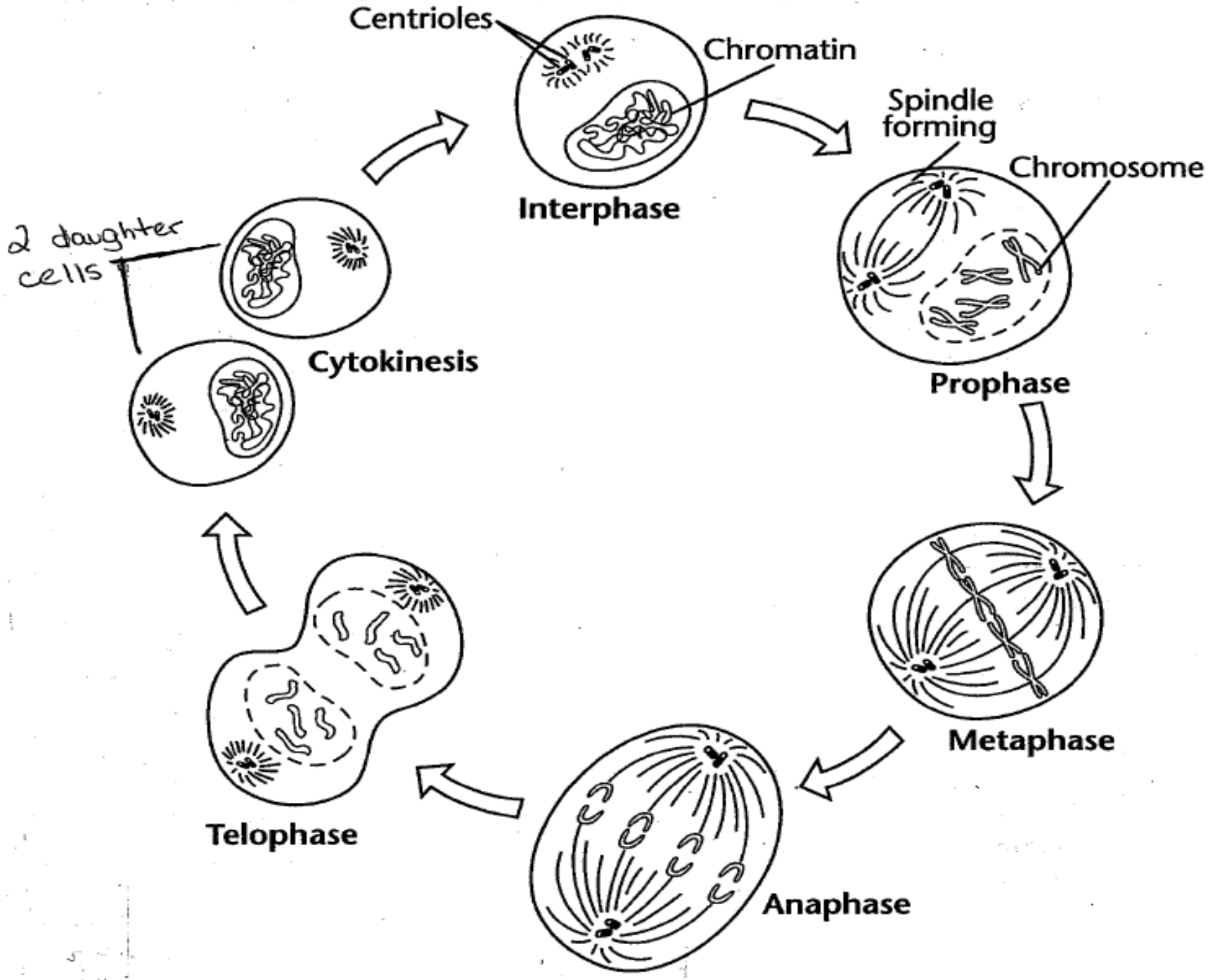


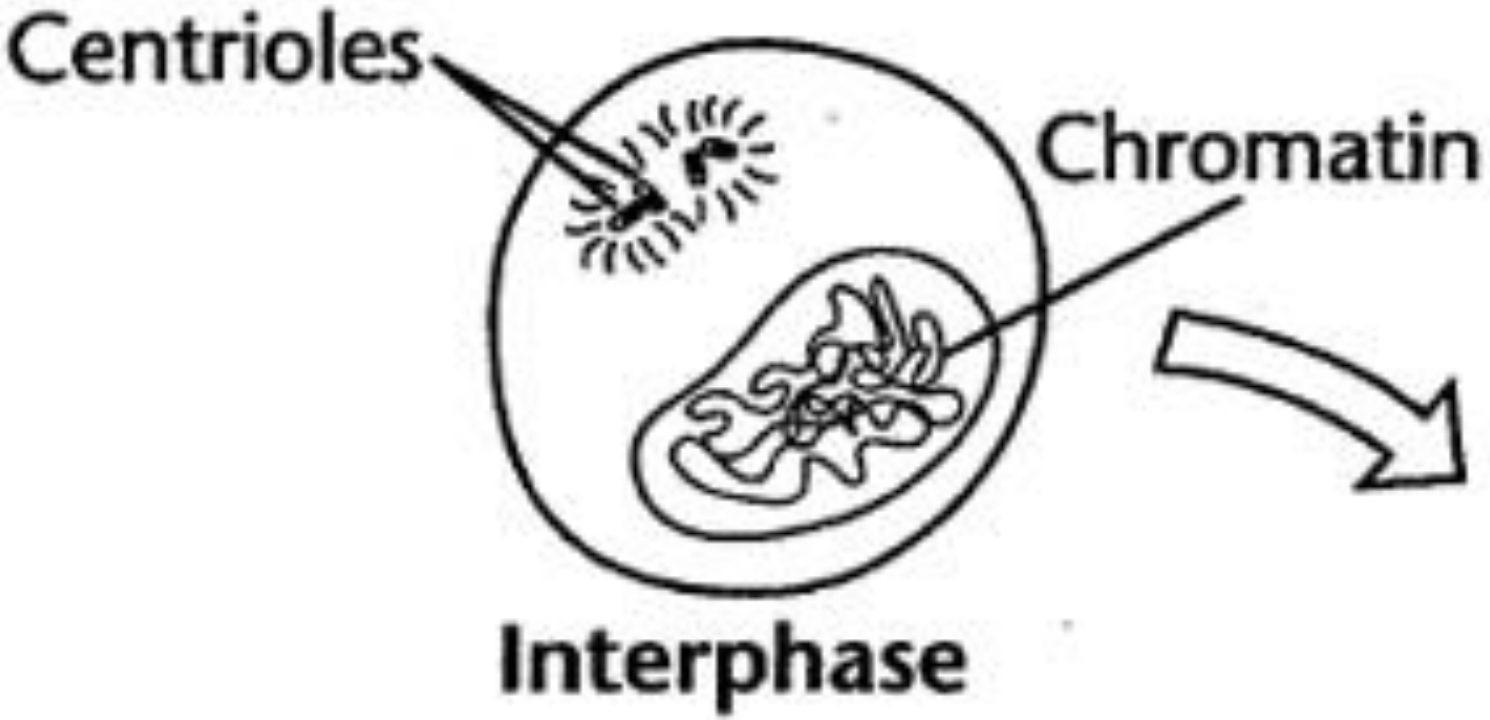
Both Mitosis AND Meiosis involve distinct stages involving specific changes inside the cell

P.M.A.T.

- Prophase
- Metaphase
- Anaphase
- Telophase

Mitosis Animation (details of each phase) (stop at 1:43)


Centrioles
Chromatin
Interphase
Spindle forming
Chromosome
Prophase
Metaphase
Anaphase
Telophase
2 daughter cells
Cytokinesis

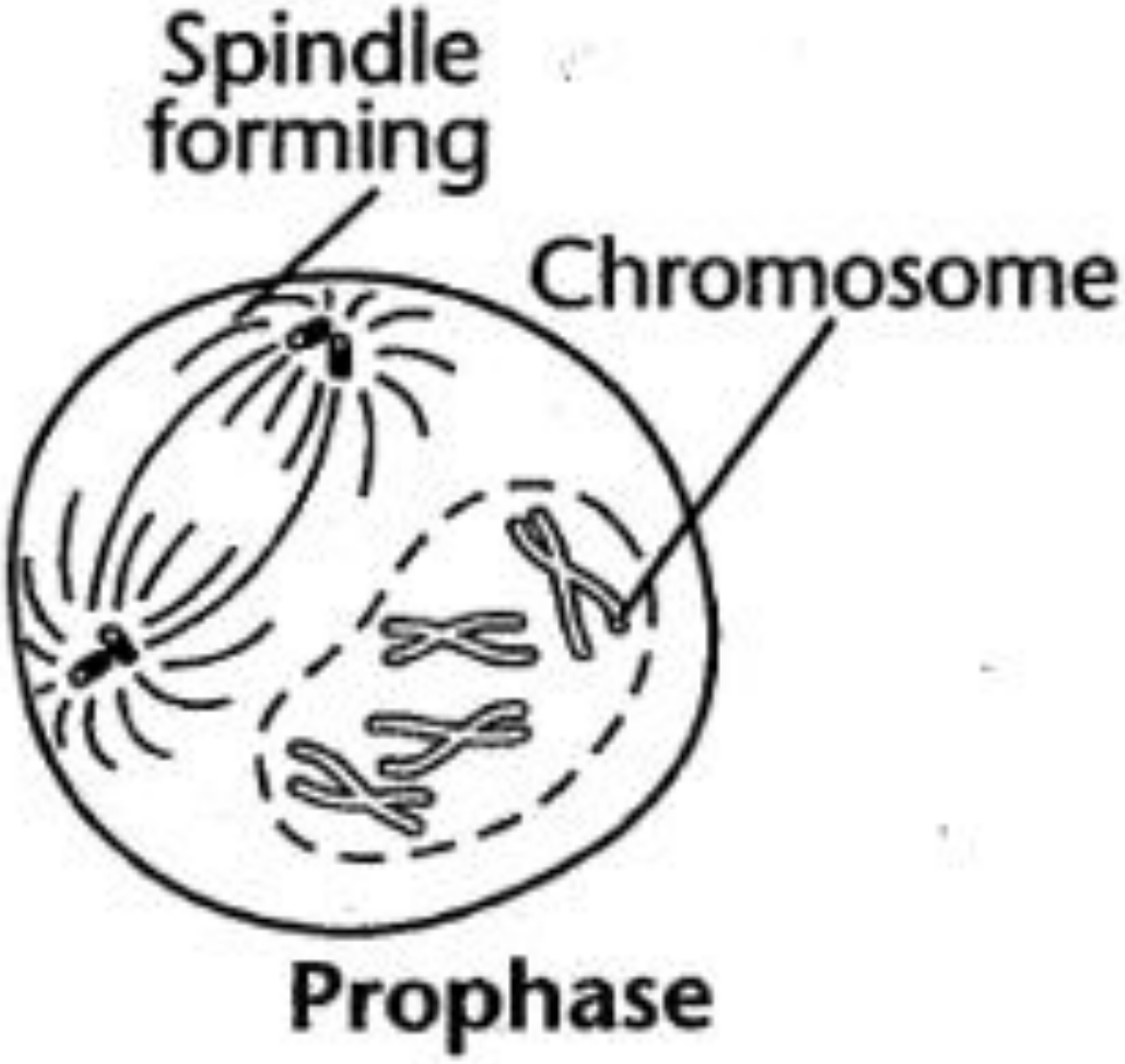


G1, S, G2 phases

NOT part of mitosis

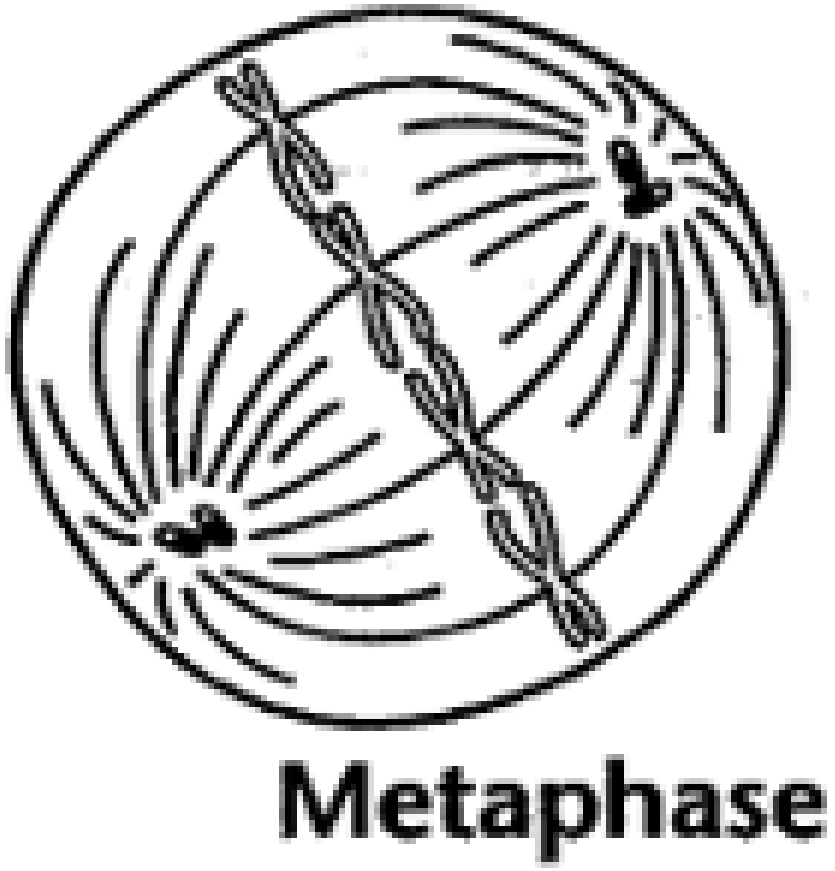
INTERPHASE

- **growth**
- **normal cell functions**
- **chromosomes replicate to prepare for cell division (are spread out in nucleus as chromatin)**



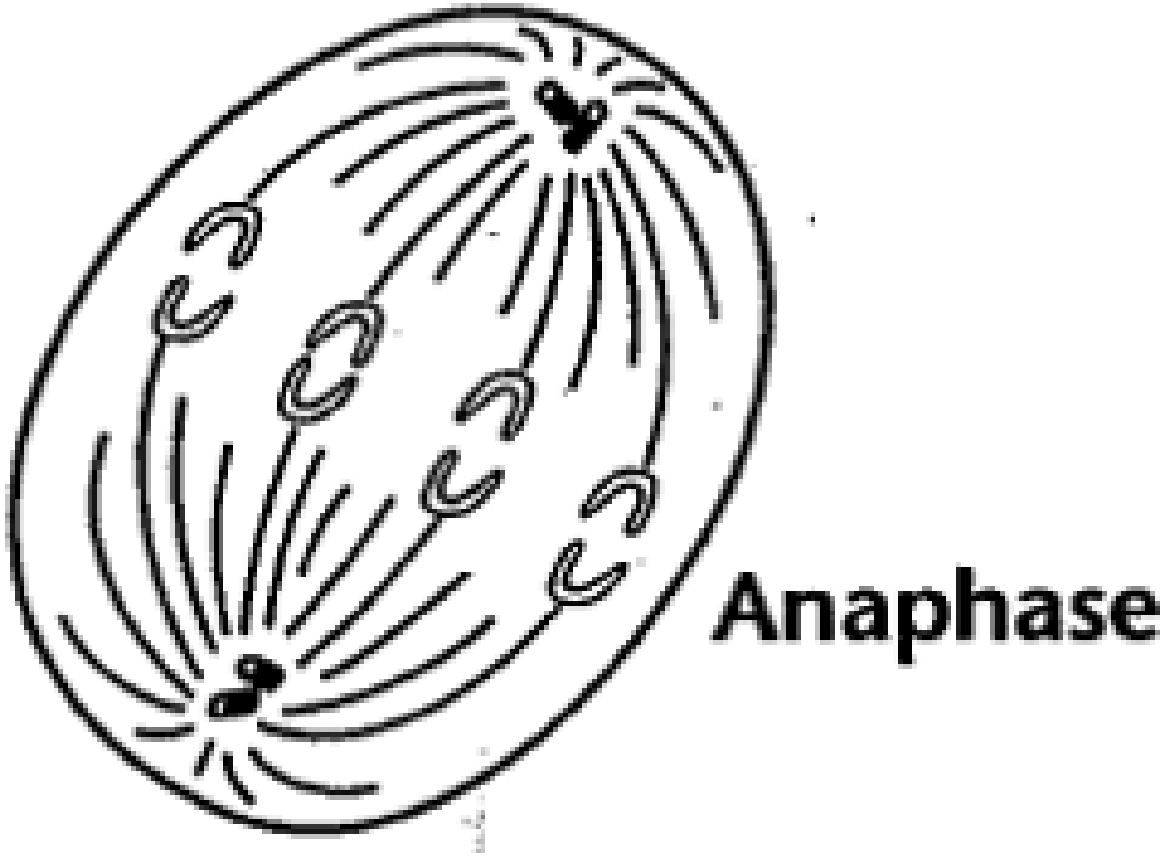
PROPHASE

- spindle fibers form
- centrioles begin to move to opposite poles (ends)
- nuclear membrane & nucleolus break down (degenerate)
- chromosomes condense / coil (become visible)



METAPHASE

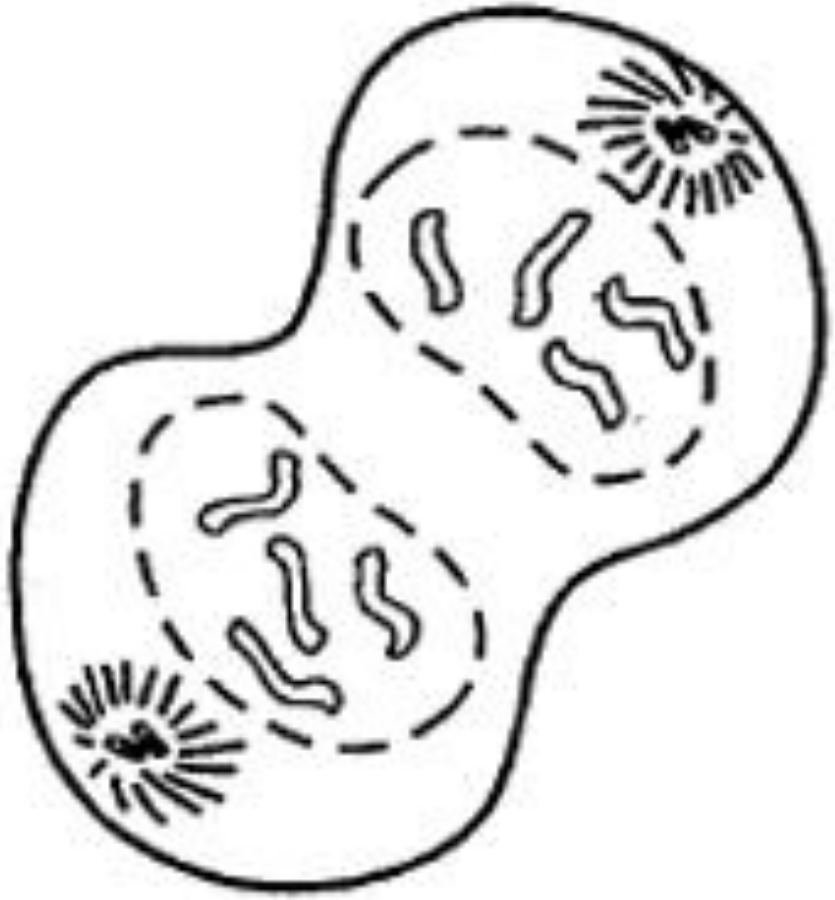
- spindle fibers attach at each centromere
- Alignment of chromosomes on equatorial plane (middle)



Anaphase

ANAPHASE

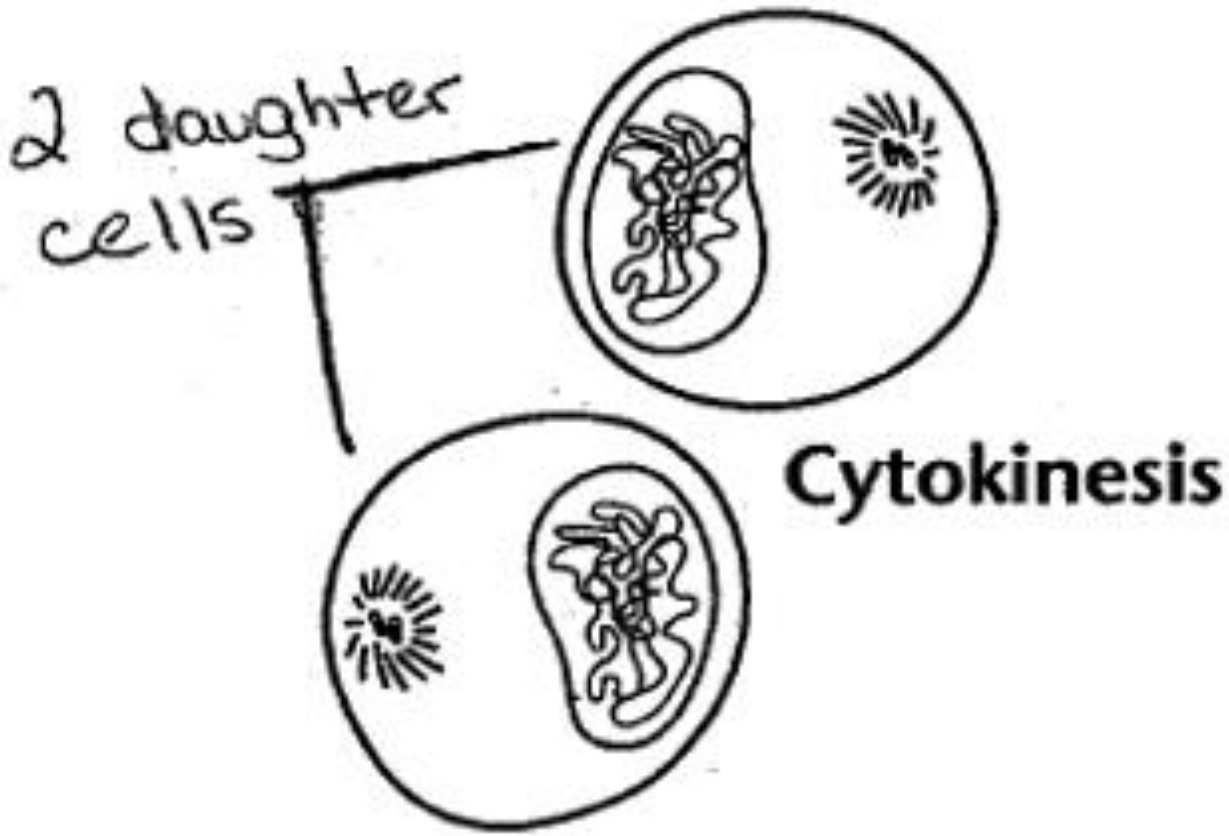
- chromatids are pulled apart by spindle fibers (Disjunction)
- 1 from each pair moves to opposite poles



Telophase

TELOPHASE

- nuclear membranes reform
- 2 separate but identical nuclei
- each has a full set of single stranded chromosomes
- Mitosis is complete



CYTOKINESIS

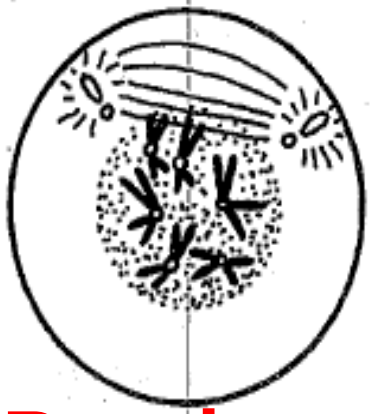
- Division of cytoplasm and other organelles
- Forms 2 identical daughter cells

Lesson 3

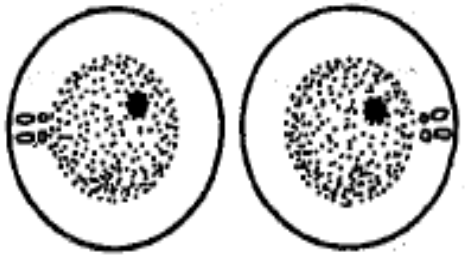
- Recap Mitosis phases
- Meiosis phases
- Compare to Mitosis

Mitosis in Animal Cells

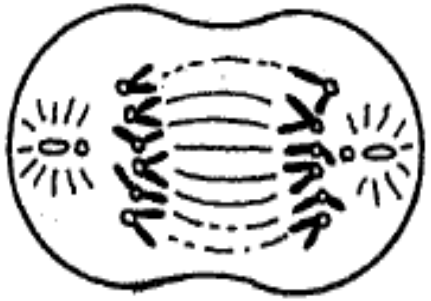
Label each stage with the proper name.



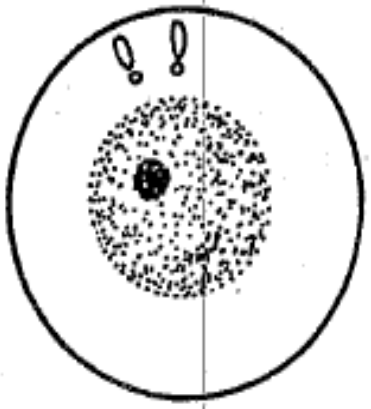
Prophase



2 daughter cells

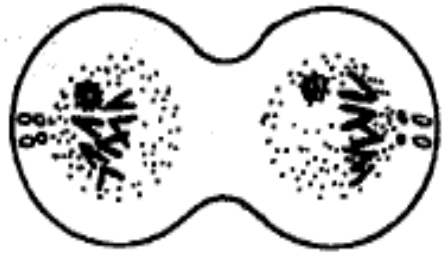


Anaphase



Interphase

Metaphase

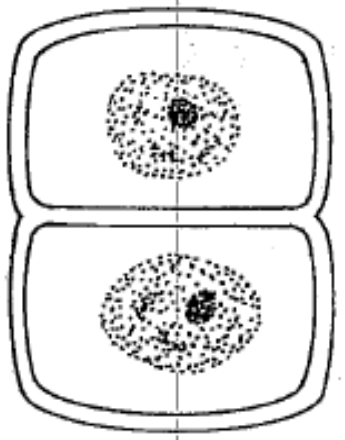


Telophase

NOTE: NO CENTRIOLES IN PLANT CELLS

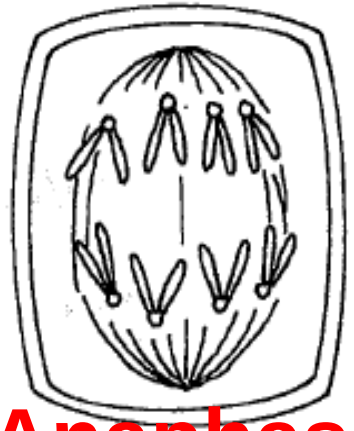
Mitosis in Plant Cells

Label each stage with the proper name.

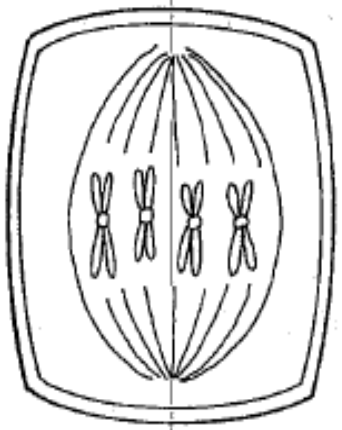


2 daughter cells

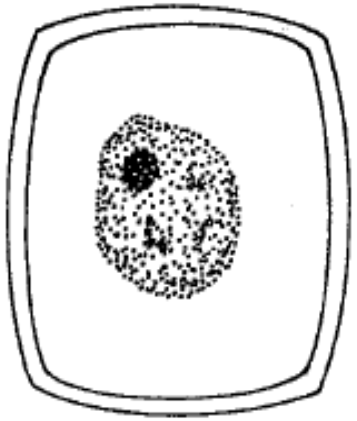
Prophase



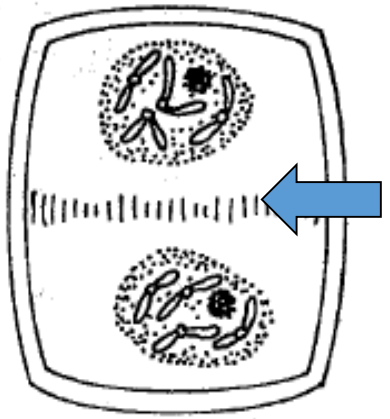
Anaphase



Metaphase



Interphase



Telophase

Cell plate forms to become cell wall

CHAPTER

21

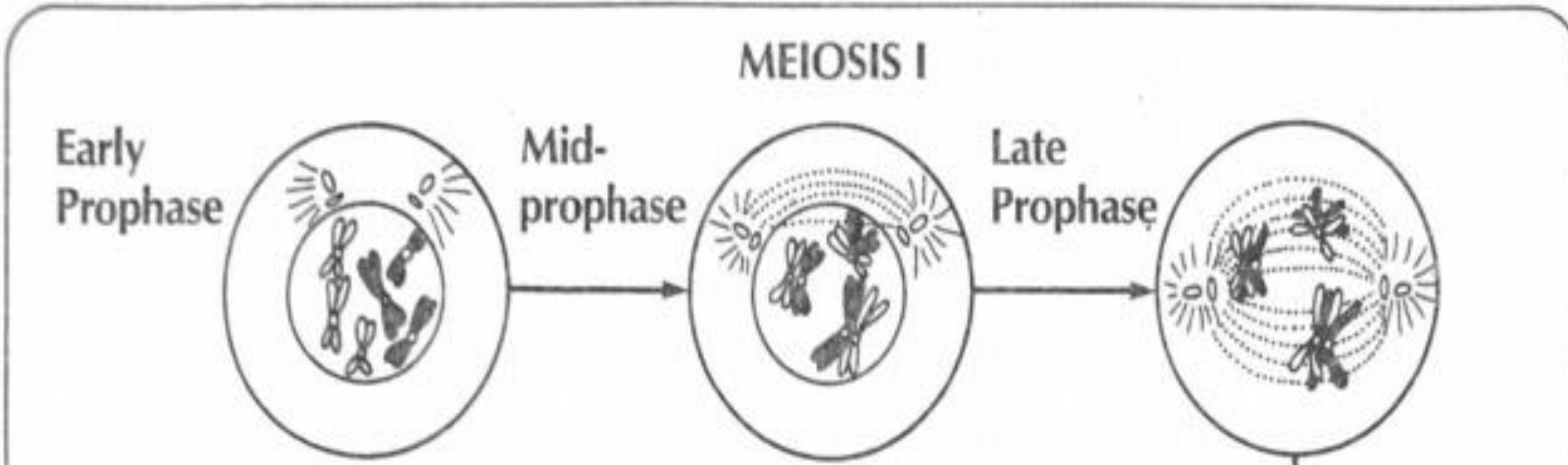
Diploid # (2n) = full set of chromosomes in body cells

- 46 in humans

Haploid # (n) = half a set of chromosomes in gametes

-23 in humans

Stages of Meiosis – to produce gametes



How many chromosomes do human body cells have?

46 (diploid # 2n)

How many chromosomes do human gametes have?

23 (haploid # n)

Why must gametes have the haploid # of chromosomes?

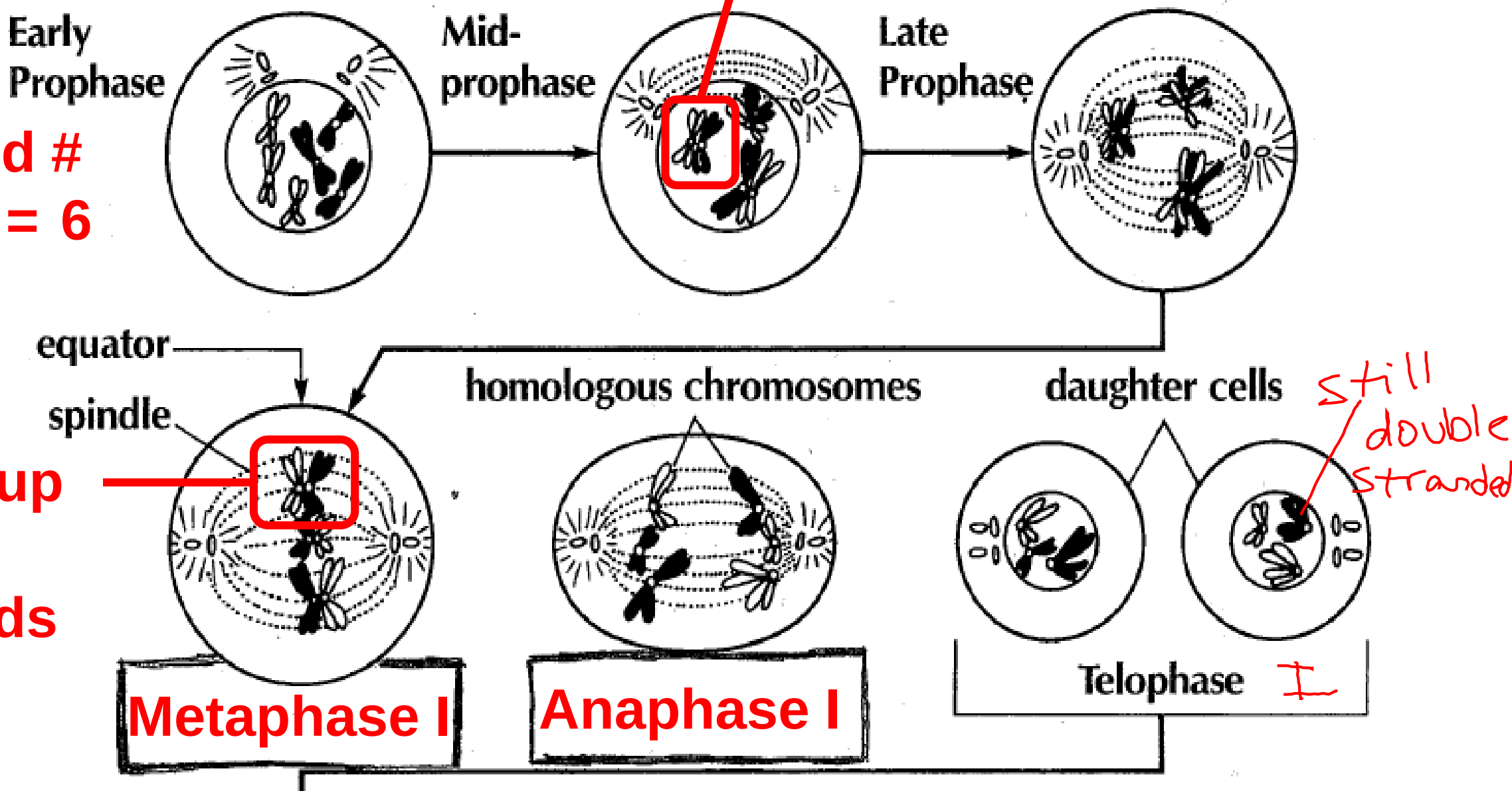
So the diploid # is restored at fertilization

Organism	Diploid # (2n)	Haploid # (n)
HUMAN	**46**	**23**
Camel	70	35
Goat	60	30
Guinea pig	64	32
Bat	44	22
Squirrel	40	20
Alligator	32	16
Chicken	78	39
King crab	208	104
Fruit fly	8	4
Pea	14	7
Apple	34	17
Potato	48	24
Soybean	40	20
Lettuce	18	9
Rice	24	12
Leopard Frog	26	13

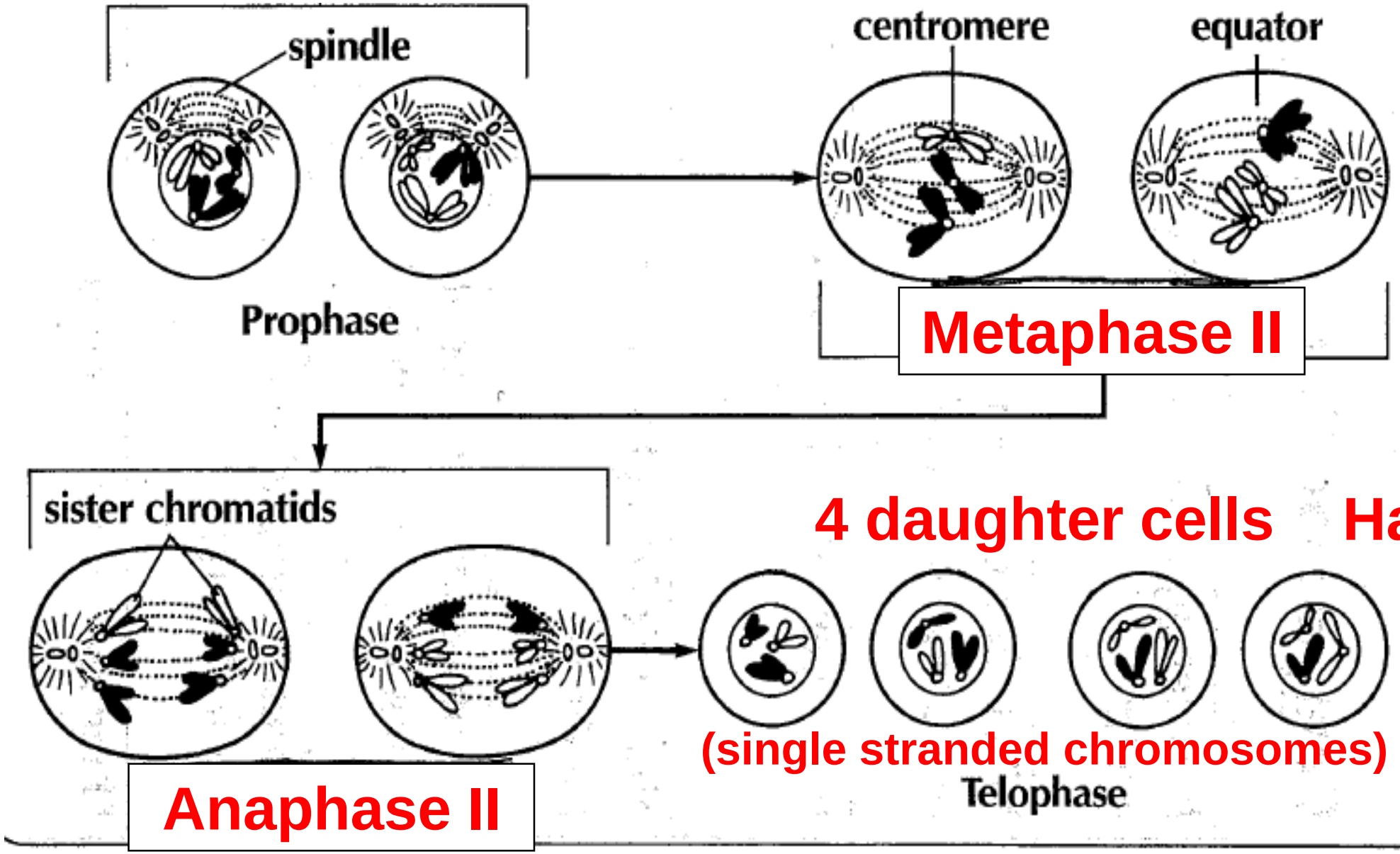
Meiosis I

Synapsis – pairing of homologous chromosomes

Diploid # (2n) = 6



Meiosis II (same as Mitosis)

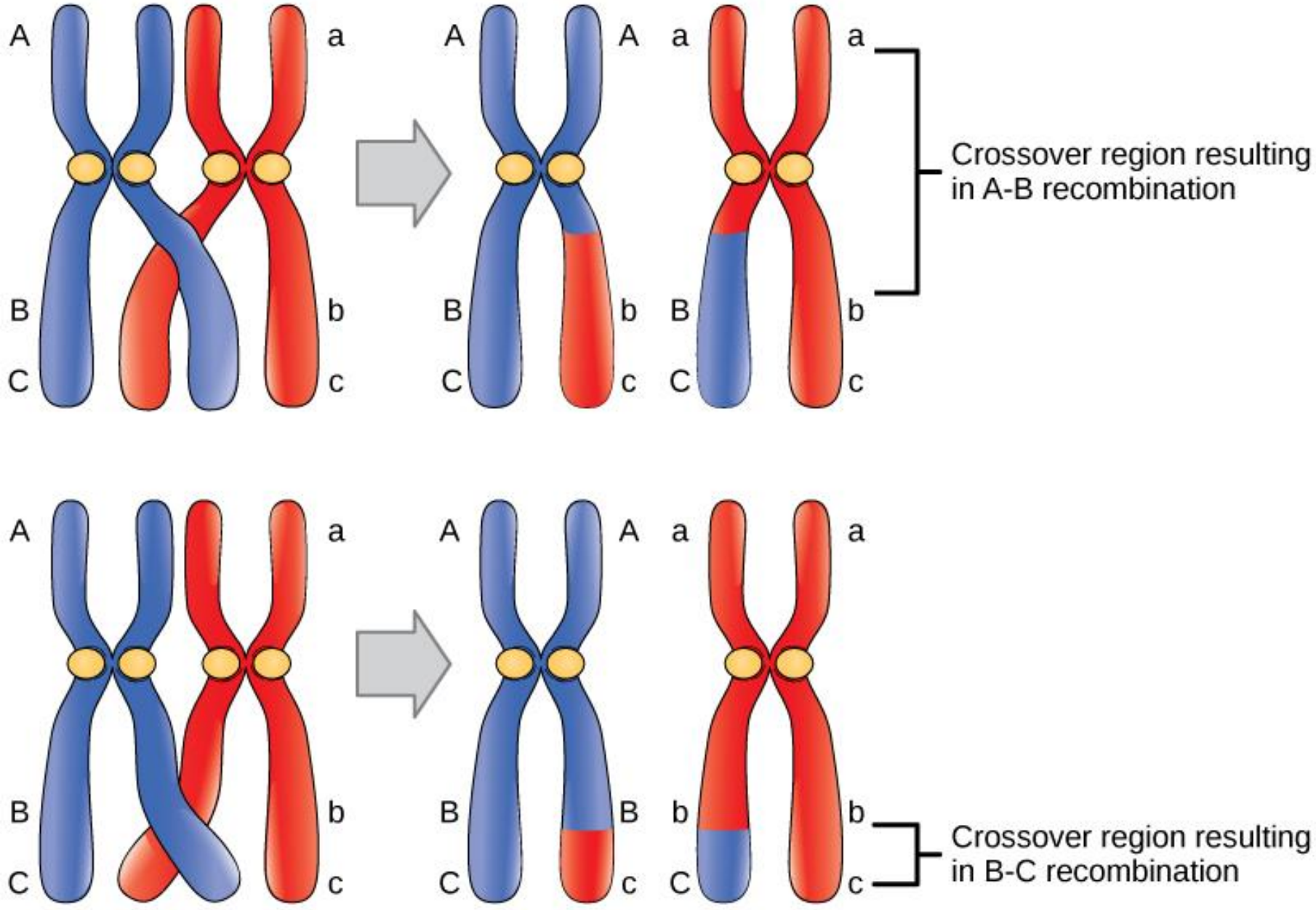


FACT: Experts estimate that one pair of parents has the potential to produce 64 trillion different children.

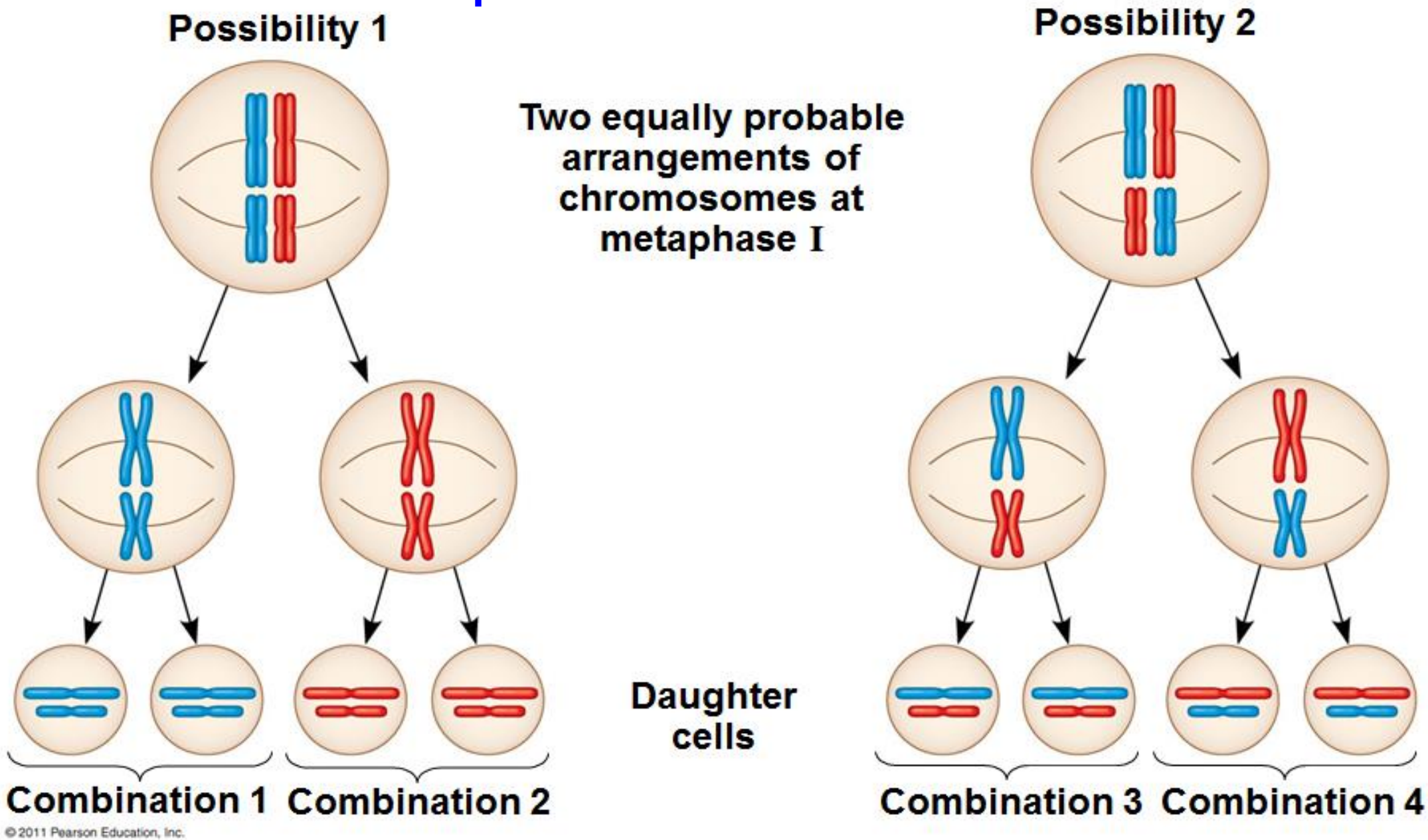
(Source: http://www.parents.com/pregnancy/getting-pregnant/genetics/genetics-and-your-baby/)

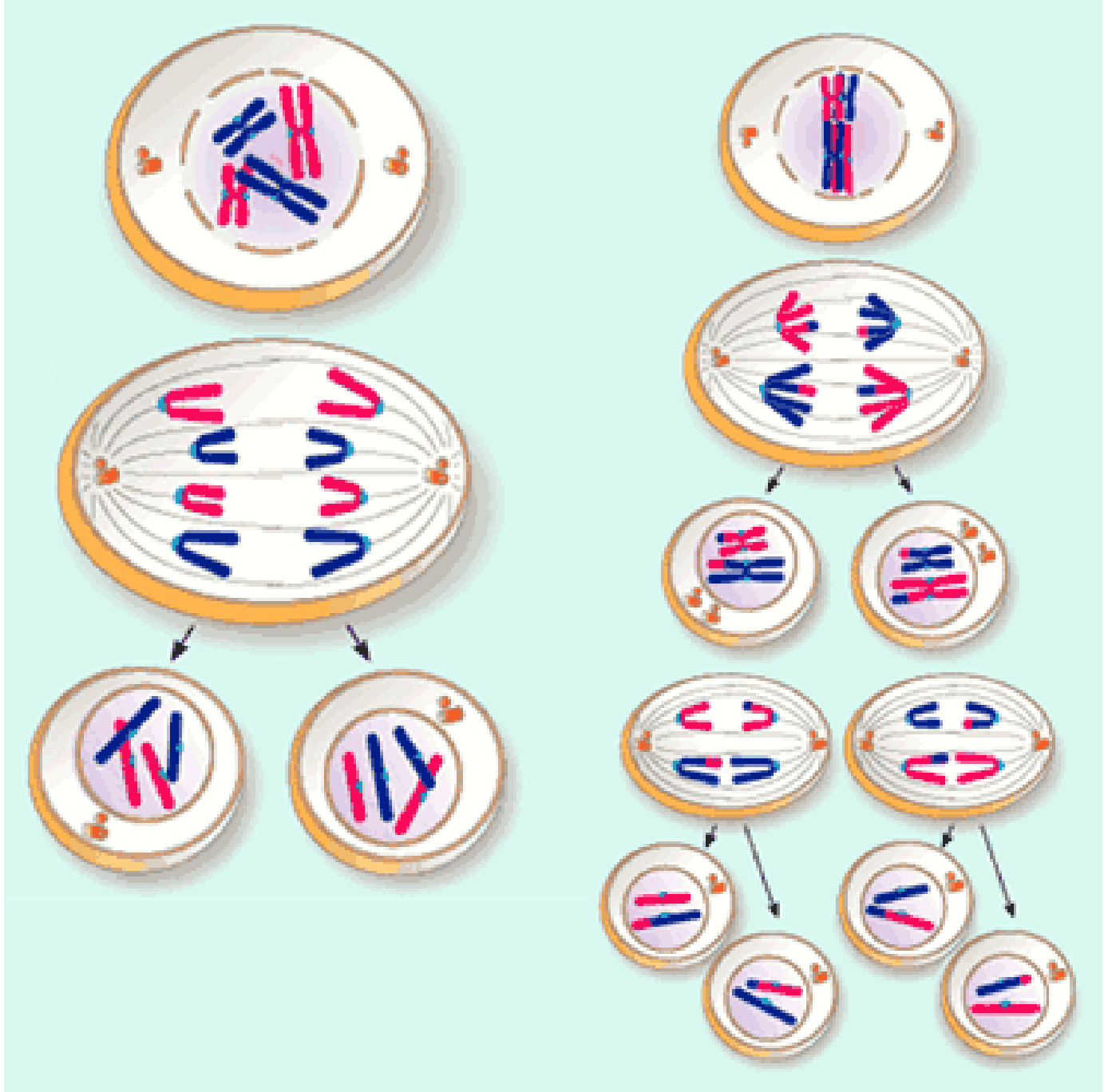
panorama™ prenatal screen | POWERED BY NATERA

Crossing-over



Independent Assortment

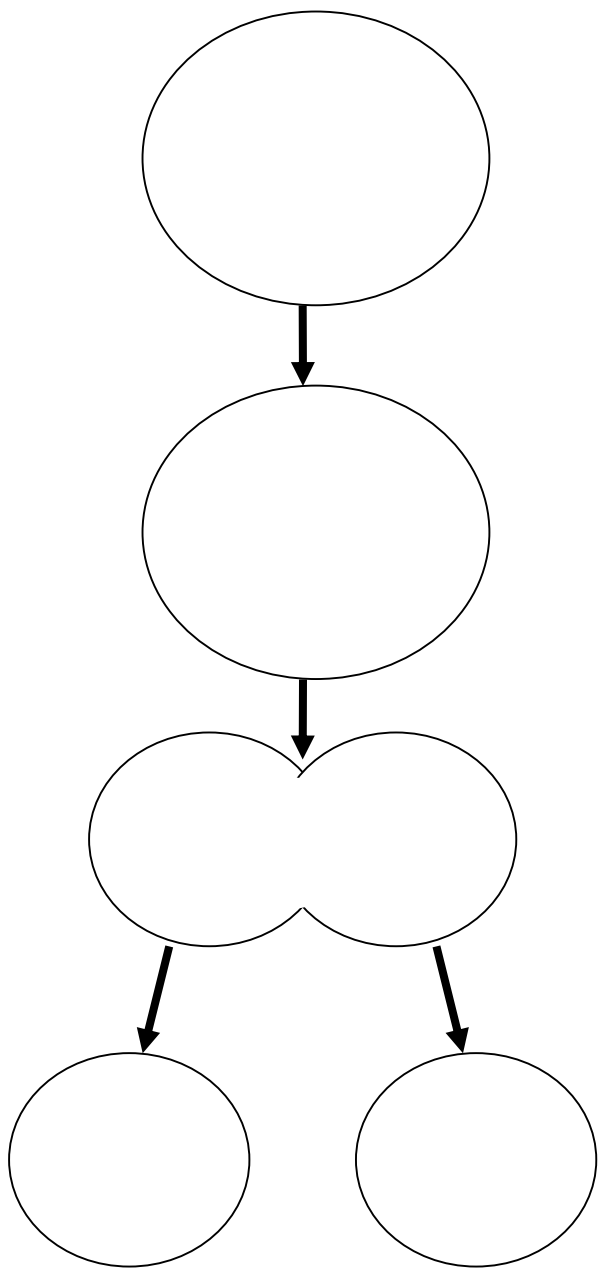


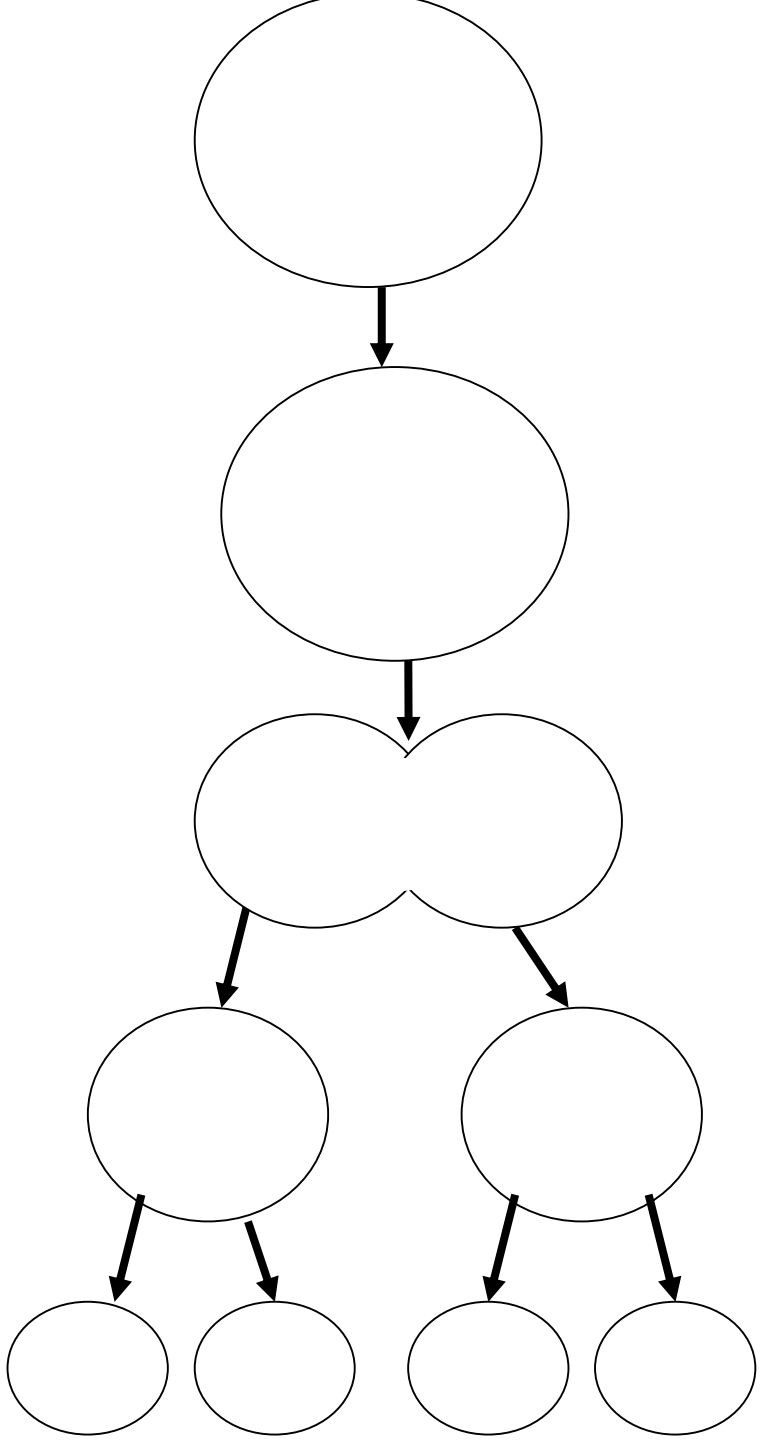


MEIOSIS VIDEO

Difference between mitosis and meiosis – YouTube

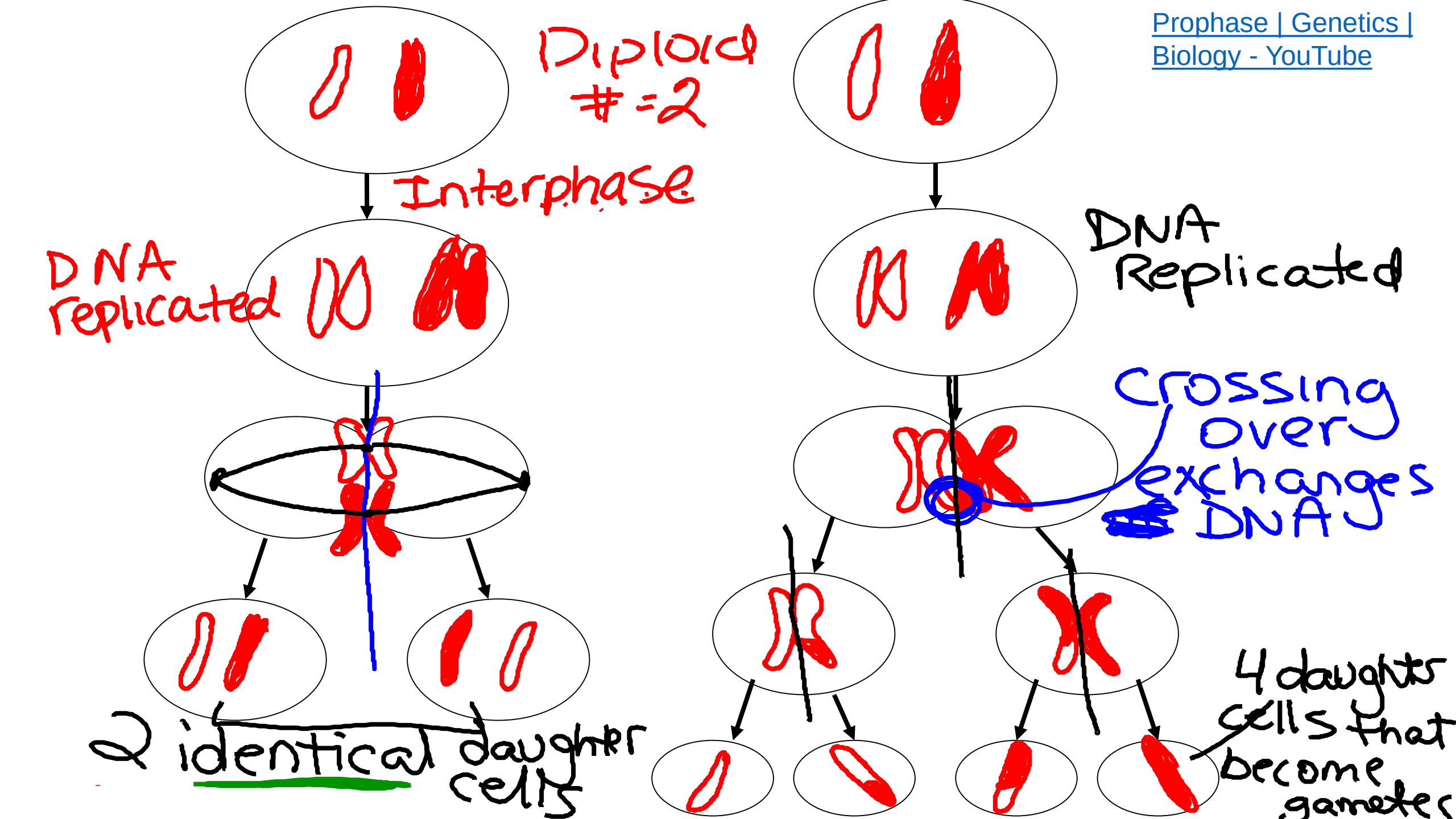
Biology : Meiosis - cell division - YouTube



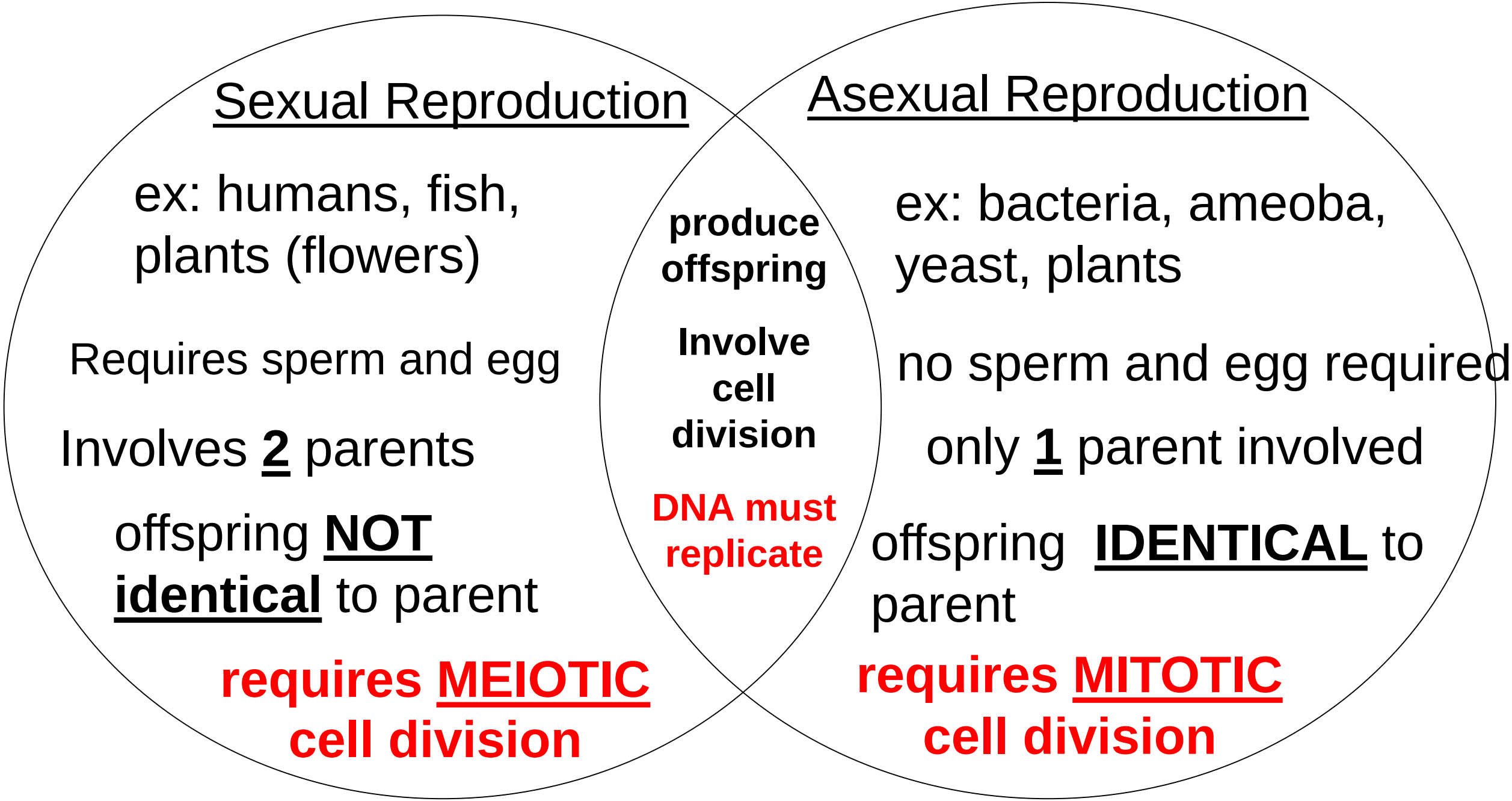


[Prophase | Genetics | Biology - YouTube]

Prophase | Genetics | Biology - YouTube



Mitosis	Meiosis
1 division → 2 daughter cells	2 divisions → 4 daughter cells
Genetically identical	Genetically varied
Chromosome number is maintained (diploid 2n)	Chromosome number is halved (haploid n)
Asexual reproduction	Sexual Reproduction
Ex. Skin repair, zygote cleavages	Ex. Gamete (sperm & egg) production in gonads
“single file,” NO crossing over	in pairs (synapsis), YES crossing over occurs


Sexual Reproduction
ex: humans, fish, plants (flowers)
Requires sperm and egg
Involves 2 parents
offspring NOT identical to parent
requires MEIOTIC cell division
produce offspring
Involve cell division
DNA must replicate
Asexual Reproduction
ex: bacteria, ameoba, yeast, plants
no sperm and egg required
only 1 parent involved
offspring IDENTICAL to parent
requires MITOTIC cell division

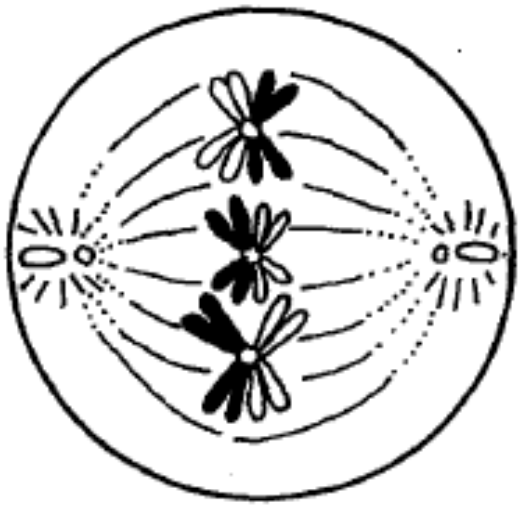
Lesson 4

- Gametogenesis
  - Spermatogenesis, Oogenesis

STAGES OF MEIOSIS

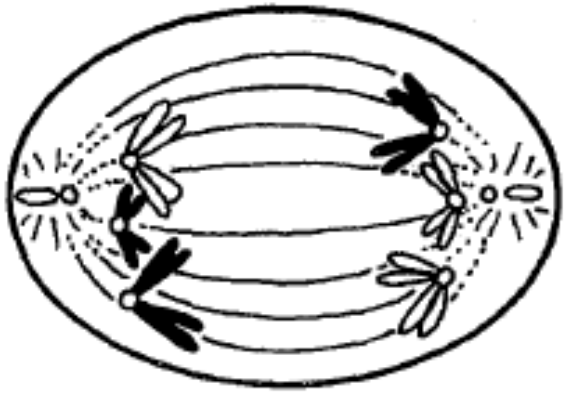
Name _____

Number the following diagrams of a first meiotic division in the proper order. Label each phase correctly as prophase I, metaphase I, anaphase I or telophase I.

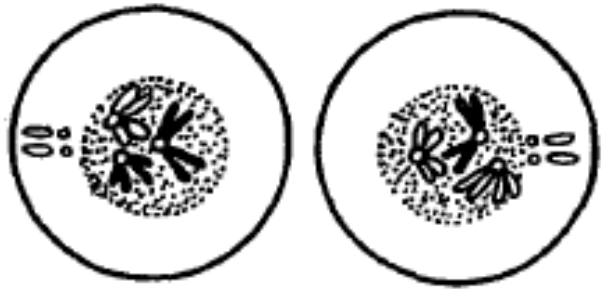


Metaphase I

Prophase I

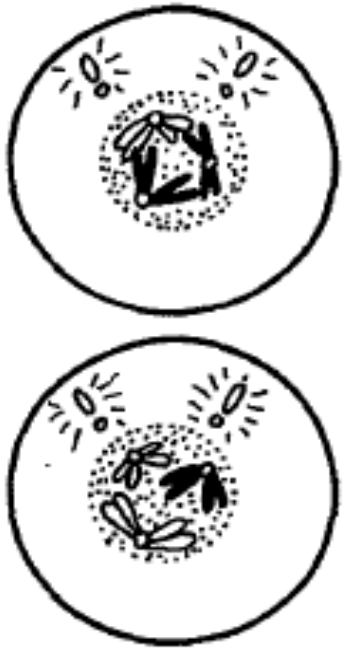


Anaphase I



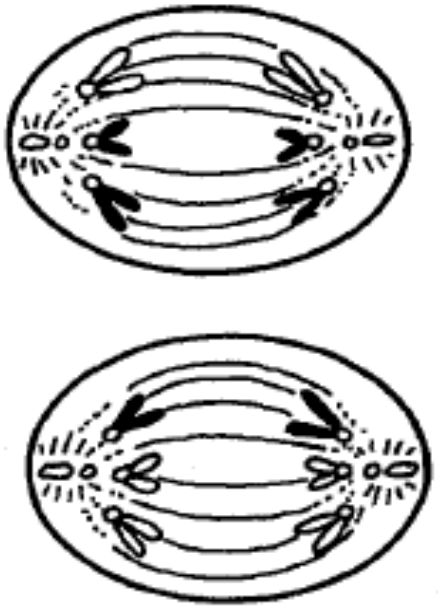
Telophase I

Do the same for the diagrams of the second meiotic division. Label each phase correctly as prophase II, metaphase II, anaphase II, telophase II .

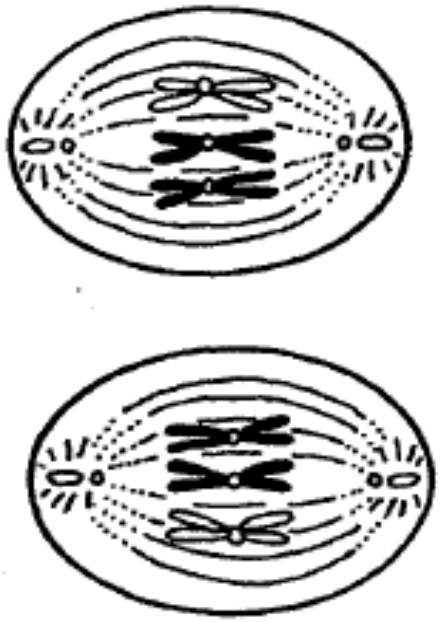


Prophase II

Telophase II



Anaphase II

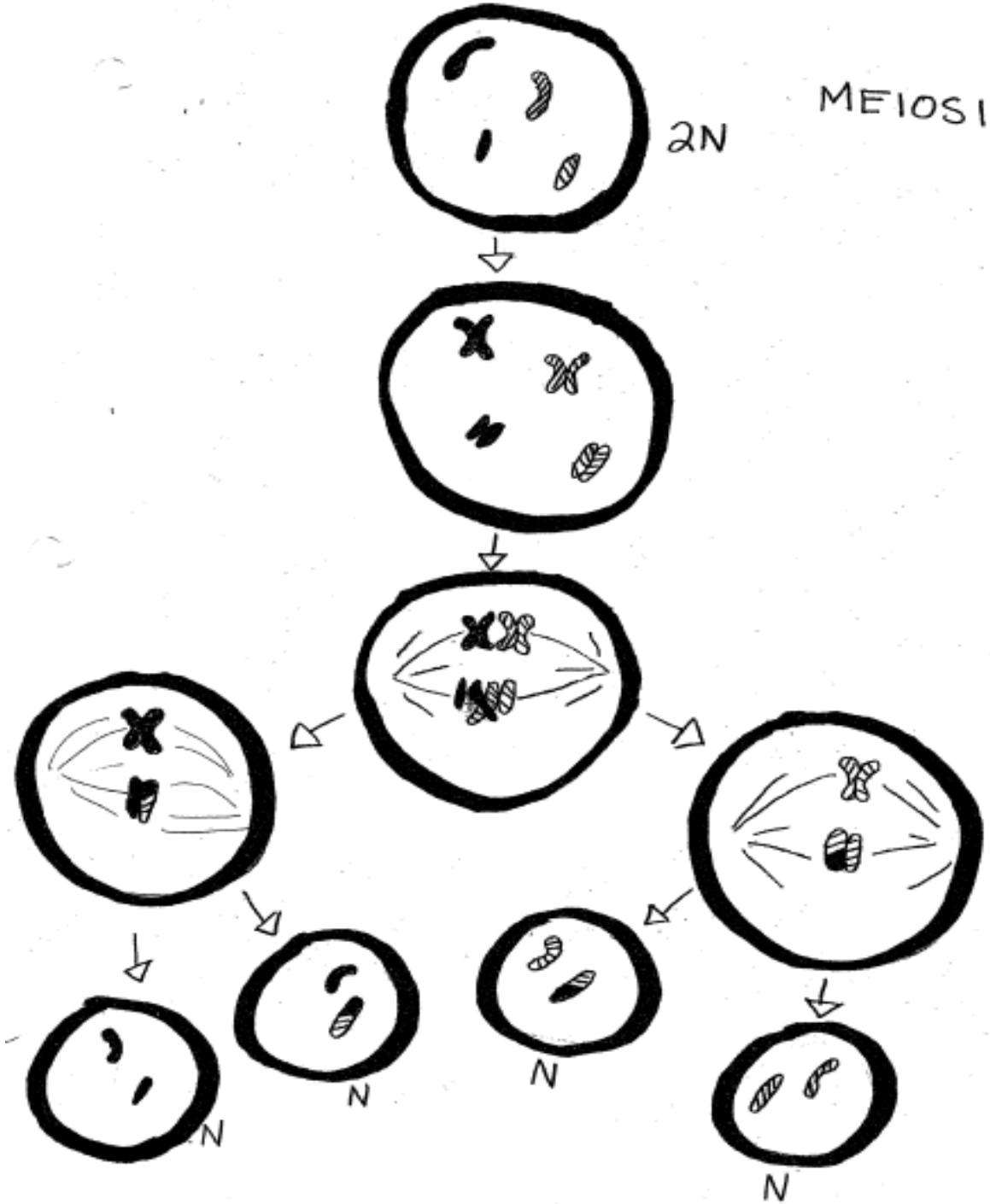


Metaphase II

Activity - Piecing together MEIOSIS!

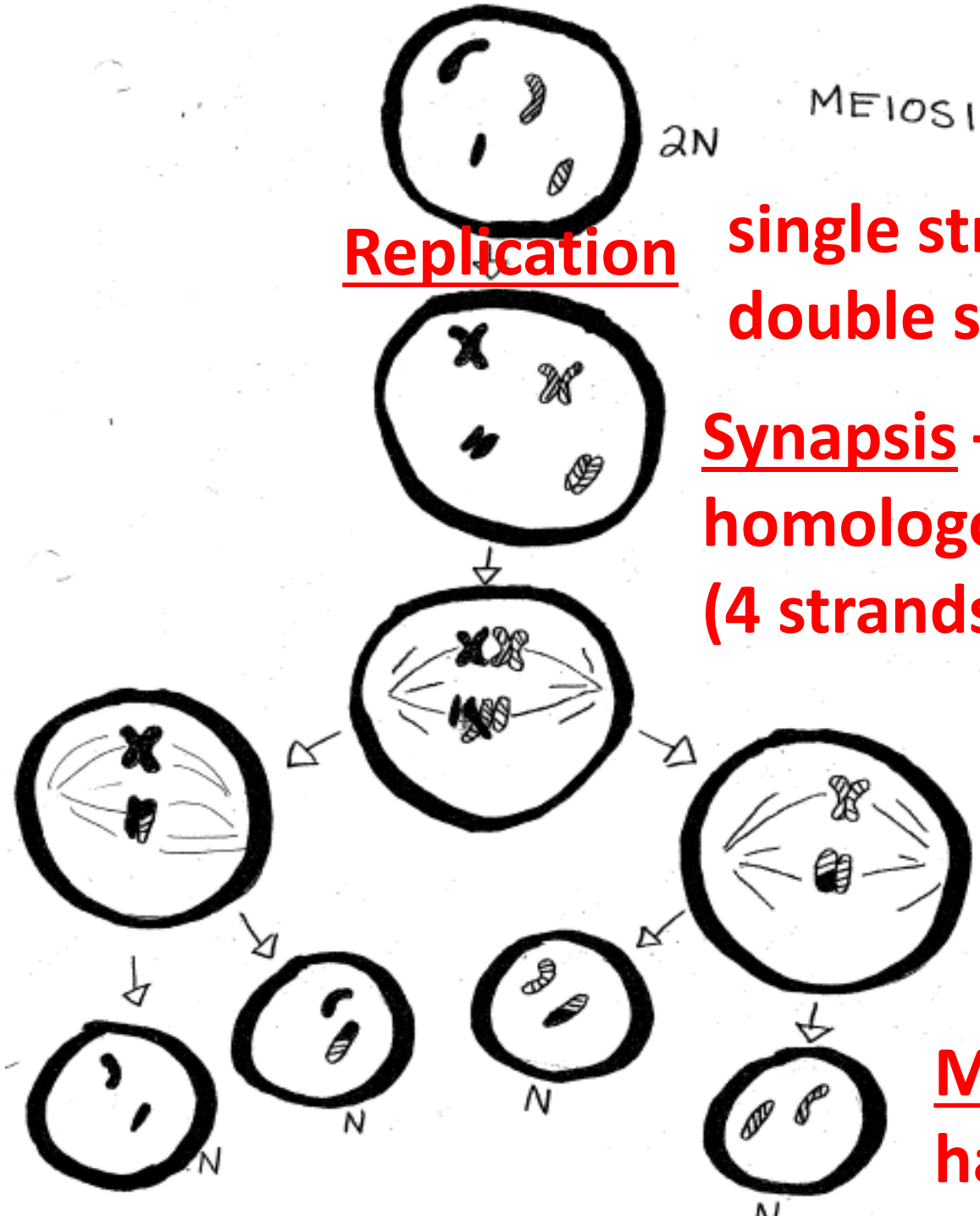
When instructed, put the pieces in your envelope in order to represent the process of meiosis

NOTE – it is a summary, NOT all phases are shown



Identify / describe:

- Replication
- Synapsis / Tetrad
- Crossing over



Replication – single stranded chromosomes become double stranded

Synapsis – pairing of double stranded homologous chromosomes forming a **tetrad** (4 strands)

Crossing over – chromosomes exchange parts when paired creating **genetic variation** in each daughter cell produced

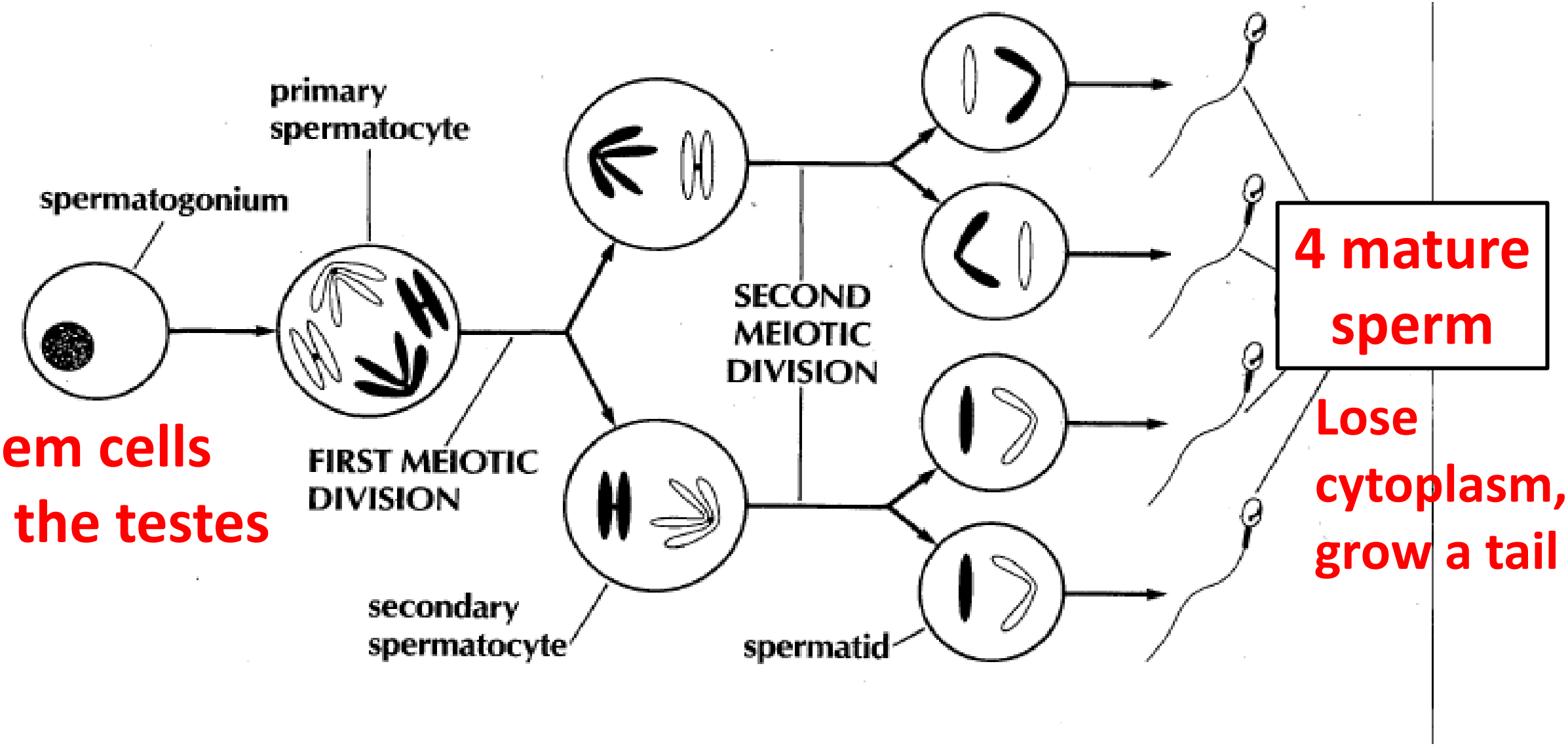
Meiosis Result – 4 genetically varied haploid daughter cells

	Mitosis	Meiosis
1. no pairing of homologs occurs	X	
2. two divisions		X
3. four daughter cells produced		X
4. associated with growth and asexual reproduction	X	
5. associated with sexual reproduction		X
6. one division	X	
7. two daughter cells produced	X	
8. involves duplication of chromosomes	X	X
9. chromosome number is maintained	X	
10. chromosome number is halved		X

11.	crossing over between homologous chromosomes may occur		X
12.	daughter cells are identical to parent cell	X	
13.	daughter cells are not identical to parent cell		X
14.	produces gametes		X
15.	synapsis occurs in prophase		X

Spermatogenesis

– meiosis in male testes to produce sperm (gametogenesis)



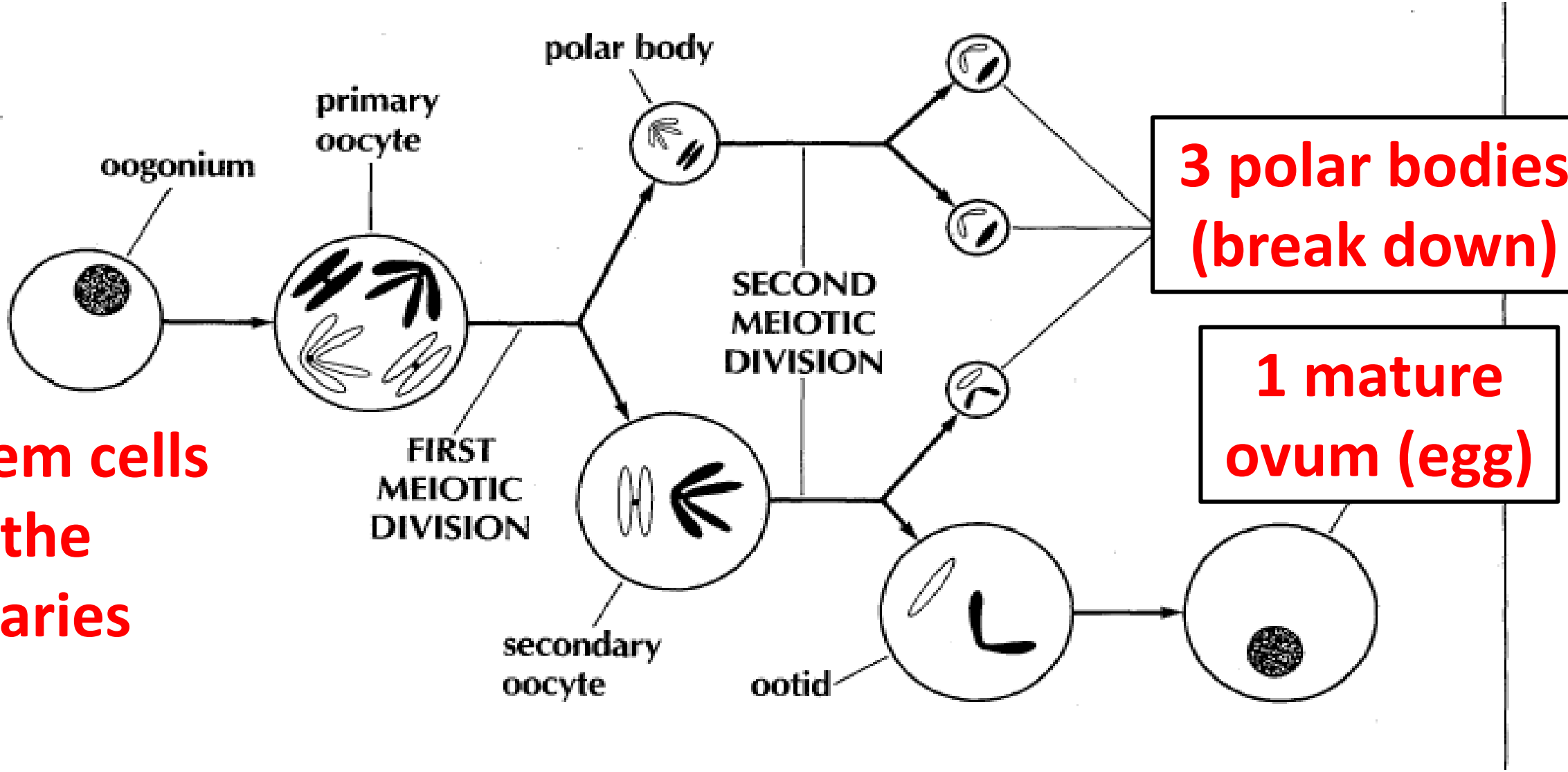
Stem cells in the testes

4 mature sperm

Lose cytoplasm, grow a tail

Oogenesis

– meiosis in female ovary to produce mature egg cell (gametogenesis)



3 polar bodies (break down)

1 mature ovum (egg)

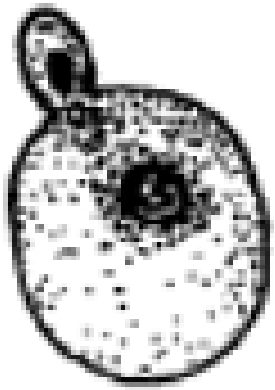
Stem cells in the ovaries

1

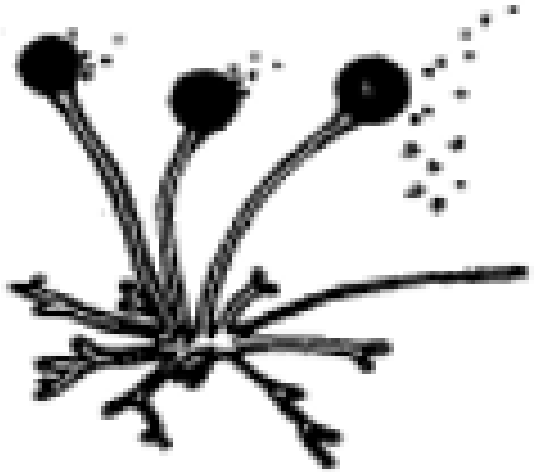
Which diagram represents binary fission?

(1)

(3)



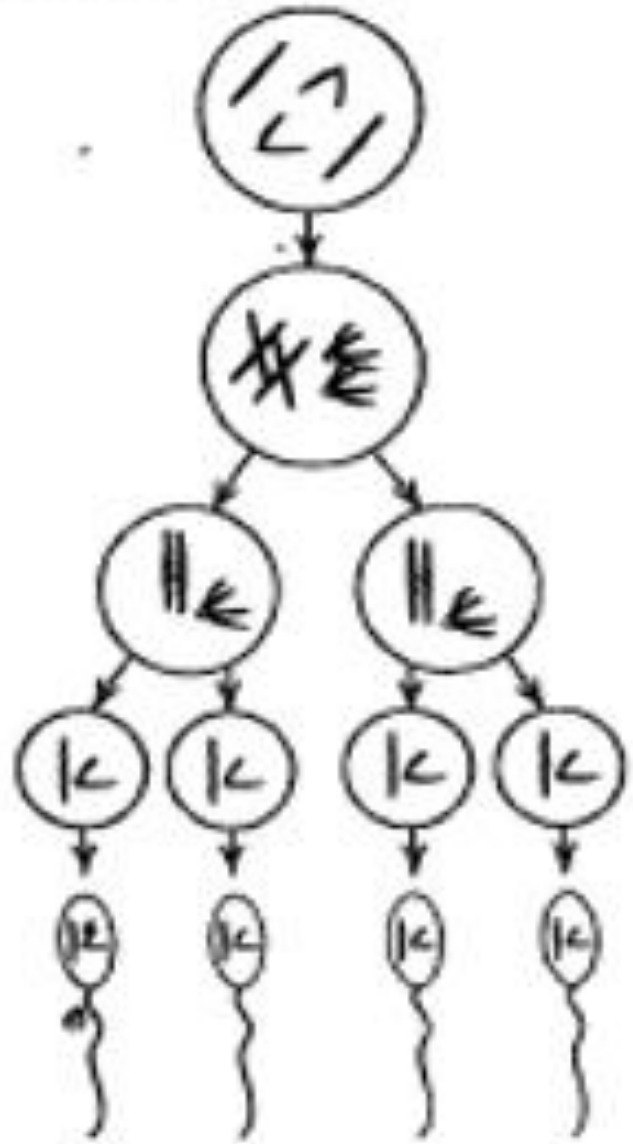
(2)



(4)

2

a. Which process is represented by the diagram below?



(1) fertilization
(2) gametogenesis
(3) binary fission
(4) vegetative propagation

1

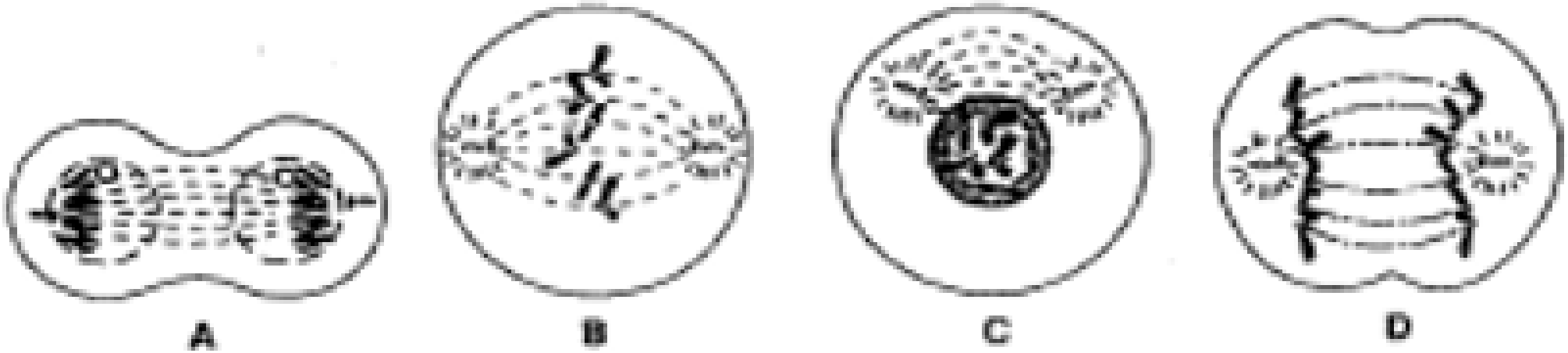
3. An adaptation for reproduction in most terrestrial vertebrates is
(1) internal fertilization
(2) regeneration
(3) mitosis
(4) vegetative propagation

1

4. Which sequence represents the correct order of events in the development of sexually reproducing animals?
(1) fertilization → cleavage → differentiation → growth
(2) cleavage → fertilization → growth → differentiation
(3) growth → cleavage → fertilization → differentiation
(4) fertilization → differentiation → cleavage → growth

3

5. The diagrams below represent stages of a cellular process.



Which is the correct sequence of these stages?

(1) $A \rightarrow B \rightarrow C \rightarrow D$
(2) $B \rightarrow D \rightarrow C \rightarrow A$
(3) $C \rightarrow B \rightarrow D \rightarrow A$
(4) $D \rightarrow B \rightarrow A \rightarrow C$

2

6. Which statement best describes the division of the cytoplasm and the nucleus in budding?
(1) Both the cytoplasm and the nucleus divide equally.
(2) The cytoplasm divides unequally, but the nucleus divides equally.
(3) The cytoplasm divides equally, but the nucleus divides unequally.
(4) Both the cytoplasm and the nucleus divide unequally.

2

7. *Rhizopus*, a bread mold, usually reproduces asexually by
(1) budding
(2) sporulation
(3) regeneration
(4) fission

1

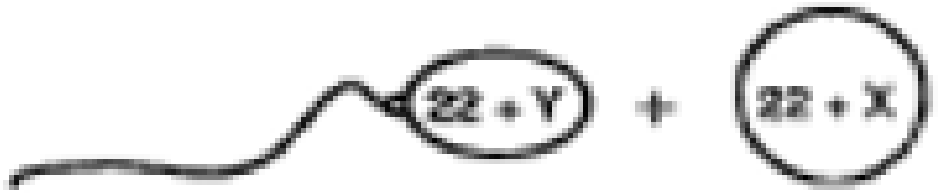
8. In sexually reproducing species, doubling of the chromosome number from generation to generation is prevented by events that take place during the process of
(1) gametogenesis (MEIOSIS)
(2) cleavage
(3) nondisjunction
(4) fertilization

3

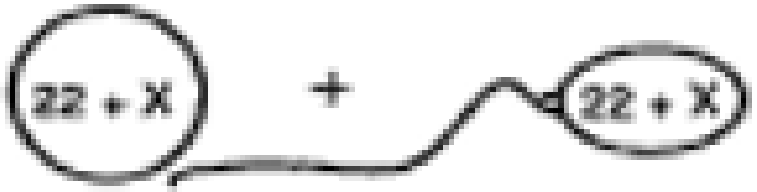
10. The production of large numbers of eggs is necessary to insure the survival of most
(1) mammals
(2) molds
(3) fish
(4) yeasts

1

11. Which pair of gametes can unite to produce a zygote that will develop into a normal human male embryo?

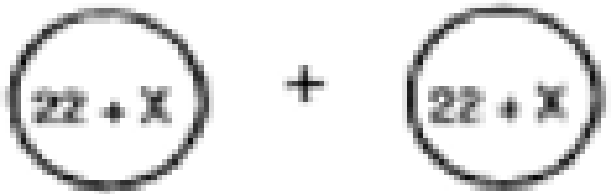


(1)



(3)

(2)



(4)

12. In humans, which cell is produced most directly by mitotic cell division?

2

(1) a sperm cell
(2) a skin cell
(3) an egg cell
(4) a zygote

13. During meiotic cell division, the process in which homologous pairs of chromosomes separate and move apart is known as

4

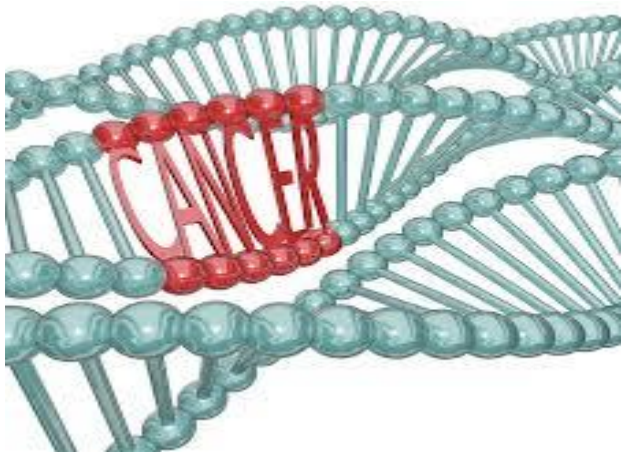
(1) internal fertilization
(2) regeneration
(3) binary fission
(4) disjunction

Lesson 5

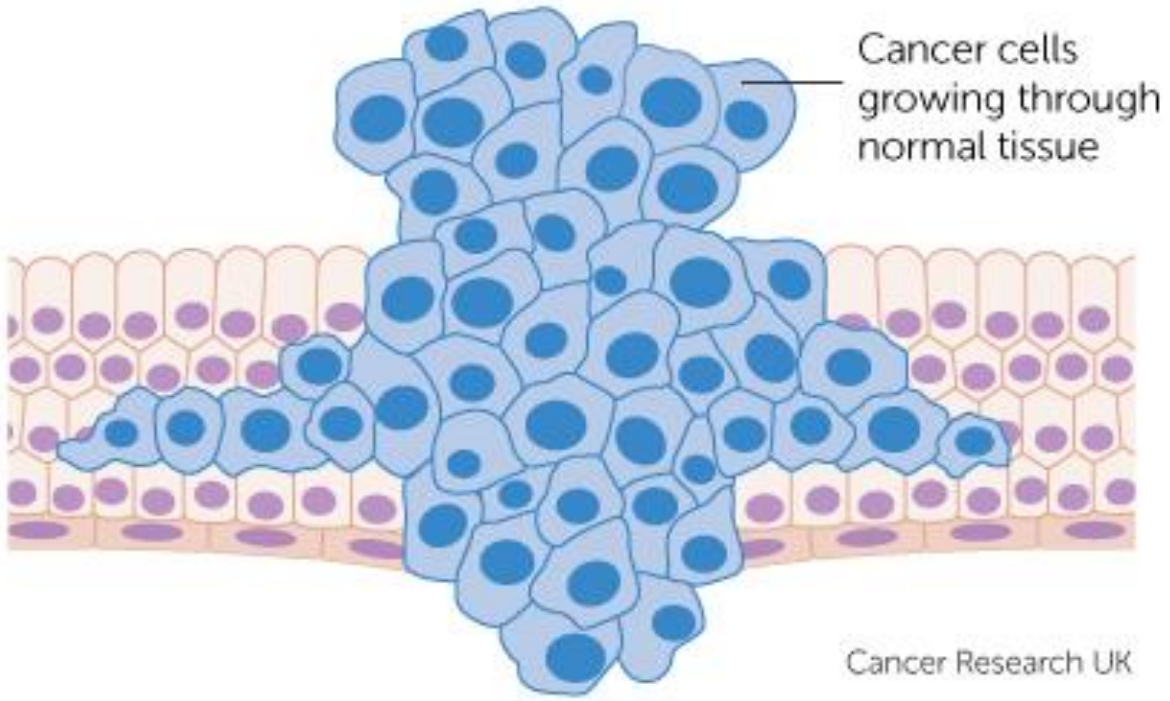
Malfunctions of cell division

- Cancer
- Nondisjunction

Malfunction of Cell Division - Cancer

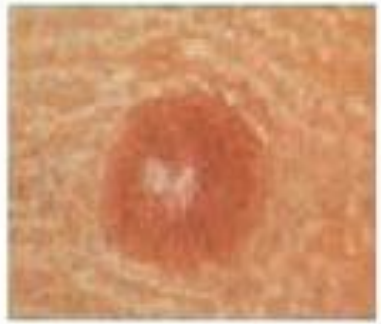
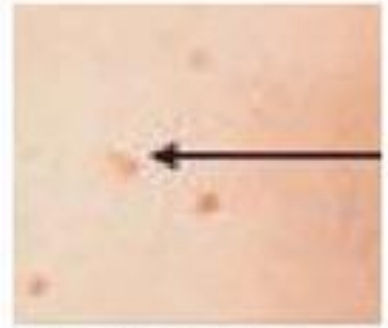
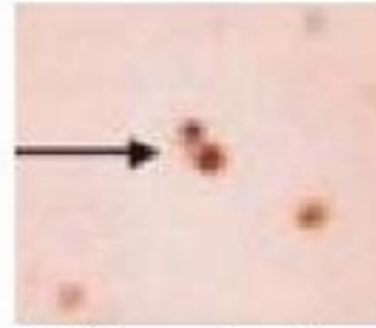


- Uncontrolled, rapid mitotic cell division
- Can occur anywhere that cells divide
- Forms a tumor (mass of cancerous cells)
- Can be caused by mutagenic/carcinogenic agents (ex. UV radiation, x-rays)
- Some forms have genetic links



Video - normal vs. cancer cell growth Brainpop - Cancer Brainpop - Body Scans

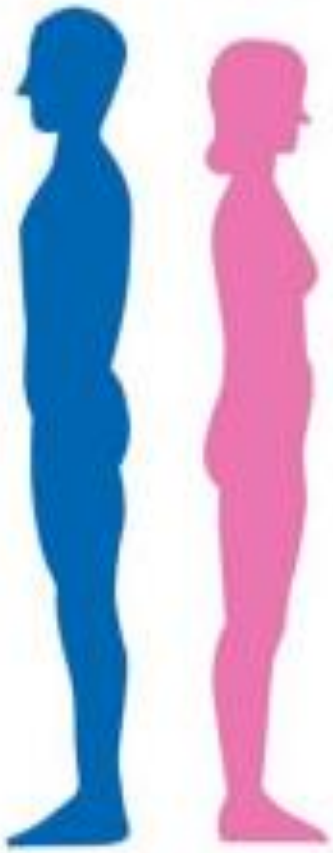
The ABCDEs of Detecting Melanoma

	A Asymmetry	B Border	C Color	D Diameter	E Evolving
NORMAL	 Symmetrical	 Borders Are Even	 One Color	 Smaller Than 1/4 Inch	 Ordinary Mole
MELANOMA	 Asymmetrical	 Borders Are Uneven	 Multiple Colors	 Larger Than 1/4 Inch	 Changing in Size, Shape and Color

Cancer Statistics

Estimated New Cases

Males			Females		
Prostate	180,890	21%	Breast	246,660	29%
Lung & bronchus	117,920	14%	Lung & bronchus	106,470	13%
Colon & rectum	70,820	8%	Colon & rectum	63,670	8%
Urinary bladder	58,950	7%	Uterine corpus	60,050	7%
Melanoma of the skin	46,870	6%	Thyroid	49,350	6%
Non-Hodgkin lymphoma	40,170	5%	Non-Hodgkin lymphoma	32,410	4%
Kidney & renal pelvis	39,650	5%	Melanoma of the skin	29,510	3%
Oral cavity & pharynx	34,780	4%	Leukemia	26,050	3%
Leukemia	34,090	4%	Pancreas	25,400	3%
Liver & intrahepatic bile duct	28,410	3%	Kidney & renal pelvis	23,050	3%
All Sites	**841,390**	**100%**	**All Sites**	**843,820**	**100%**



Estimated Deaths

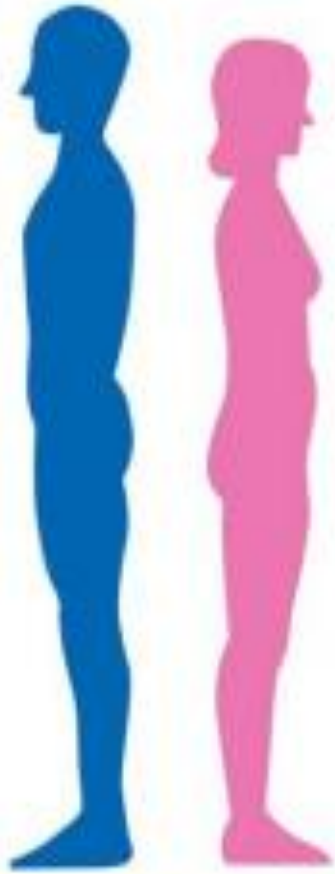
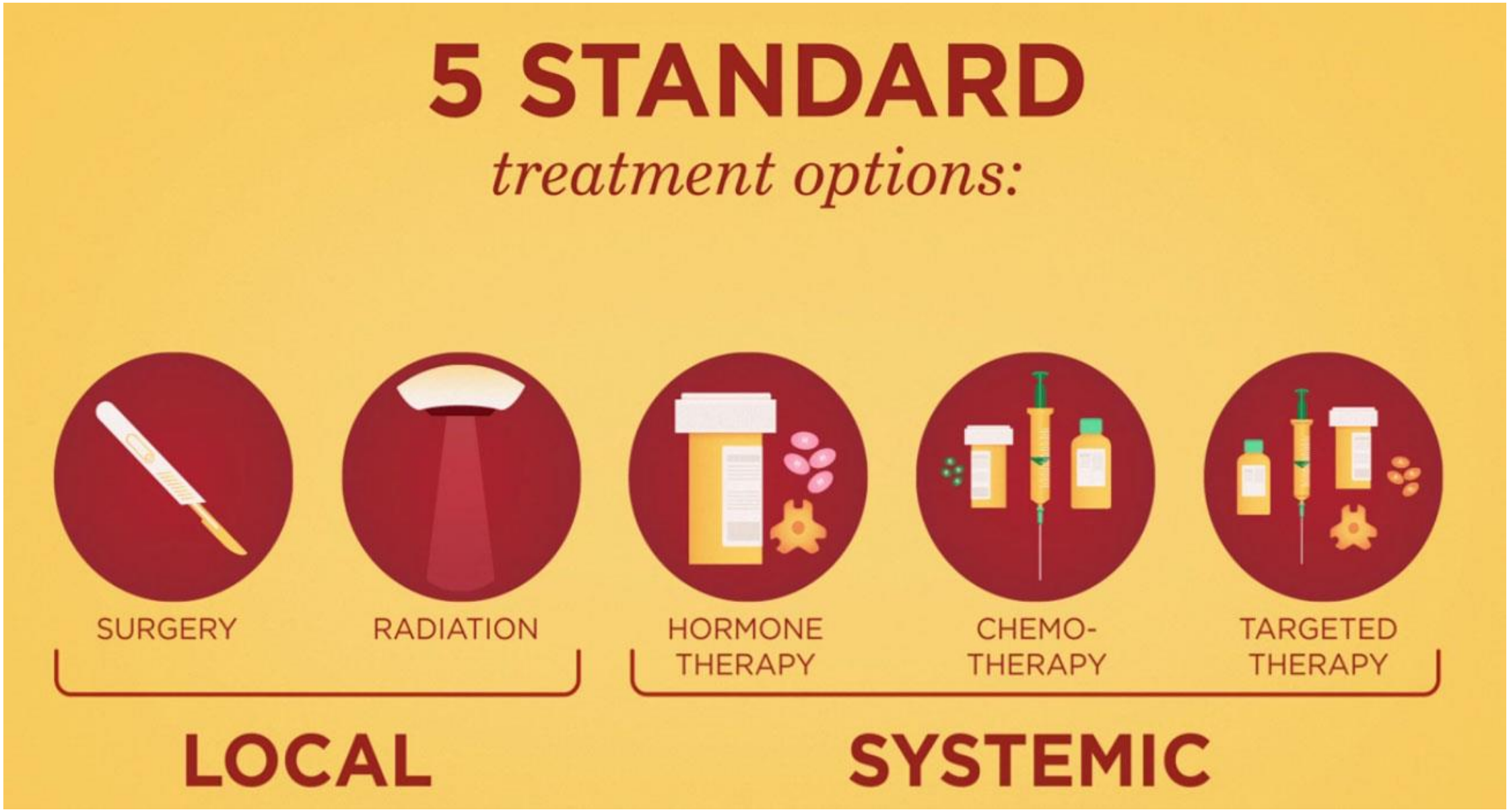
Males				Females		
Lung & bronchus	85,920	27%		Lung & bronchus	72,160	26%
Prostate	26,120	8%		Breast	40,450	14%
Colon & rectum	26,020	8%		Colon & rectum	23,170	8%
Pancreas	21,450	7%		Pancreas	20,330	7%
Liver & intrahepatic bile duct	18,280	6%		Ovary	14,240	5%
Leukemia	14,130	4%		Uterine corpus	10,470	4%
Esophagus	12,720	4%		Leukemia	10,270	4%
Urinary bladder	11,820	4%		Liver & intrahepatic bile duct	8,890	3%
Non-Hodgkin lymphoma	11,520	4%		Non-Hodgkin lymphoma	8,630	3%
Brain & other nervous system	9,440	3%		Brain & other nervous system	6,610	2%
All Sites	**314,290**	**100%**		**All Sites**	**281,400**	**100%**

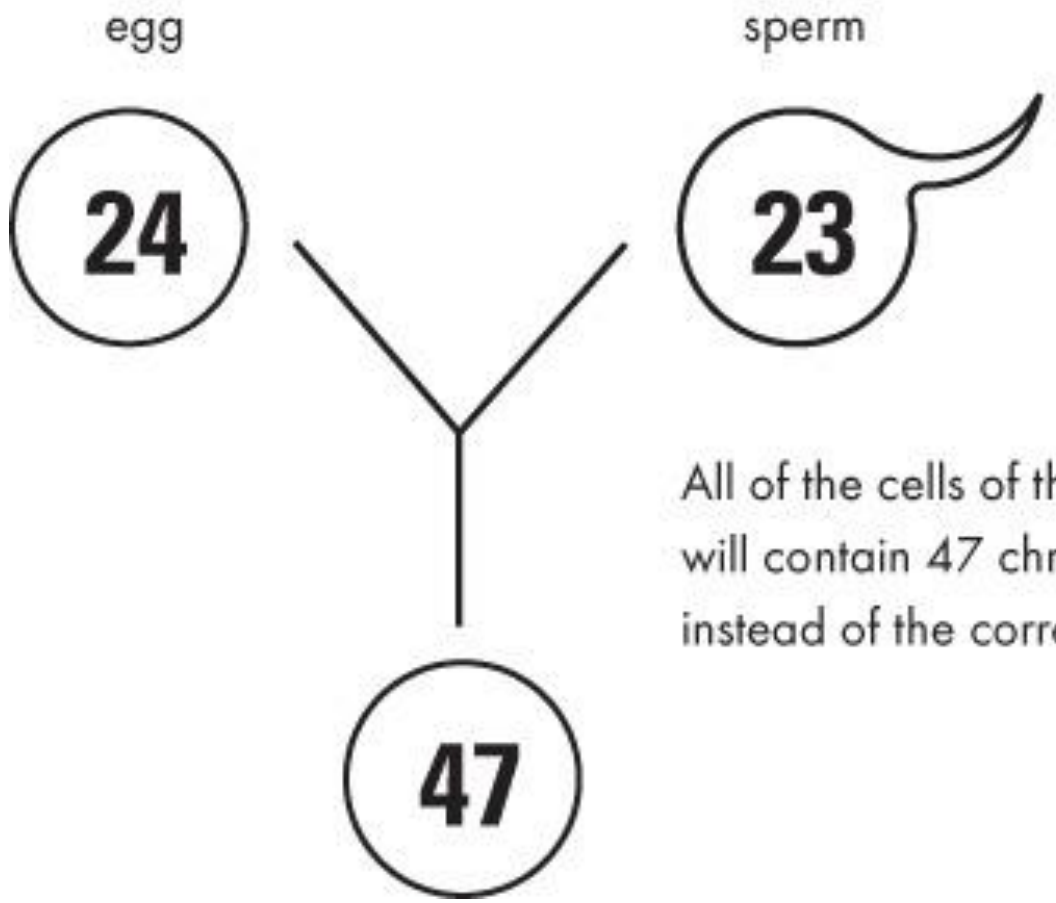
FIGURE 1. Ten Leading Cancer Types for the Estimated New Cancer Cases and Deaths by Sex, United States, 2016.
Estimates are rounded to the nearest 10 and cases exclude basal cell and squamous cell skin cancers and in situ carcinoma except urinary bladder.

Cancer Treatments



Malfunction of Cell Division - Nondisjunction

- Chromosomes fail to separate during meiosis (do not “disjoin”)
- Results in extra or missing chromosomes in the gametes produced
- Can cause genetic disorders if malformed gametes are used in fertilization

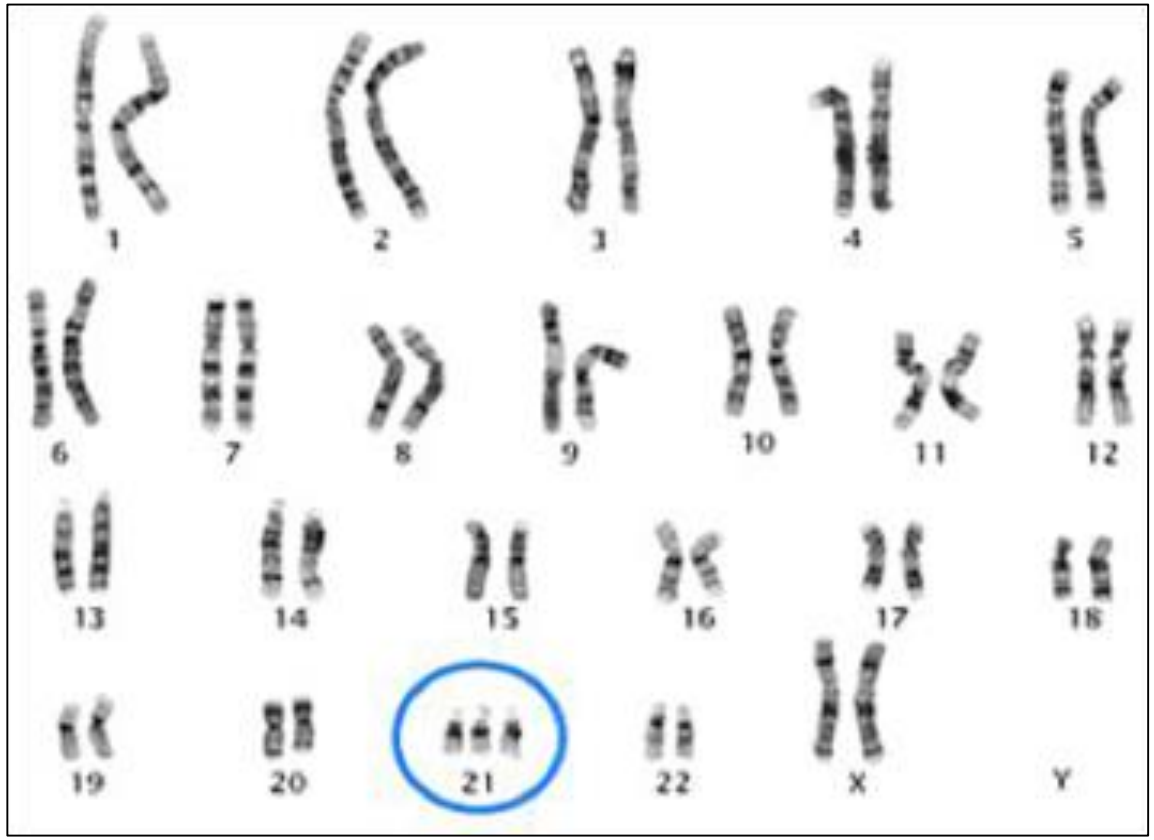


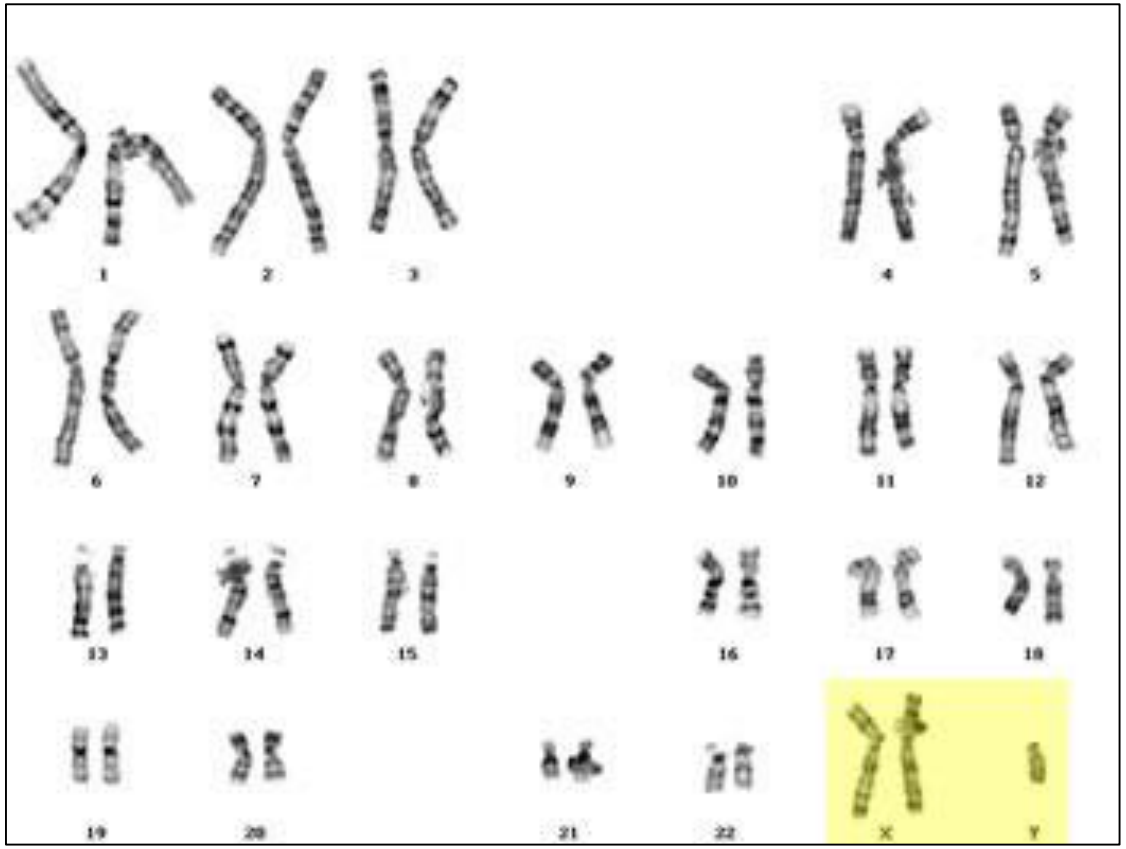
Malfunction of Meiosis - Nondisjunction

Trisomy (2n+1) – disorders with 1 extra chromosome

Ex. Down Syndrome (extra chromosome 21)

Klinefelter Syndrome (male with extra X chromosome)

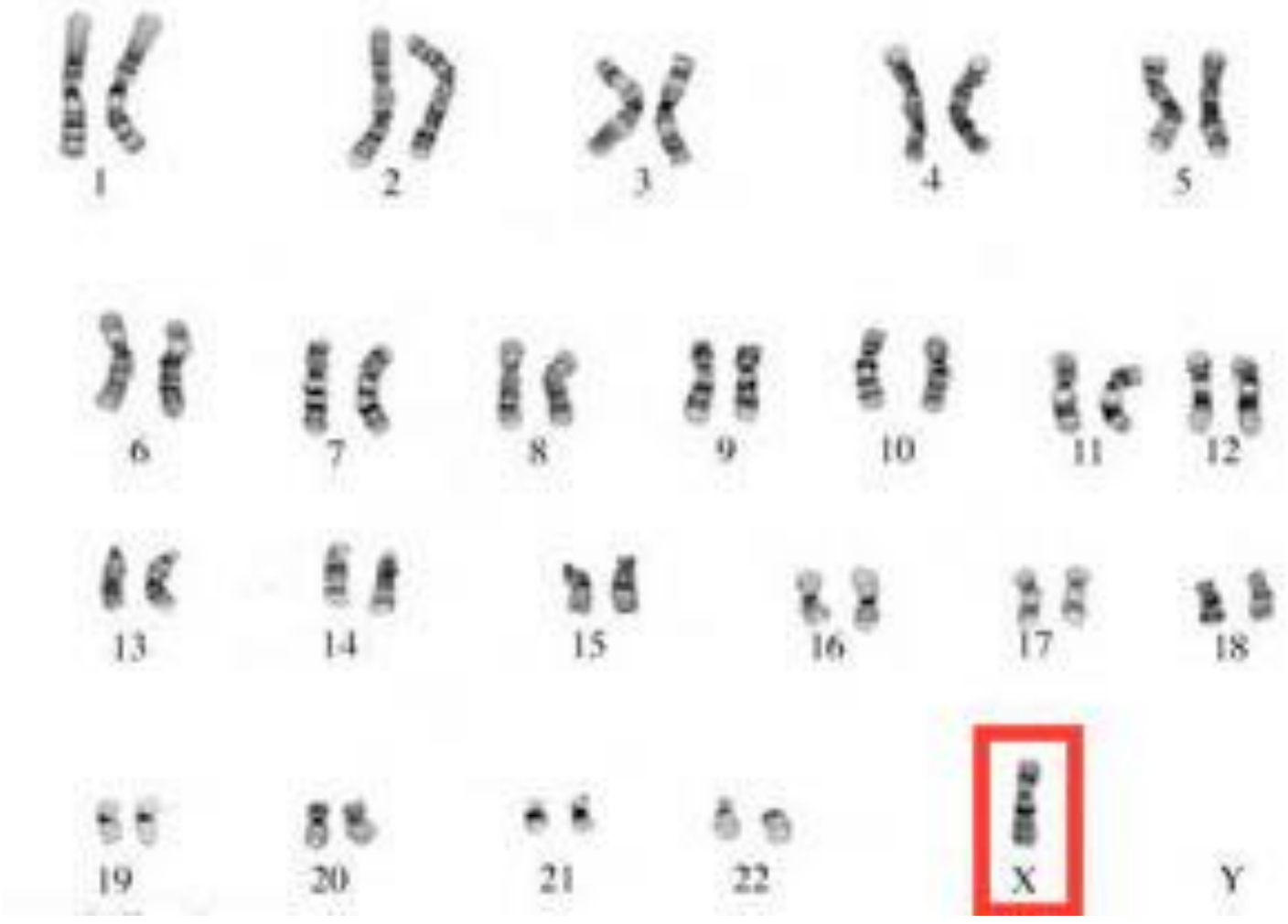


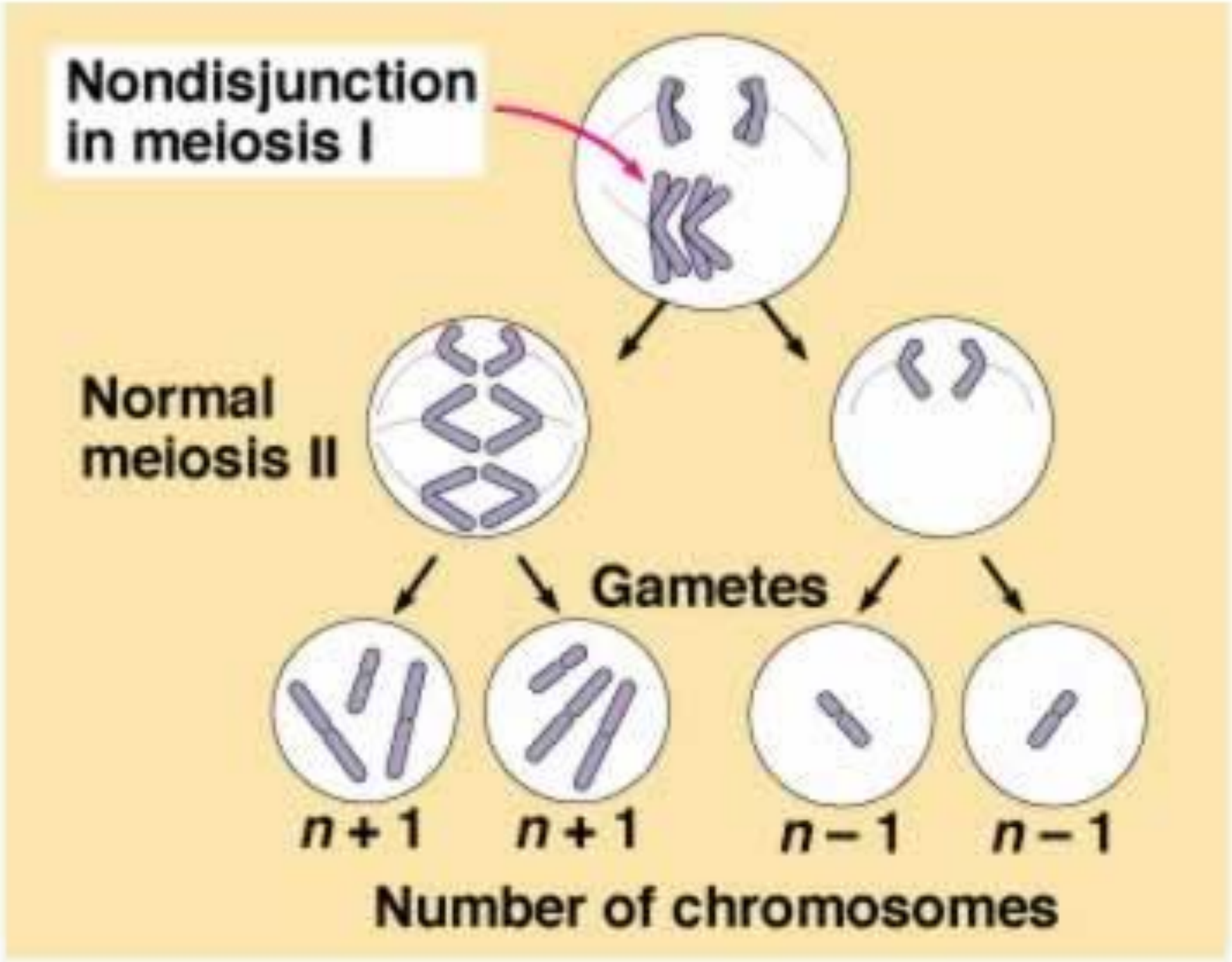


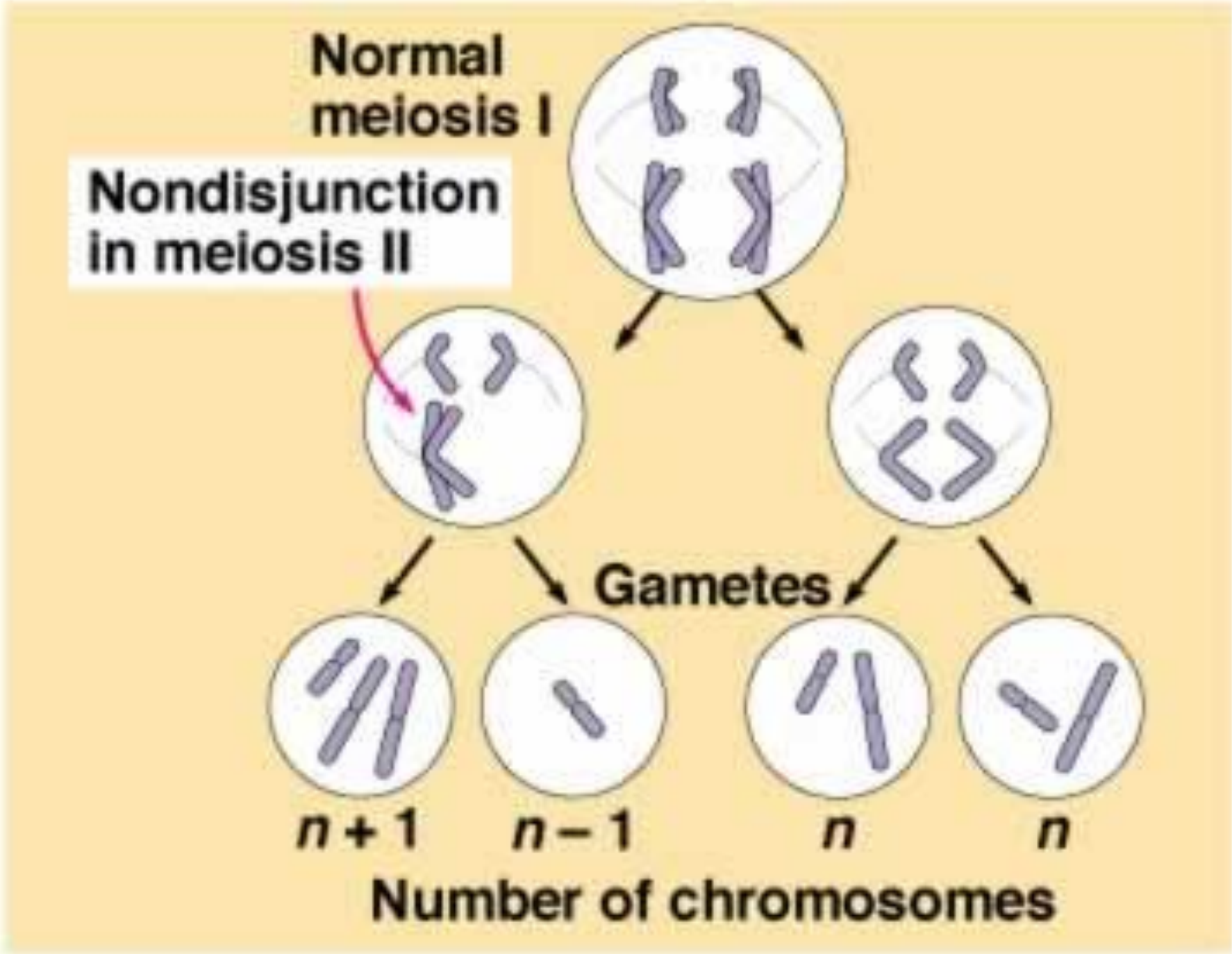
Malfunction of Meiosis - Nondisjunction

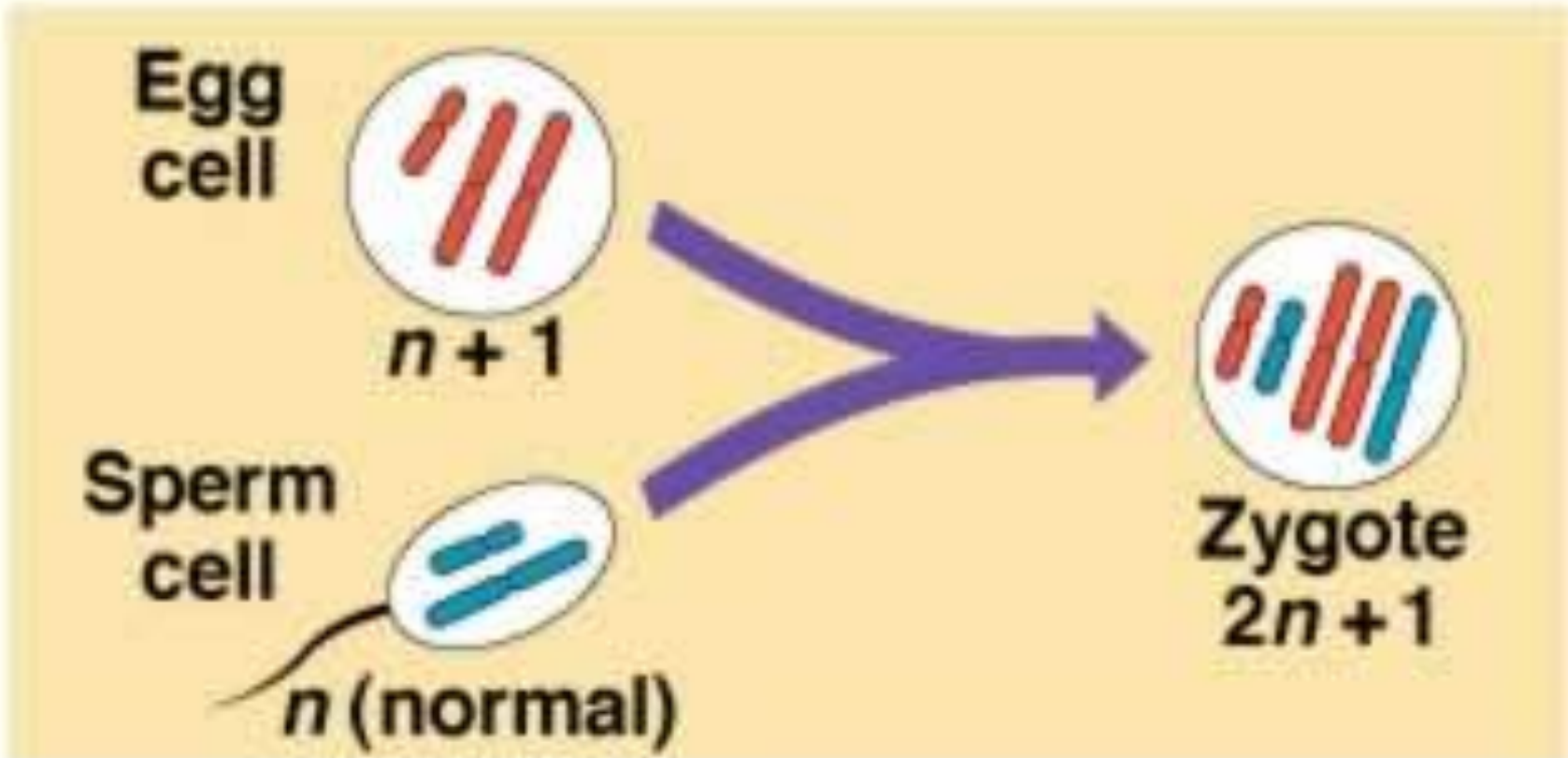
Monosomy (2n-1) – disorder with 1 missing chromosome

Ex. Turner Syndrome (female with only 1 X chromosome)




Nondisjunction in meiosis I
Normal meiosis II
Gametes
n + 1
n + 1
n − 1
n − 1
Number of chromosomes


Normal
meiosis I
Nondisjunction
in meiosis II
Gametes
n + 1
n – 1
n
n
Number of chromosomes



Video - Chromosome Nondisjunction Animation

Mitosis	Meiosis
One division (PMAT 1x)	Two divisions (PMAT 2x)
2 daughter cells produced	4 daughter cells produced
Genetically identical	Genetically varied
Chromosome number is maintained (diploid 2n)	Chromosome number is halved (haploid n)
Asexual reproduction	Sexual Reproduction
Ex. Skin repair, zygote cleavages	Ex. Gamete (sperm & egg) production in gonads
Chromosomes line up “single file”	Chromosomes line up in pairs (synapsis)
NO crossing over	YES crossing over occurs