

# 1 Cell Cycle

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## 2 Limits to Cell Growth

### 1 ■ Why do cells divide ?

– to replace dead, damaged or worn out preexisting cells

### 2 – to allow for the growth of the organism

## 3 Limits to Cell Growth

- Factors that influence the need for cell division
  - surface area
  - volume

## 4 Limits to Cell Growth

- Simple diffusion can only work with a specific ratio of surface area to volume \*
- Once this ratio is exceeded, cell division is triggered by that cell\*
- Cell division is usually stopped by contact inhibition (except in cancer cells)

## 5 The Cell Cycle \*

Stages in the cell cycle (4 or 5 parts):

- G<sub>1</sub> phase - initial growth phase, longest phase  
MOST cells are in this phase \*
- S phase - chromosome replication phase (synthesis phase)
- G<sub>2</sub> phase - growth phase and preparation for division
- M phase - mitotic phase, includes prophase, metaphase, anaphase, telophase
- Cytokinesis – the division of the cytoplasm  
sometimes cytokinesis is not considered as part of the cell cycle, but occurs and is necessary

Know the above cell cycle ORDER \*

## 6 The Cell Cycle

## 7 The Cell Cycle











## 8 The Cell Cycle

## 9 Mitosis (the M phase of the cell cycle)

- Interphase (G<sub>1</sub>, S, G<sub>2</sub>)
  - nuclear membrane present
  - normal cell activities (protein synthesis, etc.)\*
  - chromatin is diffuse (evenly spread throughout nucleus)
  - two centrioles (in late interphase they double from 2 to 4)

## 10 Mitosis (the M phase of the cell cycle)

- Interphase (G<sub>1</sub>, S, G<sub>2</sub>)


- 11  **Mitosis** (the M phase of the cell cycle)  
 ■ Interphase (G1, S, G2)
- 12  **Mitosis** (the M phase of the cell cycle)  
 ■ Interphase (G1, S, G2)
- 13  **Mitosis** (the M phase of the cell cycle)  
 ■ Prophase (part of the M phase):  
 – chromatin aggregates (condenses into chromosomes)  
 ▪ chromosomes are connected by the centromere  
 ▪ combination is called a chromatid  
 – centrioles divide (2 ==> 4)  
*(late interphase or early prophase)*  
 – nuclear membrane dissolves  
 – chromatids move toward equatorial plate  
 – centrioles move toward the poles  
 – spindle apparatus begins to form
- 14  **Mitosis** (the M phase of the cell cycle)  
 ■ Prophase (part of the M phase):
- 15  **Mitosis** (the M phase of the cell cycle)  
 ■ Prophase (part of the M phase):
- 16  **Mitosis** (the M phase of the cell cycle)  
 ■ Metaphase (part of the M phase):  
 – centrioles reach the poles  
 – chromatids line up on the equatorial plate  
 – spindle apparatus is complete
- 17  **Mitosis** (the M phase of the cell cycle)  
 ■ Metaphase (part of the M phase):
- 18  **Mitosis** (the M phase of the cell cycle)  
 ■ Metaphase (part of the M phase):
- 19  **Mitosis** (the M phase of the cell cycle)  
 ■ Anaphase (part of the M phase):  
 – chromatids are pulled toward the poles by the spindle apparatus  
 – centromeres \* (the constricted region in the center of two attached chromatids) break \*  
 – usually the gap between the chromosomes is small to be considered anaphase  
 – If the gap is substantial, it is considered telophase
- 20  **Mitosis** (the M phase of the cell cycle)  
 ■ Anaphase (part of the M phase):

- 21  **Mitosis** (the M phase of the cell cycle)  
■ Anaphase (part of the M phase):
- 22  **Mitosis** (the M phase of the cell cycle)  
■ Telophase (part of the M phase):  
– chromosomes reach the poles  
– cell membrane begins to constrict in the center (a cleavage furrow develops)  
– nuclear membrane begins to reform  
– chromosomes become diffuse (which means evenly spread out and not clumped)
- 23  **Mitosis** (the M phase of the cell cycle)  
■ Telophase (part of the M phase):
- 24  **Mitosis** (the M phase of the cell cycle)  
■ Telophase (part of the M phase):
- 25  **Cytokinesis** - C phase of the cell cycle  
■ phase where cytoplasm is divided  
■ the cytoplasm appears to flow toward opposite sides (to each cell)  
■ the cytoskeleton is very useful in the phase too
- 26  **Cytokinesis** - C phase of the cell cycle
- 27  **Cytokinesis** - C phase of the cell cycle
- 28  **Cytokinesis** - C phase of the cell cycle
- 29  **G<sub>1</sub> – Daughter Cell Interphase**  
■ Cells are smaller (1/2 size) than other cells in the microscope field  
■ They have all of the characteristics of interphase  
– nuclear membrane present  
– cell activities (protein synthesis, etc.)  
– chromatin diffuse (evenly spread throughout nucleus)
- 30  **G<sub>1</sub> – Daughter Cell Interphase**
- 31  **Last thoughts about Mitosis**  
■ In plant cells, there is a cell plate that develops between the two daughter cells  
■ The least specialized cells divide the most often  
■ Injury can increase cell division  
(it usually does)  
■ Cancer is an uncontrolled kind of cell division

32  **Reproduction**

33  **Asexual Reproduction**

- Binary fission - the equal division of both the cytoplasm and the nuclear material
  - result is two equal daughter cells
  - most body cells reproduce by binary fission
  - many bacteria and protists reproduce via binary fission

34  **Asexual Reproduction**


- Binary fission

35  **Asexual Reproduction**

- Budding- formation of a bud (bulge) on cell that will eventually grow to a new organism
- A bud has 100% of the DNA and is exactly like parent cell
- Yeast reproduce by budding

36  **Asexual Reproduction**

- Budding in yeast

37  **Asexual Reproduction**

- Spore formation - formation of DNA wrapped with protein to withstand harsh conditions
- Bacteria form spores (endospores)
- Ferns reproduce by spores for part of their life cycle
- Fungi reproduce by spore formation

38  **Asexual Reproduction**

- Spore formation

39  **Sexual Reproduction**

- It is the exchange of gametes or sex cells
- Sexual reproduction gives organisms great diversity over asexual reproduction \*
- Egg - the female gamete
- Sperm - the male gamete
- Gametes have half of the chromosomes present in normal somatic (body) cells \*
  - diploid = 100% (# in somatic cells) \*
  - haploid = 50% (# in gametes) \*

40  **Sexual Reproduction**

- Humans have 46 chromosomes in somatic cells
  - 23 pairs of matched chromosomes \*
  - 22 homologous pairs + X and Y or X and X
  - Think of homologous as matched!*
- Somatic cells are body cells that are not sex cells and that means MOST body cells are diploid \*
- Humans have 23 chromosomes in gametes (22 plus an X or Y). Gametes are haploid \*

- 41  **Sexual Reproduction**
- Chromosomes from a human female
- 42  **Sexual Reproduction**
- Chromosomes from a human male
- 43  **Sexual Reproduction**
- Zygote - the union of a sperm and an egg
  - Reproduction requires , egg, sperm, fertilization, meiosis and gamete formation \*
- 44  **Sexual Reproduction**
- Every human's first baby photo!
- 45  **Meiosis**
- Meiosis is double mitosis that results in FOUR (4) haploid daughter cells (reduction division) \*
  - Meiosis reduces the parental chromosome number by 1/2 \*
  - The stages in meiosis
    - prophase
    - metaphase
    - anaphase
    - telophase
    - prophase II
    - metaphase II
    - anaphase II
    - telophase II
- 46  **Meiosis**
- 47  **Meiosis**
- Only gametes can undergo meiosis
  - Males produce sperm cells (haploid) and  $3.0 \times 10^8$  are produced per day
  - Females produce eggs (haploid)
  - Females produce one egg and 3 polar bodies (useless) at the end of one cycle of meiosis
- 48  **Meiosis**
- 49  **Mitosis and Meiosis Compared**
- 50  **Mitosis and Meiosis Compared**
- Chromosome number practice \*
    - A banded leghorn chicken has a chromosome number of 18 in its leg, what is the chromosome number in the egg? \_\_\_\_
    - A Pacific halibut has 40 chromosomes in its sperm cell, predict the number of chromosomes in its tail cells. \_\_\_\_? \_\_\_\_