Terms - Alphabetical

Actin

A globular protein that forms microfilaments and is found in all eukaryotic cells

Centromere

Structure in chromosome that holds together the two chromatids

Cleavage Furrow

Occurs when animal cell membranes indent due to contraction of actin microfilaments in order for the cell to divide

Crossing Over

Swapping of genetic information between homologous chromosomes

Equtorial Plane

Place where chromosomes line up in the center of thee cell during cell division

Homologous Chromosomes

Two similar, but **not identical**, chromosomes where one comes from the mother, the other from the father, also called homologues

Independent Assortment

: Random separation of homologues into gametes during meiosis

Karyotype

Organization of chromosomes and their homologous pairs from chromosome 1 – 23, from longest to shortest

Kinetochore

Protein located at the centromere region that holds sister chromatids together

Terms - Alphabetical (cont)

Mitosis

Process of cell division in somatic cells (body cells) to make identical cells

Meiosis

Cell division that occurs in germ cells (only produce sex cells)

Sister Chromatid

Identical replicated chromosomes

Spindle Fibres

Microtubules that transport chromosome during cell division

Synapsis

Process of drawing together homologous chromosomes down their entire lengths so that crossing over can occur

Chromosomes

• Humans have 46 chromosomes that are in 23 pairs in a cells nucleus

• **Autosomes** are the 22 pairs of chromosomes that control traits that **do not relate to gender**

• **Sex chromosomes** are the 1 pair that contain the genes that **do control gender**

• **Body cells (somatic cells)** have 46 (2n) chromosomes in pairs called **diploid**

• Sex cells (gametes) have 23 (n) chromosomes not in pairs called haploid

n = number of chromosomes
n = 23
2n = 2(23) = 46

Control of the Cell

• External signals (hormones) can stimulate a cell to divide

• Genes stimulate the cell cycle:

• Proto-oncogenes stimulate cell cycle

Control of the Cell (cont)

• Tumour-suppressor genes inhibit the cell cycle

Genetic Variation

There are many variations of each gene, called alleles

Gene combinations we inherit from our parents depend on how their genes were sorted during meiosis process

Each sperm or egg that are made will always be different

Crossing over happens between two non-sister chromatids of homologous chromosomes. They break at the same point, exchanging sections of chromosomes, resulting in hybrid chromosomes.

In metaphase I, how homologous chromosomes pair up is random. Different arrangements of which homologous chromosome goes to which pole lead to gametes with various combinations of parental chromosomes. This randomness is called independent assortment.

Sexual reproduction significantly influences species evolution by quickly creating new genetic combinations, leading to genetic diversity. Three methods contribute to this diversity:

1. Independent assortment
2. Crossing over
3. Random fertilization, where any of 8 million sperm can fertilize the egg, further enhances genetic variation.

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Eukaryotic Cell Cycle Phases

Divided into Phases

Interphase (G1, S, and G2 phases) Cell grows larger, organelles double and DNA replicates

G1 phase: The cell grows, doubling its organelles

S phase: DNA replication (DNA synthesis). Each homologous chromosome replicates, forming 2 identical copies of **sister chromatids** that are joined together by a centromere.

G2 phase: Needs proteins for division

Cell Division

Mitosis (M phase): Dividing the nucleus. Protein synthesis stops and no more cell growth occurs

Cytokinesis (C phase): Dividing the cytoplasm

Cell Division: Mitosis

Prophase

• Chromosome are visible and condensed.

• The nuclear membrane and nucleolus breaks down

• The centrioles migrate to opposite poles of the cell and spindle fibres (microtubules) form

Metaphase (Middle)

• Chromosomes line up in the middle of the cell attached to the microtubules

• The centromeres are aligned along the equatorial plane (equator) that divides the cell in half

Anaphase (away)

• Sister chromatids separate to opposite poles

• The spindle fibres start to disintegrate near the centriole, leading the shortening spindles to tug the chromosomes toward the cell's poles.

Telophase ("two" – two cells)

Cell Division: Mitosis (cont)

• A new nuclear membrane surrounds the set of chromosomes at each pole

• Chromosomes begin to uncondensed

• Nucleolus reforms

• There are now two daughter nuclei - **not daughter cells**

Cytokinesis

• The cytoplasm divides equally

• There are now two daughter cells

• In animal cells, actin filaments contract and pinch the cell in two – this forms a cleavage furrow

• ATP is required for the contraction – two new identical, somatic, diploid daughter cells are produced

Checkpoints

G1:

It checks whether the cell is big enough and has made the proper proteins for the synthesis phase. If not, the cell goes through a resting period (G0) until it is ready to divide.

G2:

It checks whether DNA has been replicated correctly. If so, the cell continues on to mitosis.

M:

It checks whether mitosis is complete. If so, the cell divides, and the cycle repeats.

If it does not pass the checkpoints the cell self-destructs and prevents damaged cells from dividing

Changes in Chromosome Number

Nondisjunction is the failure of chromosomes to separate correctly during either meiosis I or meiosis II

This leads to an abnormal chromosome number

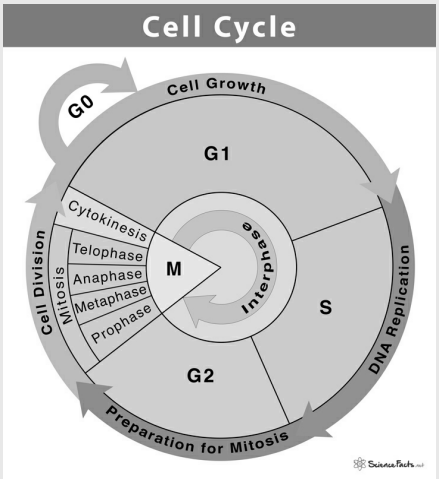
When a gamete has an abnormal number of chromosomes, it's called aneuploidy, which means there's an abnormal chromosome count.

If fertilization involves gametes with abnormal chromosome numbers, normal development typically isn't possible, leading to early death.

However, if there's an extra chromosome 21, or less commonly, an extra chromosome 22, development can proceed.

A child with an extra chromosome 21, known as trisomy 21 or Down syndrome, experiences delayed development and mental impairment.

Mitosis Cycle



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Meiosis Overview

• Contributes to genetic variety
• Makes only germ cells – gametes
• Is a reduction division 46 -> 23 chromosomes
• Meiosis involves 2 divisions
• Meiosis I – separates the homologous pairs
• Meiosis II – separates the sister chromatids

Phases of Meiosis I

Prophase I
• Same as mitosis
• The pairing/intertwining of homologous chromosomes is **Synapsis**
Metaphase I (middle)
• The homologous pairs with their attached sister chromatids that line up.
Anaphase I (Away)
• The spindle fibers start to break down near the centrioles, causing the shrinking spindles to pull the homologous chromosomes towards the cell's poles, while the sister chromatids remain connected.
Telophase I
• Homologous chromosomes are found at both ends of the cell, and the spindle fibers break apart. New nuclear membranes form around each set of chromosomes at both ends of the cell, the chromosomes start to relax, and the nucleolus reappears.
Cytokinesis

Phases of Meiosis I (cont)

• The cytoplasm is evenly split, ensuring each new cell gets its share of organelles and fluid. Two haploid cells are made, but since each homologous chromosome stays connected to its sister chromatid, each cell has 46 chromosomes. So, another cell division happens to give each gamete just 23 chromosomes.

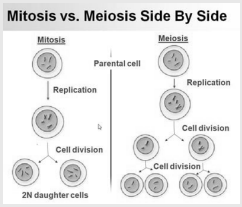
Phases of Meiosis II

Prophase II
Before the next prophase, DNA doesn't replicate. Cells from meiosis I proceed directly to meiosis II, skipping a second S phase. DNA condenses, the nuclear membrane and nucleolus break down, centrioles move, and spindle fibers form.
Metaphase II (middle)
Spindle fibres connect to the kinetochore, and the chromosomes line up at the equatorial plane, but now in meiosis II, the chromosomes with their sister chromatid all line up.
Anaphase II (Away)
Spindle fibres begin to break down at the centriole end, which causes the sister chromatids to separate toward each end of the cell.
Telophase II
At each end of the cell, sister chromatids are present, and the spindle fibers break apart. A fresh nuclear membrane forms around each set of 23 chromosomes on both ends of the cell, the chromosomes start to relax, and the nucleolus reappears.
Cytokinesis:

Phases of Meiosis II (cont)

In males, meiosis II results in four sperm cells, each containing 23 chromosomes. In females, during each cell division, one cell receives more cytoplasm, becoming the egg cell, while the other becomes a polar body that dissolves. However, females don't finish the final meiotic division unless fertilization happens. Eggs remain paused in metaphase II until ovulation and won't complete the last division if not fertilized.

Difference with mitosis and meiosis



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