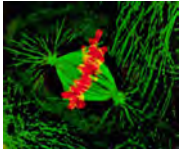


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MITOSIS





Dr. Susan Maskel
Western CT State University

Background Information

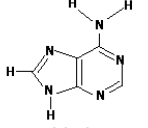
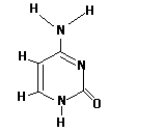
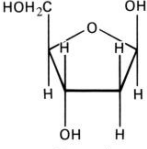
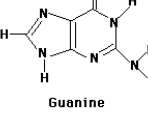
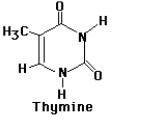
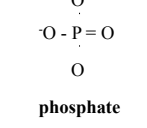
CHROMOSOMES

DNA	proteins
deoxyribonucleic acid	interspersed with DNA
stores genetic info	controls processes

DNA


- 2 strands
- double helix
- sugars (deoxyribose)
- phosphate groups
- nitrogenous bases:
adenine, thymine,
guanine, cytosine

Purines	Pyrimidines	
 Adenine	 Cytosine	 β -Deoxyribose
 Guanine	 Thymine	 phosphate

Structure of Components of DNA

DNA

P	S	B	B	S	P	Key: S = sugar P = phosphate B = base
P	S	B	B	S	P	
P	S	B	B	S	P	
P	S	B	B	S	P	
P	S	B	B	S	P	
P	S	B	B	S	P	



sugar-phosphate backbone

nitrogenous bases form "rungs of ladder"

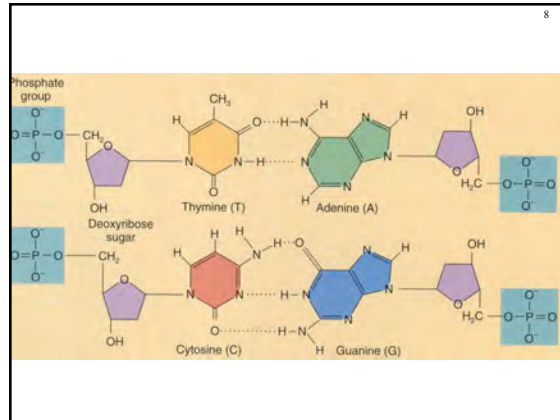
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Nitrogenous Bases in DNA

- Adenine (A)
- Thymine (T)
- Cytosine (C)
- Guanine (G)

- Specificity of base pairing
- A - T
- C - G



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DNA

Key:

- Thymine (T)
- Adenine (A)
- Cytosine (C)
- Guanine (G)
- Deoxyribose sugar
- Phosphate
- Hydrogen bond

(B)
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Types of Chromosomes

unduplicated

(1 double stranded (ds)
DNA + protein)

duplicated

(2 ds DNAs + protein)

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Duplicated Chromosomes

DNA

sister chromatids

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Humans have 46 chromosomes in their somatic cells (i.e., not sperm, not egg)

diploid number = 2N = 46

Humans have 23 chromosomes in their sex cells (i.e., egg or sperm)

haploid number = 1N = 23

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The Cell Cycle

At any given time,
a cell is either:

not dividing

dividing

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When NOT dividing: INTERPHASE

G1 phase (growth phase 1)
normal cell metabolism
synthesis of proteins not used in mitosis
chromosomes are unduplicated

S phase (synthesis phase)
normal cell metabolism
DNA synthesis (DNA replication or duplication)
chromosomes go from unduplicated to duplicated

G2 phase (growth 2 phase)
normal cell metabolism
synthesis of proteins needed for mitosis
chromosomes are duplicated

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DNA Replication

- DNA unzips
- New nucleotides (sugar-phosphate-base combinations) add according to specificity of base pairing
- 2 sister chromatids form; are identical
- each sister chromatid has 1 new & 1 old DNA strand
- semiconservative replication

Key:
A = Adenine
T = Thymine
C = Cytosine
G = Guanine

old strand
new strand
sister chromatid sister chromatid

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When cells ARE dividing:

MITOSIS
division of the nucleus of somatic cells; 1 division maintains the chromosome number
1 mother cell with 46 chromosomes gives rise to 2 daughter cells, each with 46 chromosomes

MEIOSIS
division of the nucleus of sex cells; 2 divisions halves the chromosome number
1 mother cell with 46 chromosomes gives rise to 4 daughter cells, each with 23 chromosomes

CYTOKINESIS
division of cytoplasm
occurs during mitosis & meiosis

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CELL CYCLE

INTERPHASE
G1: unduplicated chromosomes
S: chromosomes duplicate
G2: duplicated chromosomes

MITOSIS (M phase)
start with duplicated chromosomes; end with unduplicated chromosomes
4 phases:
Prophase
Metaphase
Anaphase
Telophase
(cytokinesis occurs mainly during telophase)

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INTERPHASE

before mitosis begins; NOT part of mitosis
cell is not dividing
includes G1, S, G2 phases
nuclear membrane visible
nucleoli visible
chromatin in nucleus

NOTE:

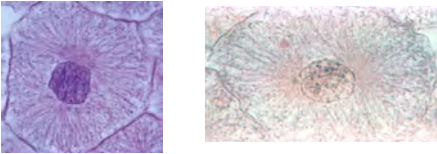
- nuclear membrane intact
- nucleolus visible
- chromatin not visible as individual structures

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Interphase

nuclear membrane present
chromatin not visible



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MITOSIS

nuclear division of somatic cells

4 phases:
Prophase
Metaphase
Anaphase
Telophase

cytokinesis – division of cytoplasm –
occurs mainly during telophase


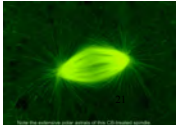
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PROPHASE

lasts 1 – several hours
nuclear membrane disappears
nucleoli disappear

chromatin winds upon itself to form chromosomes;
chromosomes are duplicated

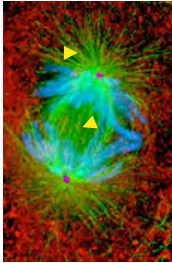
centrioles made of microtubules; (replicated to form 2
pairs at end of G1); move to opposite poles of cell
spindle and asters form

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Spindle & Asters


aster
probably anchors
apparatus to
cell
membrane



spindle
helps organize
chromosomes
during mitosis

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Prophase

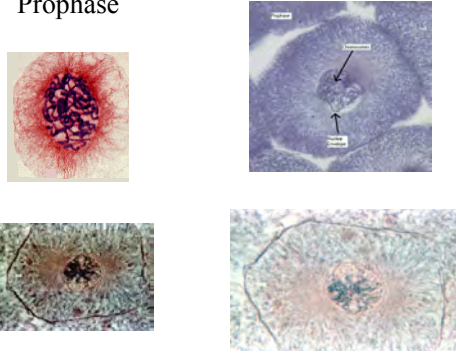


NOTE:
nuclear membrane disappears
nucleolus disappears
chromatin → chromosomes
spindle & asters form

In this hypothetical cell, $2N = 4$.
In humans, $2N = 46$.

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Prophase



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METAPHASE

5 – 15 minutes

chromosomes line up in single file along center of spindle

chromosomes are attached to spindle fibers in area of centromere

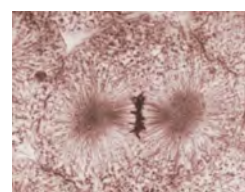




NOTE:

chromosomes lined up in single file in center of spindle

In this hypothetical cell, $2N = 4$.
In humans, $2N = 46$.

Metaphase

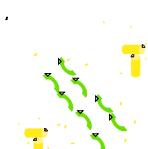
ANAPHASE

2 – 10 minutes

spindle fibers pulled toward opposite poles of cell

centromere splits

sister chromatids pulled toward opposite poles of cell


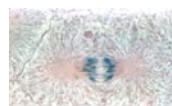
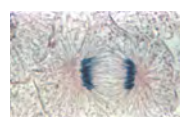
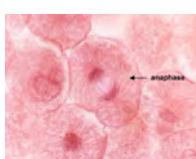


NOTE:

sister chromatids being pulled toward opposite poles of cell

In this hypothetical cell, $2N = 4$.
In humans, $2N = 46$.

Anaphase

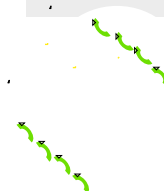





TELOPHASE

10 – 30 minutes

cleavage furrow forms & deepens until cell divides into 2 daughter cells (cytokinesis)

opposite of prophase occurs:
nuclear membrane & nucleoli reappear
chromosomes uncoil into chromatin
spindle & asters disappear

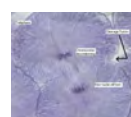


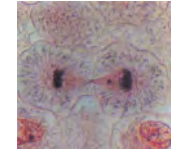


NOTE:

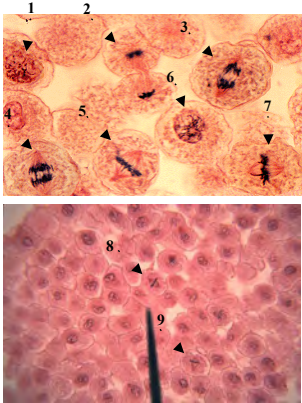
cleavage furrow forms; 2 daughter cells will form; the opposite of prophase will occur

In this hypothetical cell, $2N = 4$.
In humans, $2N = 46$.

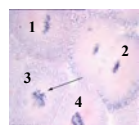
Telophase

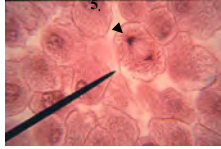





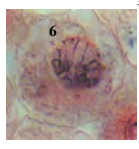
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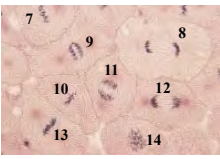


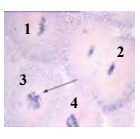
1	prophase
2	telophase
3	anaphase
4	anaphase
5	metaphase
6	prophase
7	metaphase
8	metaphase
9	metaphase

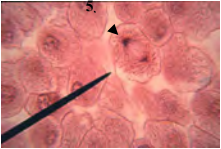


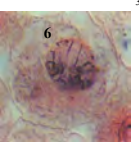


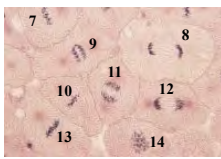














1	metaphase	8	late anaphase/ early telophase
2	telophase	9	anaphase
3	prophase	10	metaphase
4	anaphase	11	anaphase
5	anaphase	12	anaphase
6	prophase	13	metaphase
7	metaphase	14	prophase

Now it's YOUR turn to identify stages of mitosis with a microscope!