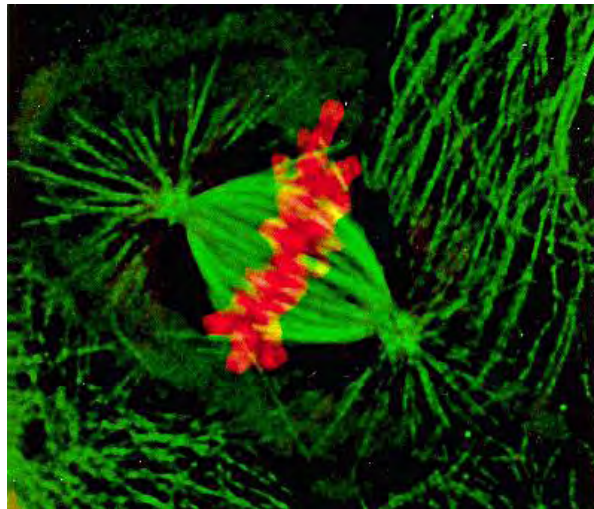


MITOSIS



Dr. Susan Maskel
Western CT State University

Background Information

CHROMOSOMES

DNA

deoxyribonucleic acid

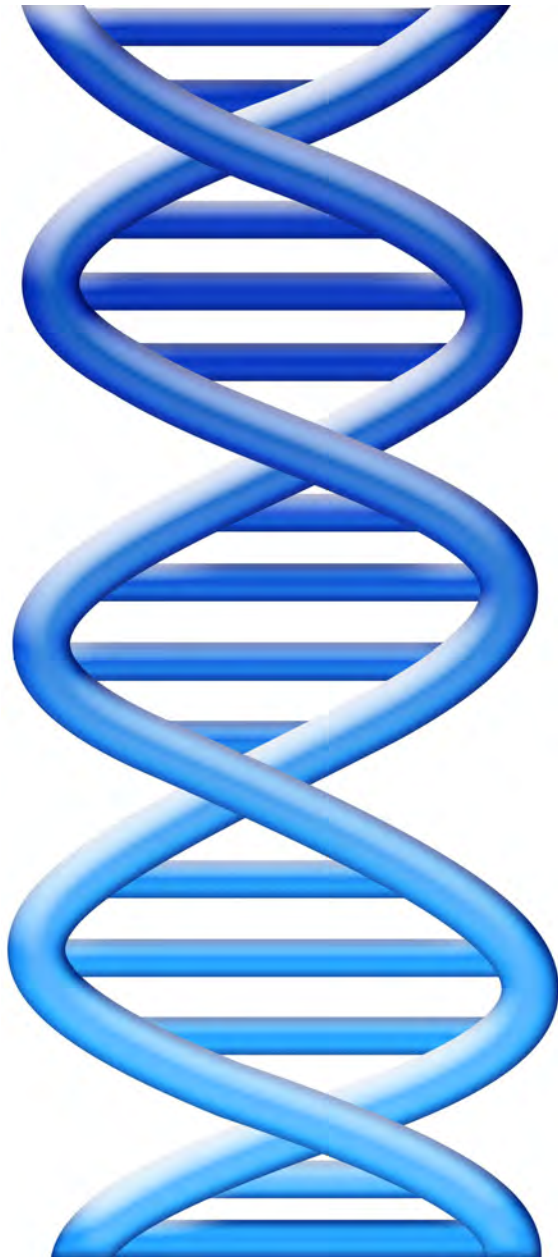
stores genetic info

proteins

interspersed with DNA

controls processes





DNA

2 strands

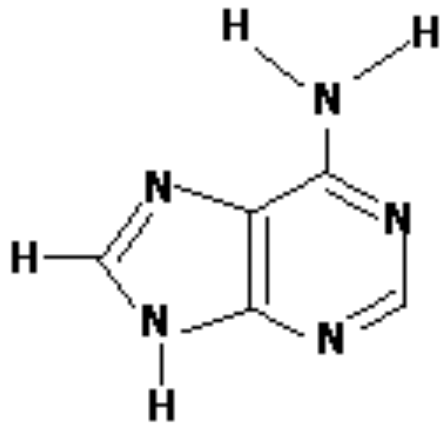
double helix

sugars (deoxyribose)

phosphate groups

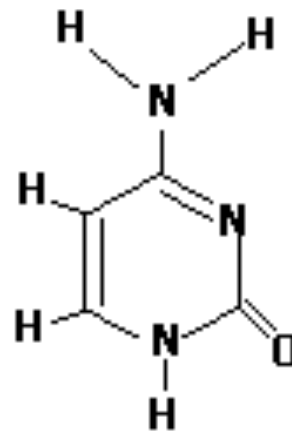
nitrogenous bases:
adenine, thymine,
guanine, cytosine

Purines

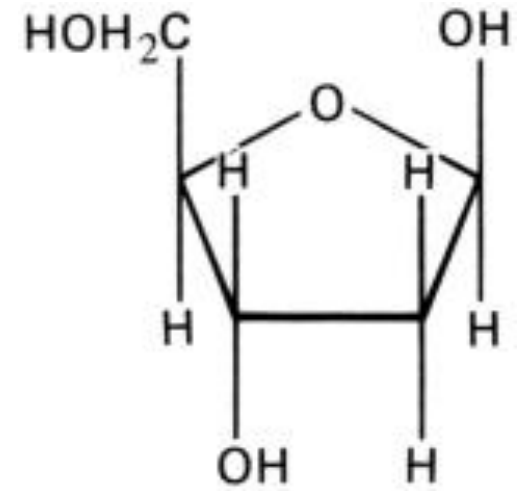


Adenine

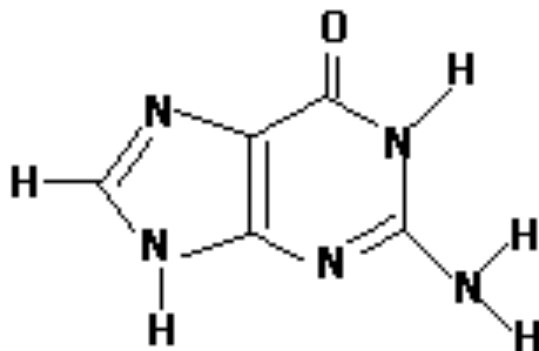
Pyrimidines



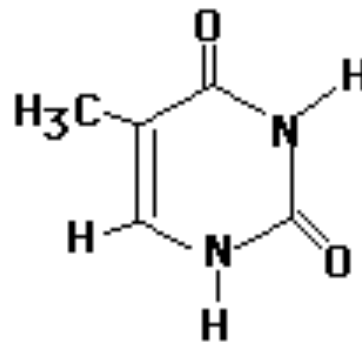
Cytosine



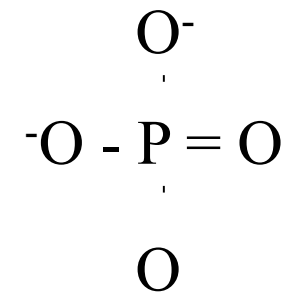
β -Deoxyribose



Guanine



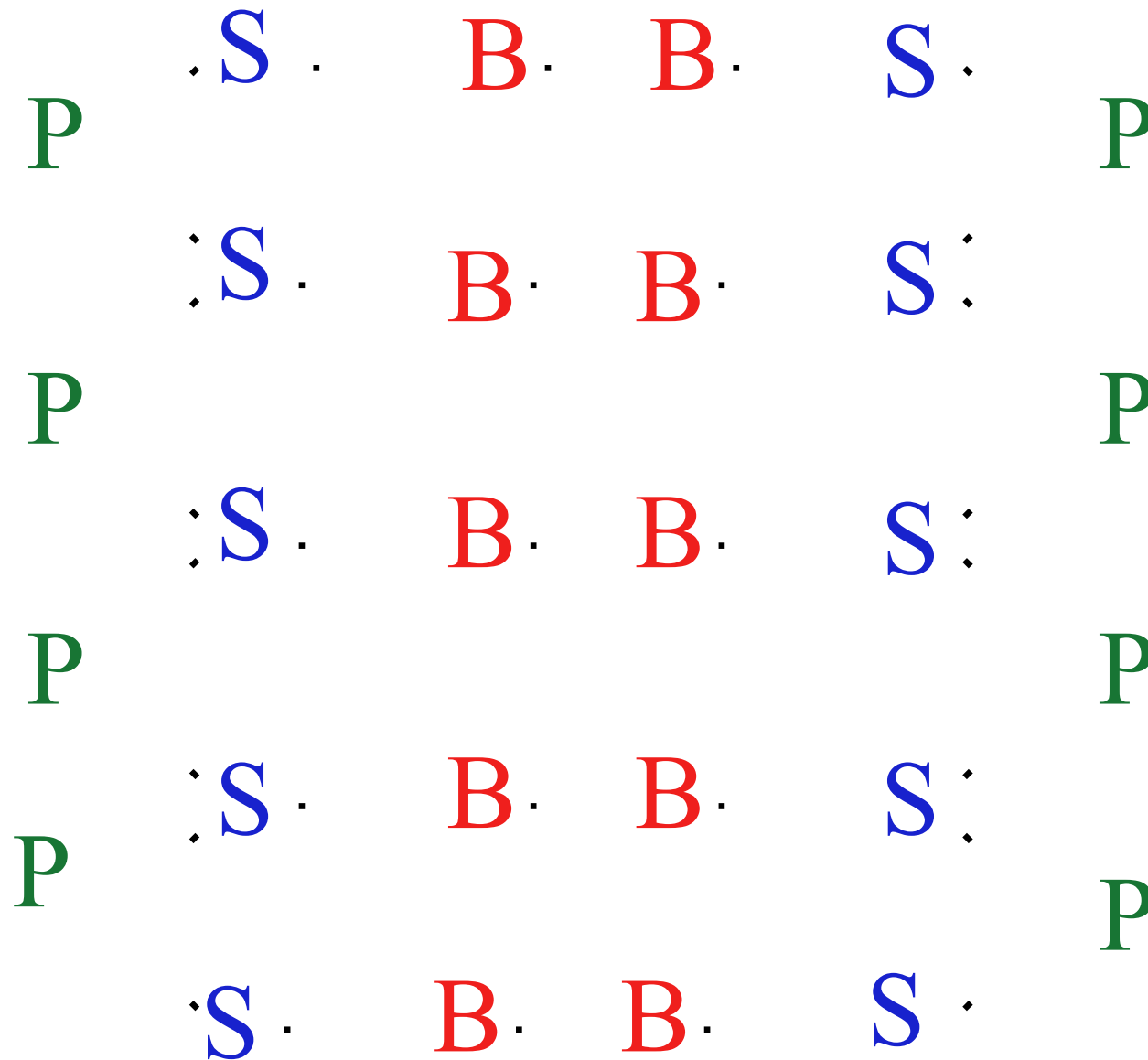
Thymine



phosphate

Structure of Components of DNA

DNA

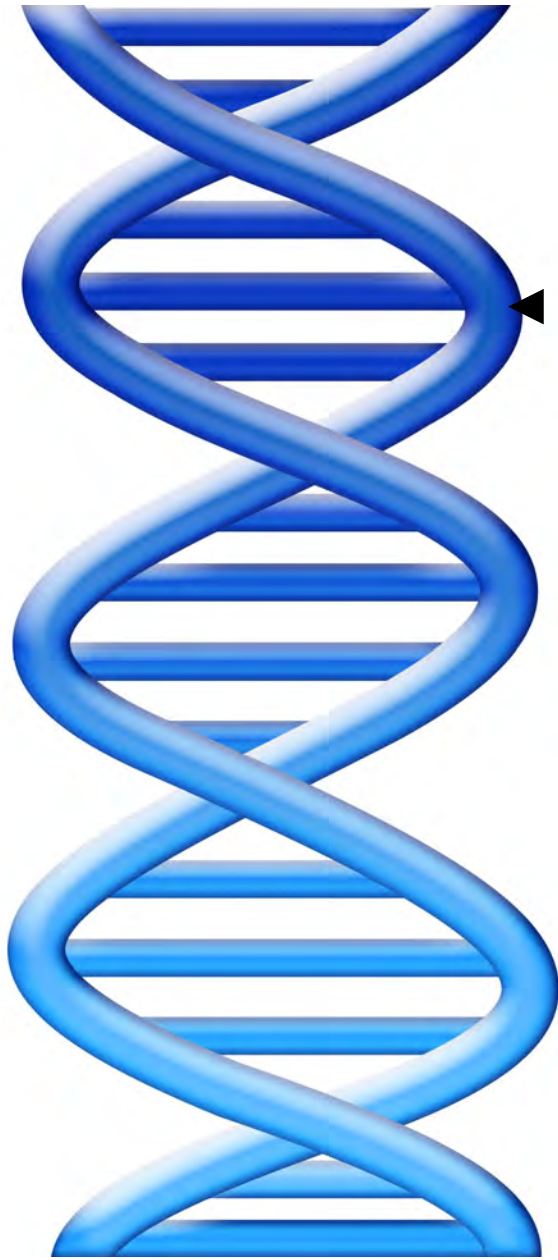


Key:

S = sugar

P = phosphate

B = base



sugar-
phosphate
backbone

nitrogenous
bases form
“rungs of
ladder”

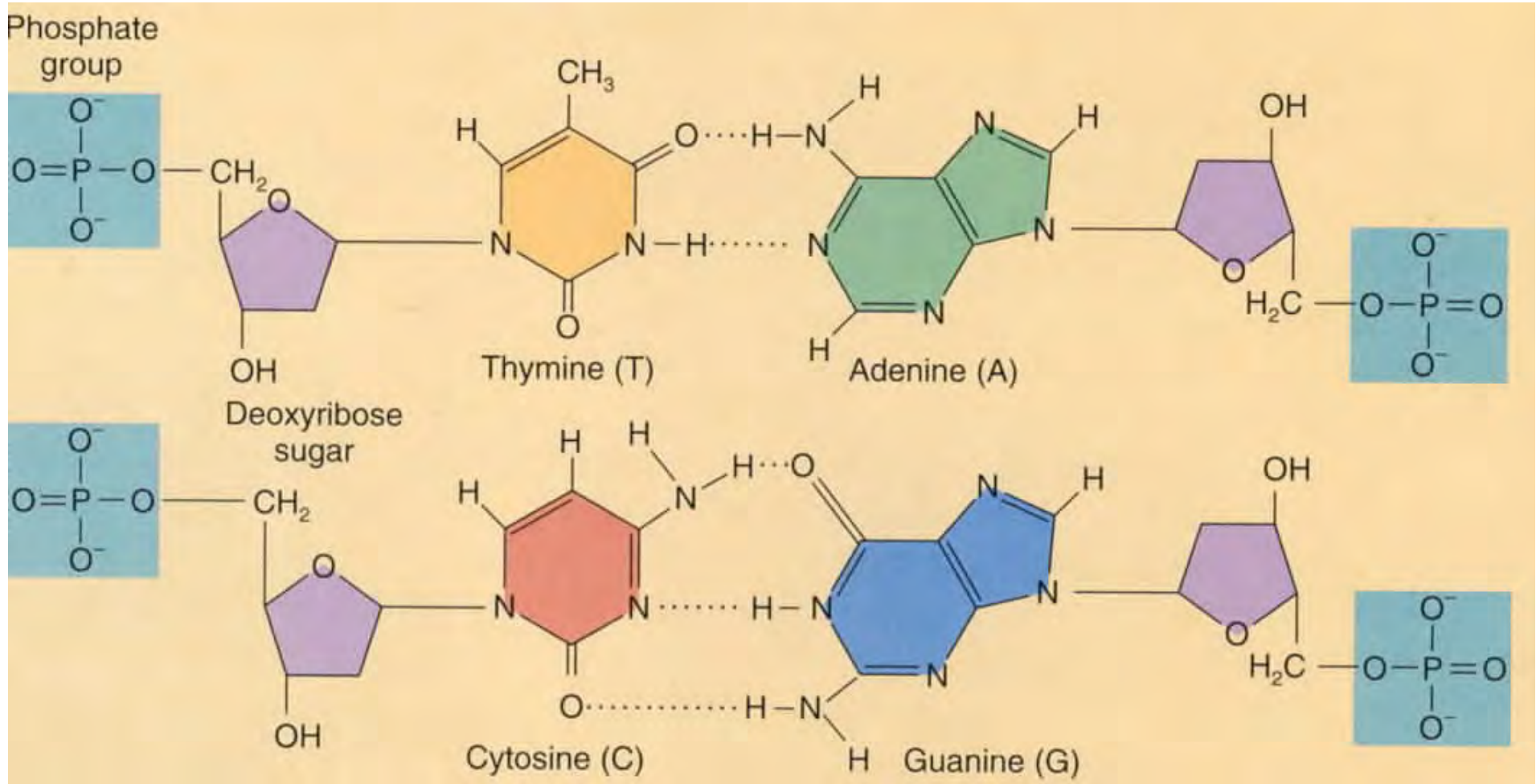
Nitrogenous Bases in DNA

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

- Specificity of base pairing







A - T

C - G



DNA

Key:

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



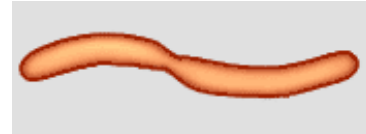
(b)

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Types of Chromosomes

unduplicated

(1 double stranded (ds)
DNA + protein)

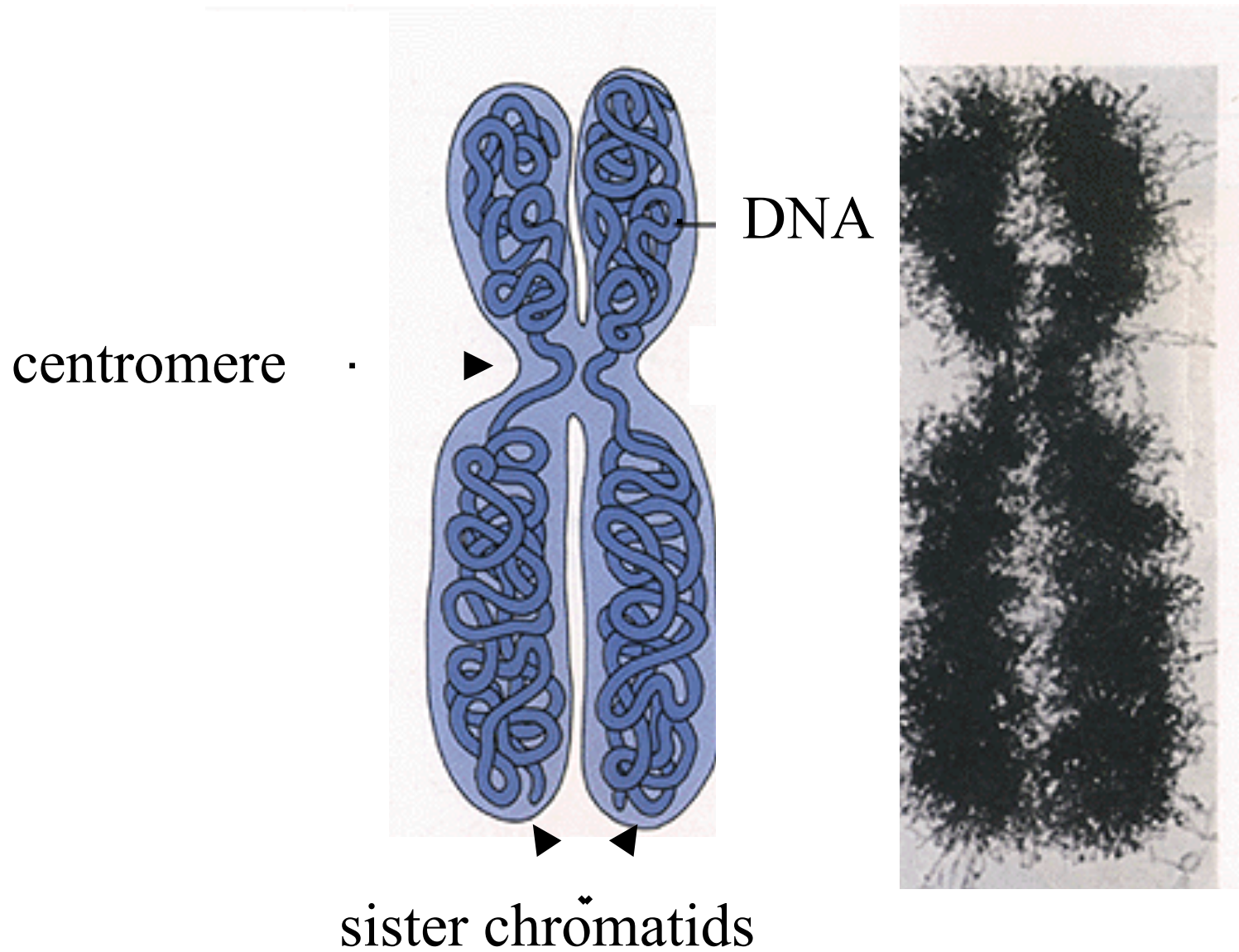


duplicated

(2 ds DNAs + protein)



Duplicated Chromosomes



▪ **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 =
 $1N = 23$**

The Cell Cycle

At any given time,
a cell is either:

not dividing

dividing

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

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



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

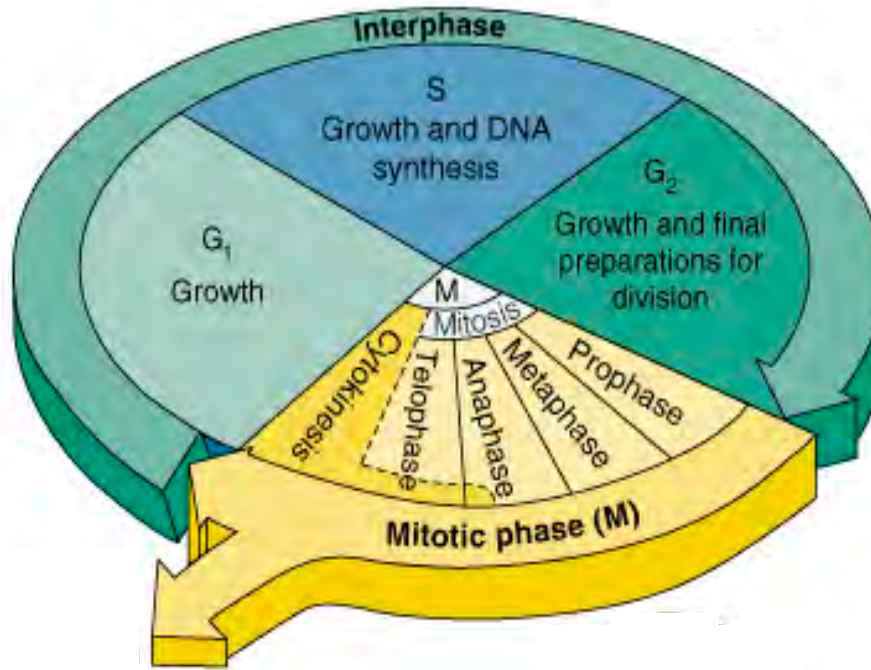
CELL CYCLE

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)

INTERPHASE

before mitosis begins; NOT part of mitosis

cell is not dividing

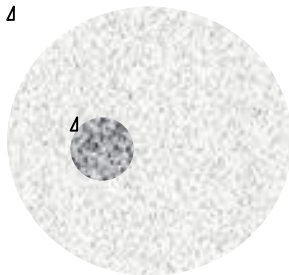
includes G1, S, G2 phases

nuclear membrane visible

nucleoli visible

chromatin in nucleus

4

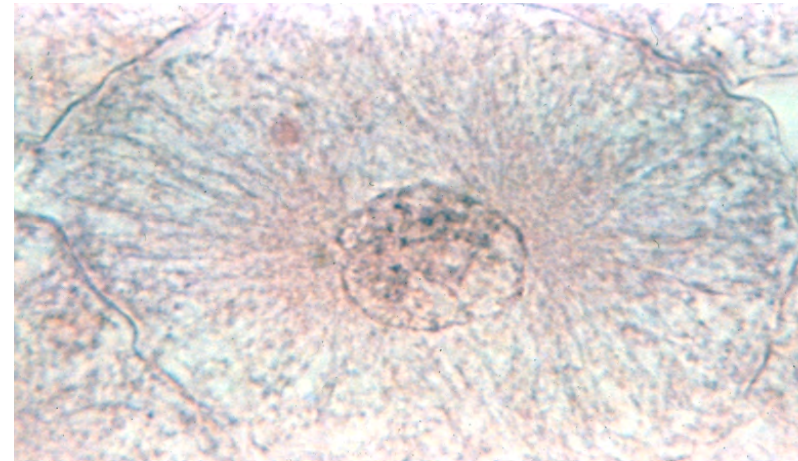
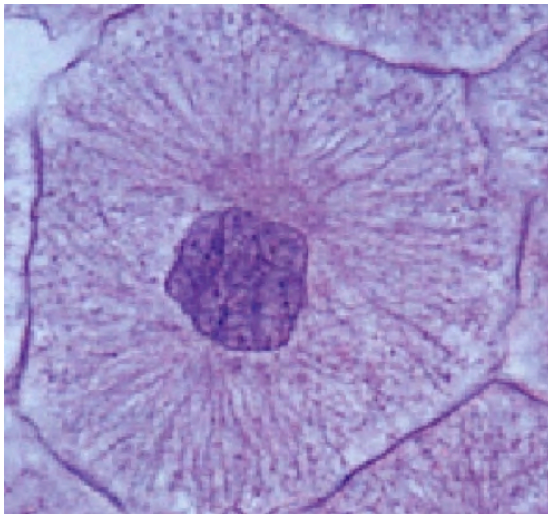


NOTE:

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

- Interphase

- nuclear membrane present
chromatin not visible



MITOSIS

nuclear division of somatic cells

4 phases:

Prophase

Metaphase

Anaphase

Telophase

cytokinesis – division of cytoplasm –
occurs mainly during telophase

PROPHASE

lasts 1 – several hours

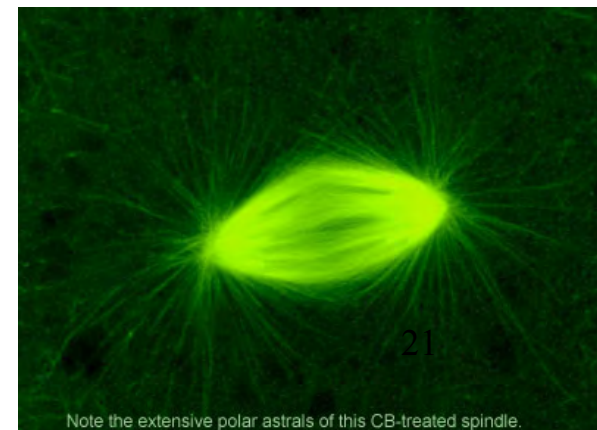
nuclear membrane disappears

nucleoli disappear

chromatin winds upon itself to form chromosomes;
chromosomes are duplicated

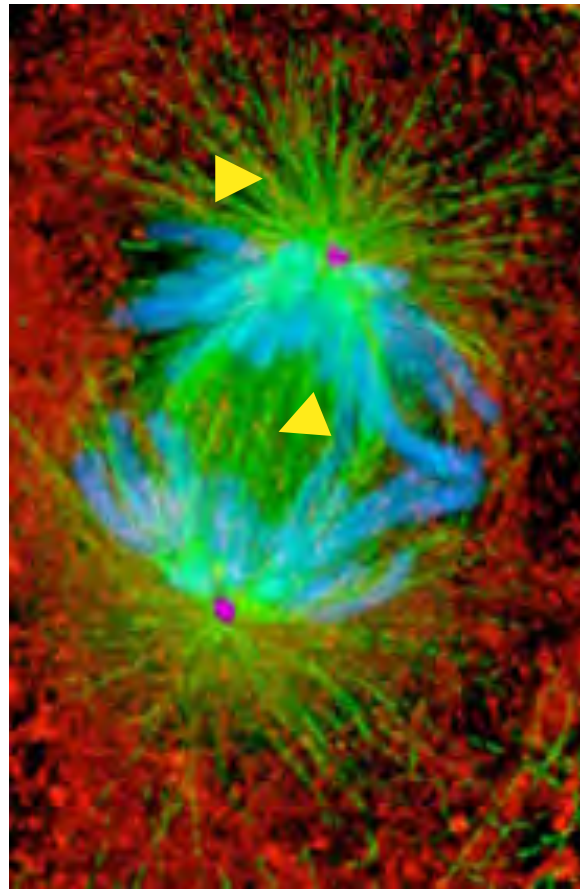
centrioles made of microtubules; (replicated to form 2
pairs at end of G1); move to opposite poles of cell

spindle and asters form



Spindle & Asters

aster
probably
anchors
apparatus to
cell
membrane



spindle
helps organize
chromosomes
during mitosis

Prophase

4



NOTE:

nuclear membrane disappears

nucleolus disappears

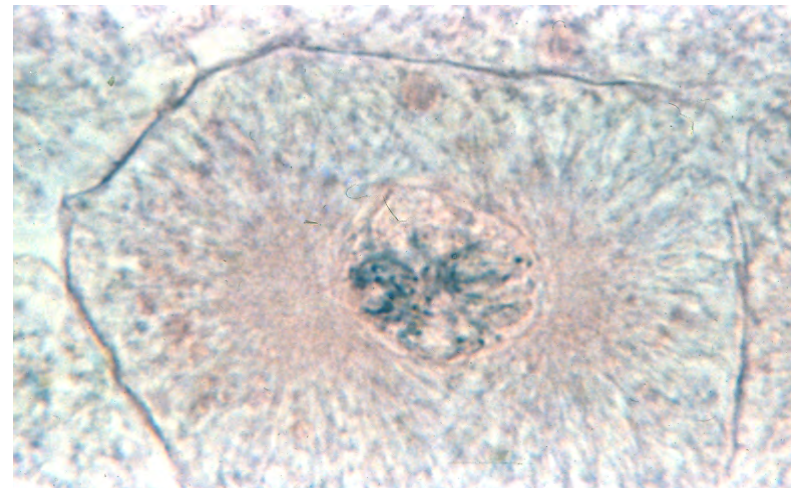
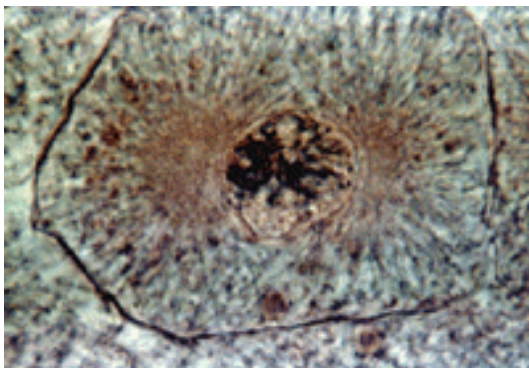
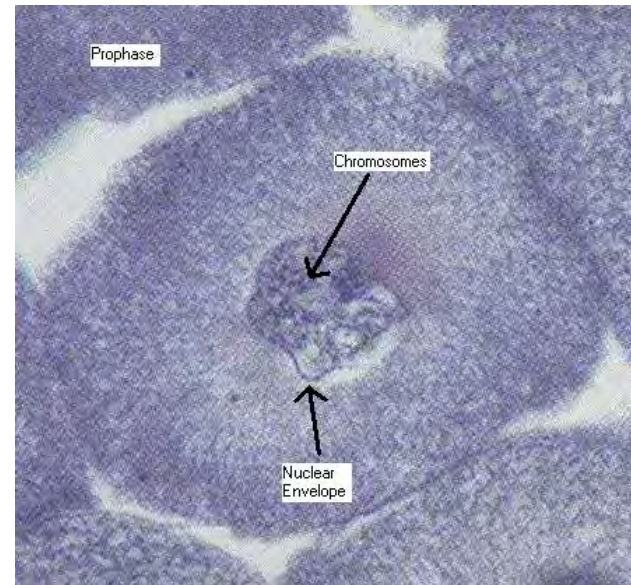
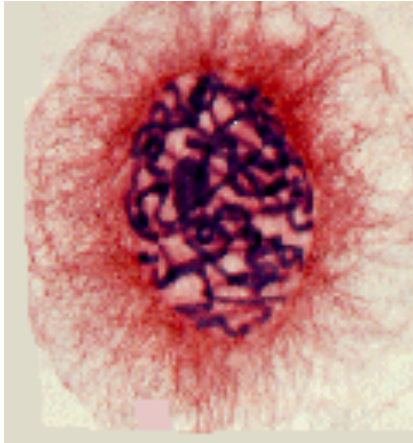
chromatin \longrightarrow chromosomes

spindle & asters form

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

In humans, $2N = 46$.

Prophase



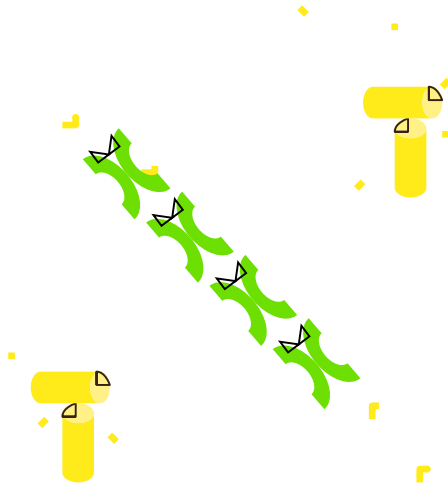
METAPHASE

5 – 15 minutes

chromosomes line up in single file along center of spindle

chromosomes are attached to spindle fibers in area of centromere

4



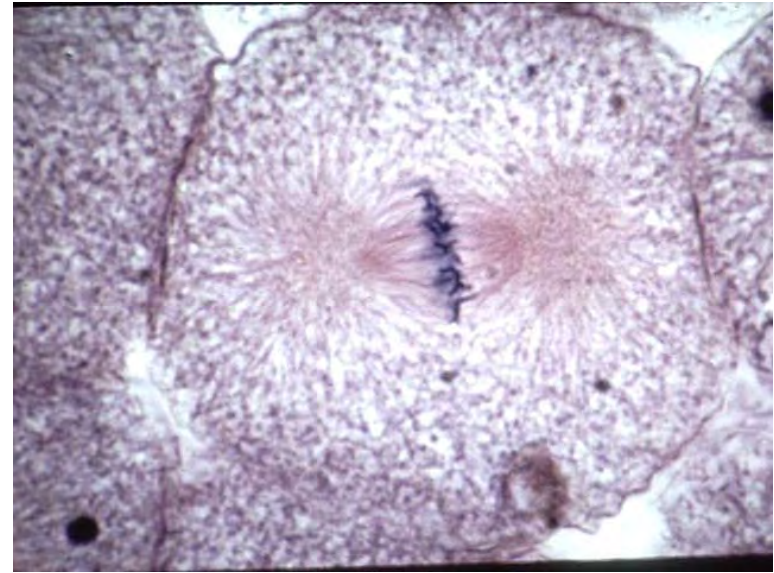
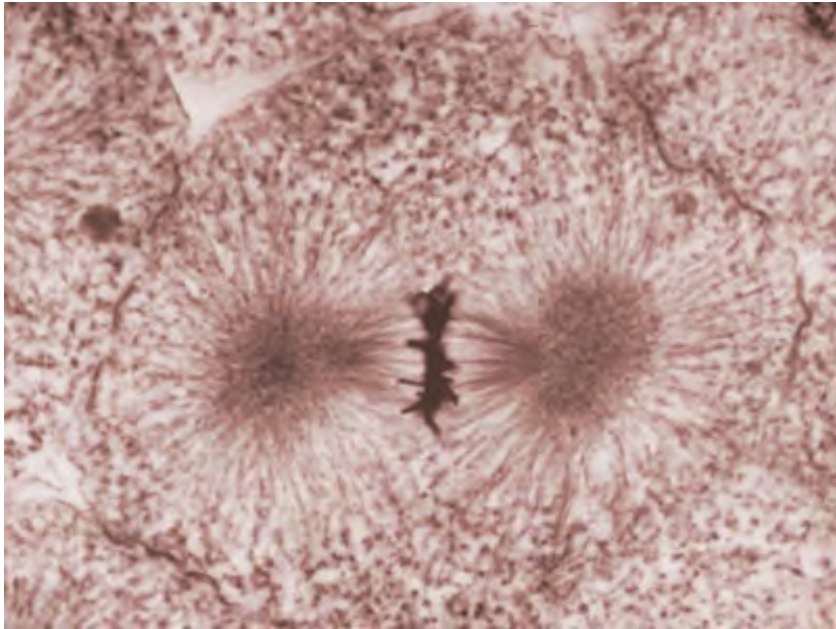
NOTE:

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

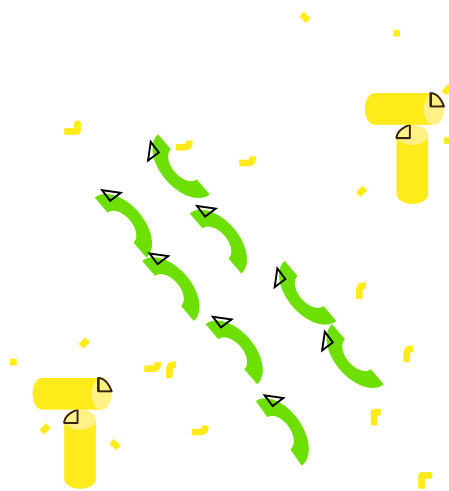
spindle fibers pulled toward opposite poles of cell

centromere splits

sister chromatids pulled toward opposite poles of cell

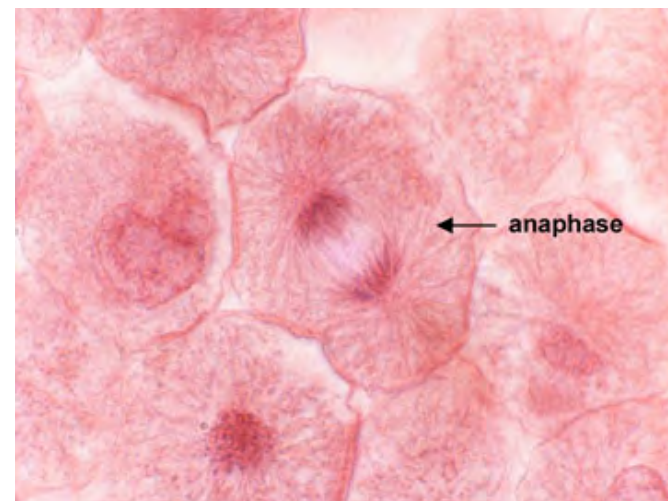
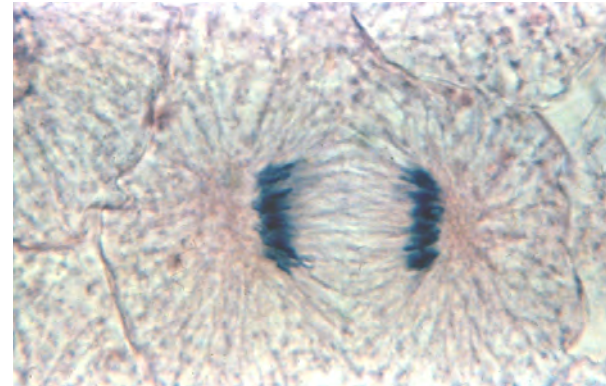
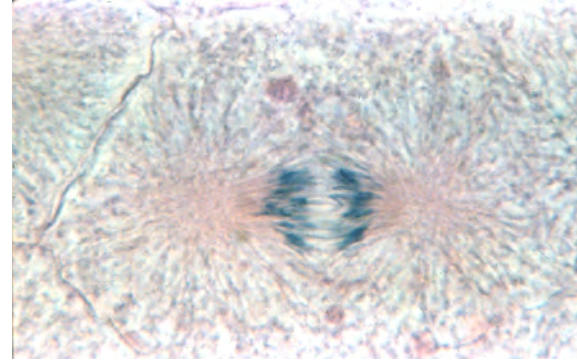
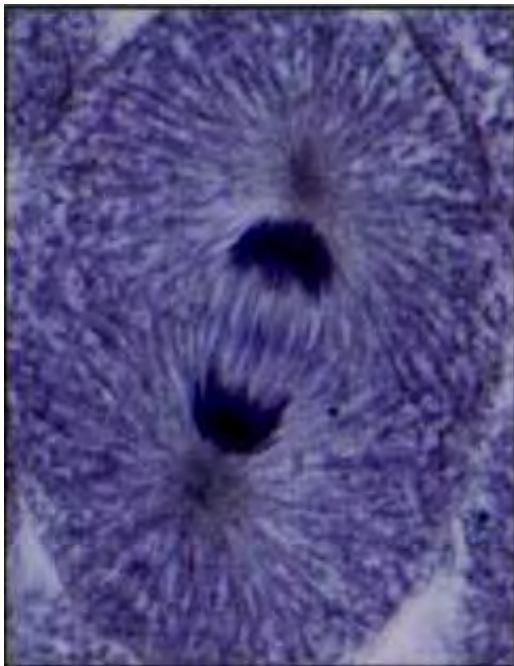
NOTE:

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)

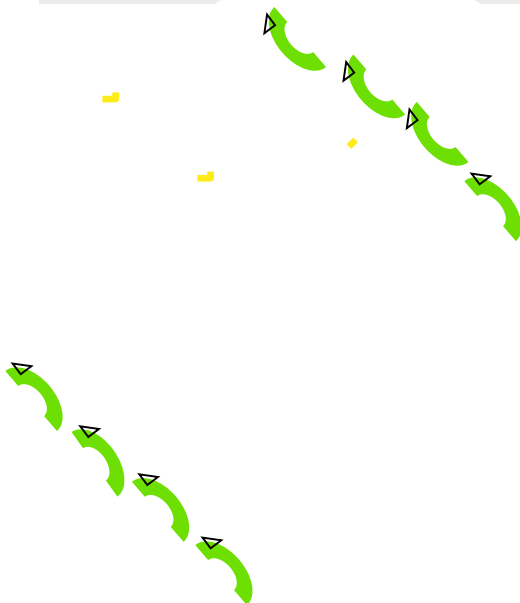
opposite of prophase occurs:
nuclear membrane & nucleoli reappear
chromosomes uncoil into chromatin
spindle & asters disappear

NOTE:

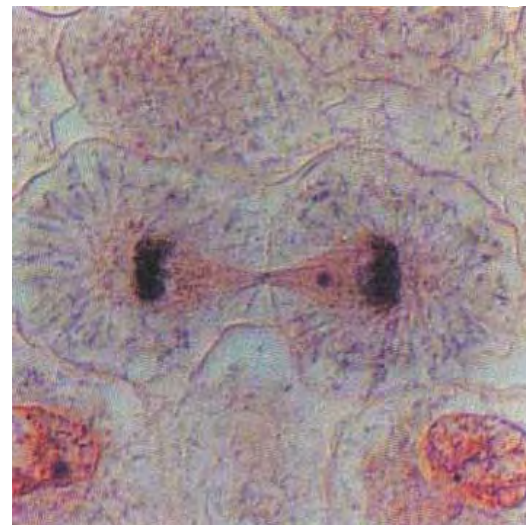
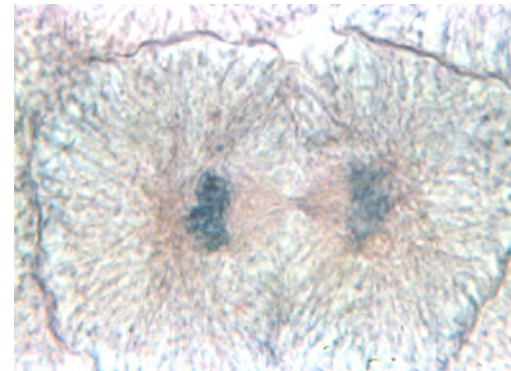
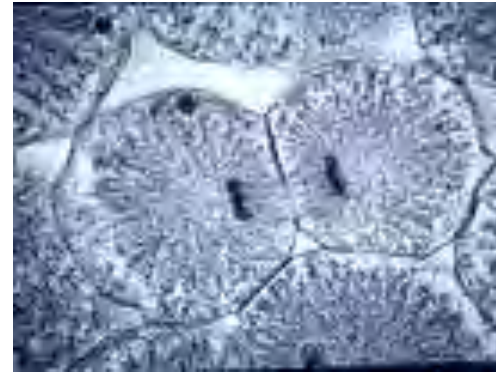
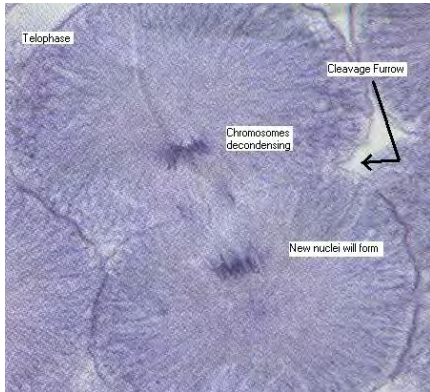
cleavage furrow forms;
2 daughter cells will form; the
opposite of prophase will occur

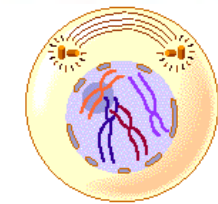
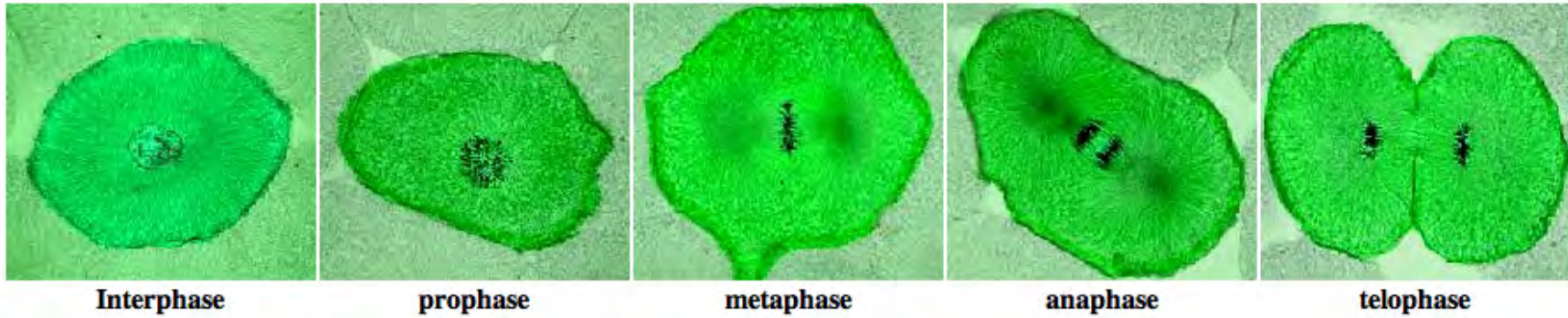
In this hypothetical cell, $2N = 4$.

In humans, $2N = 46$.

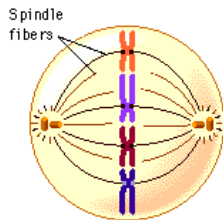


Telophase

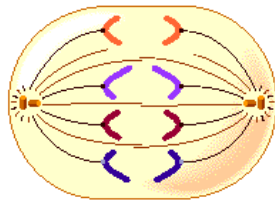




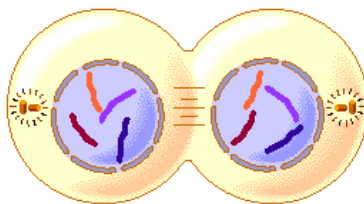
Prophase



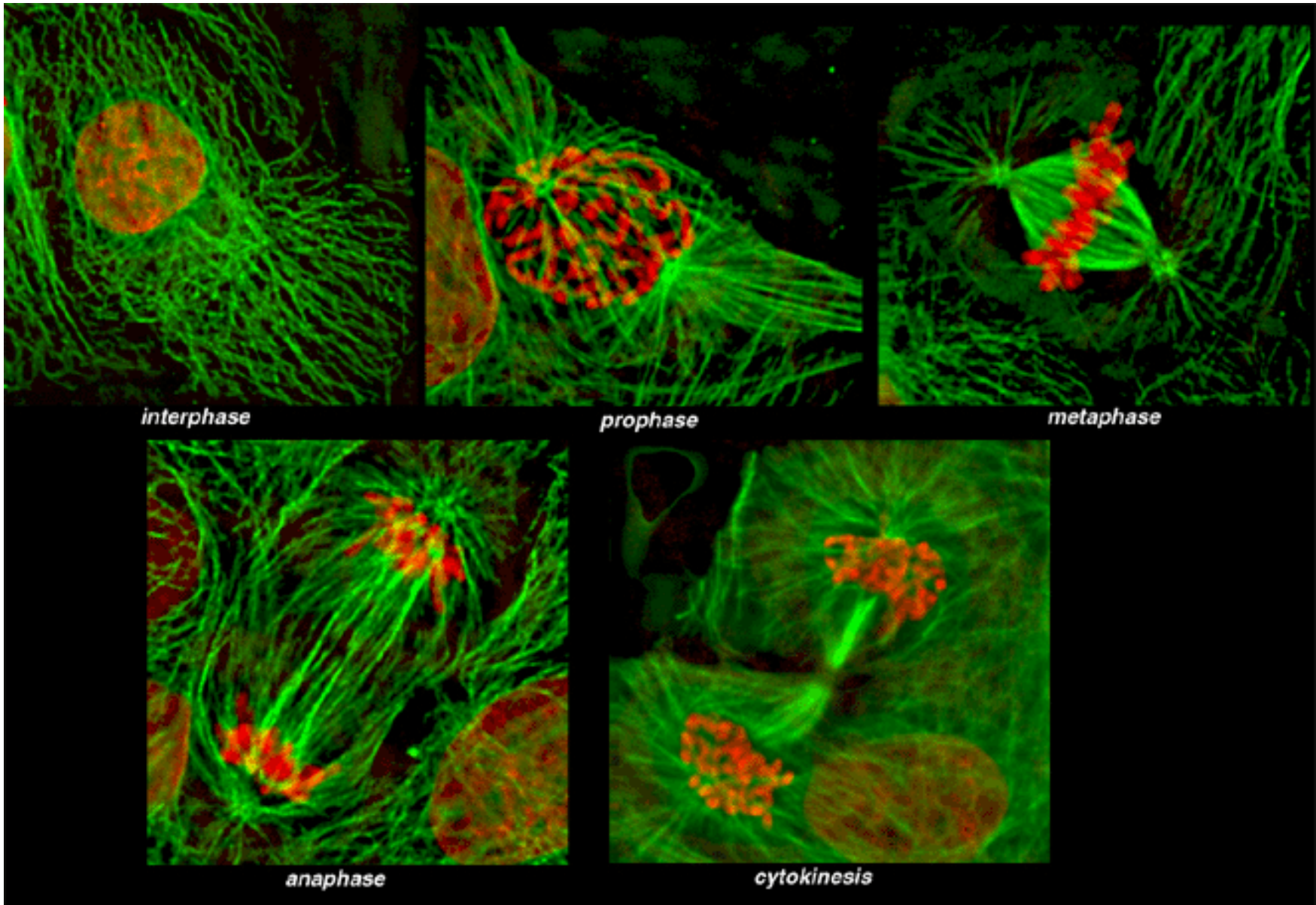
Metaphase

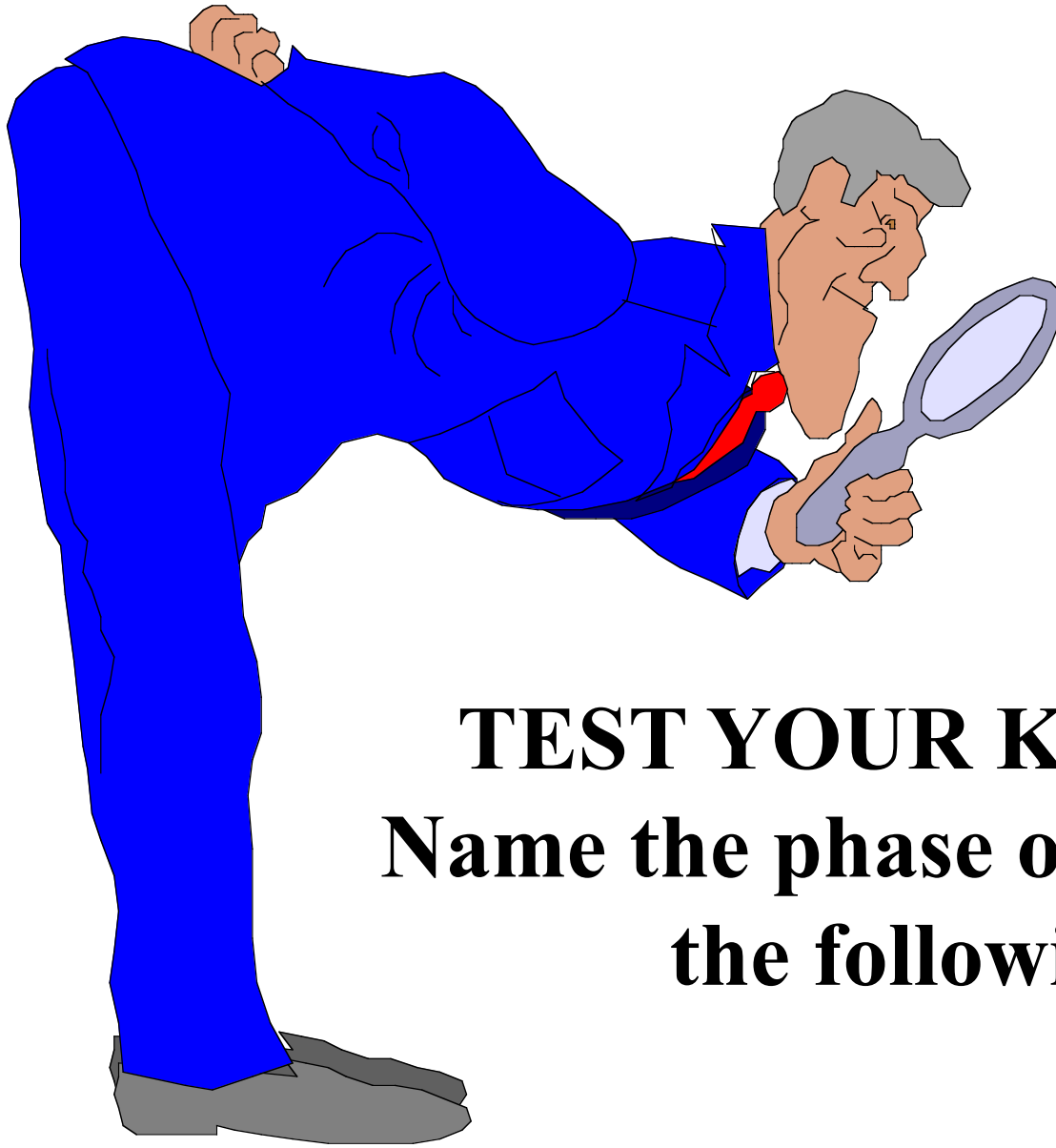


Anaphase

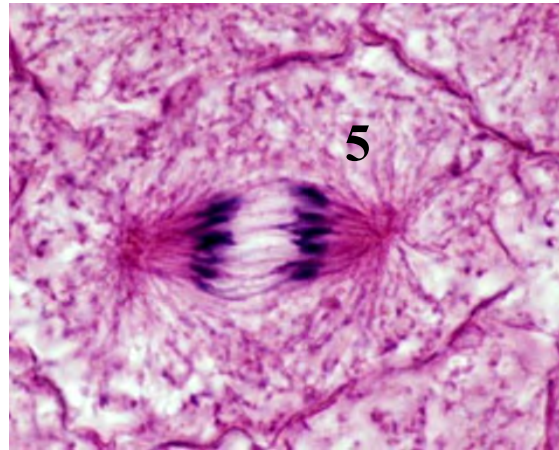
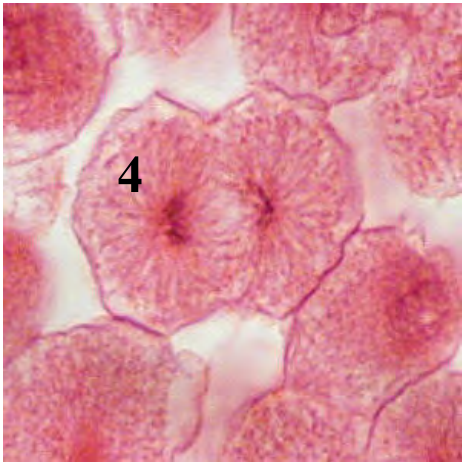
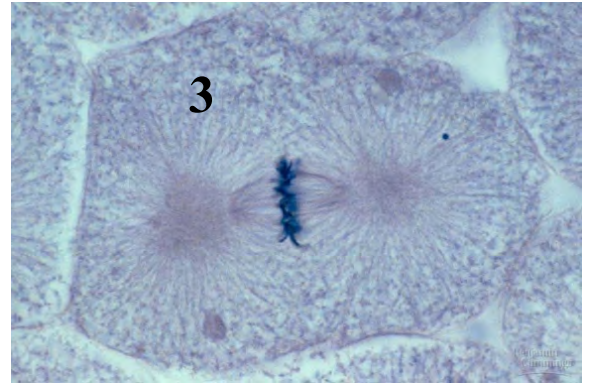
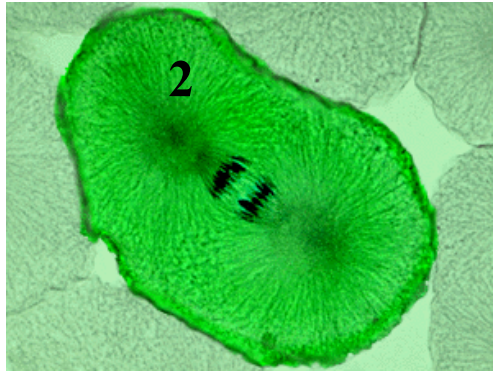
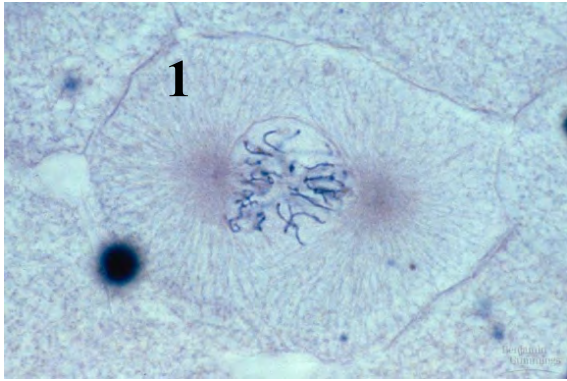


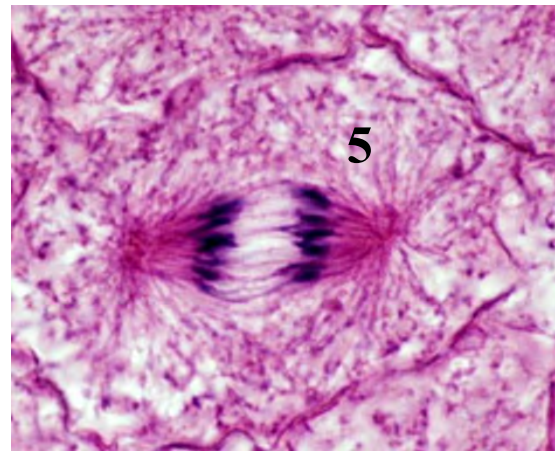
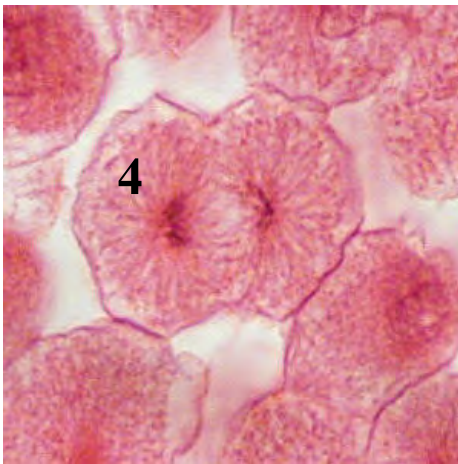
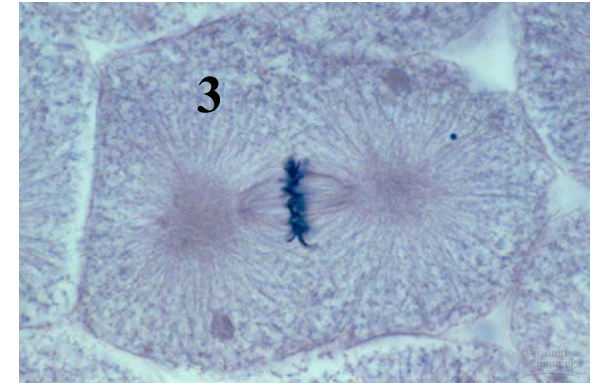
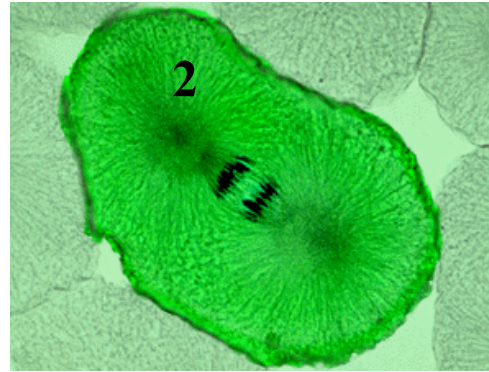
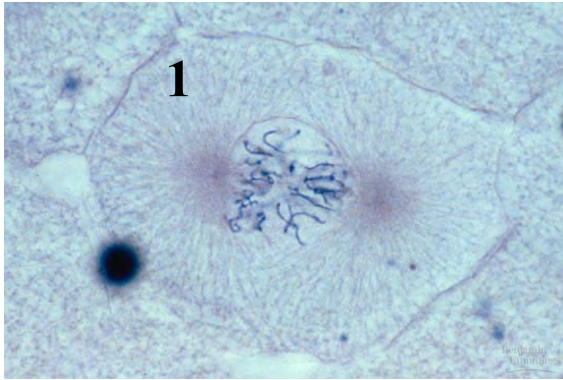
Telophase



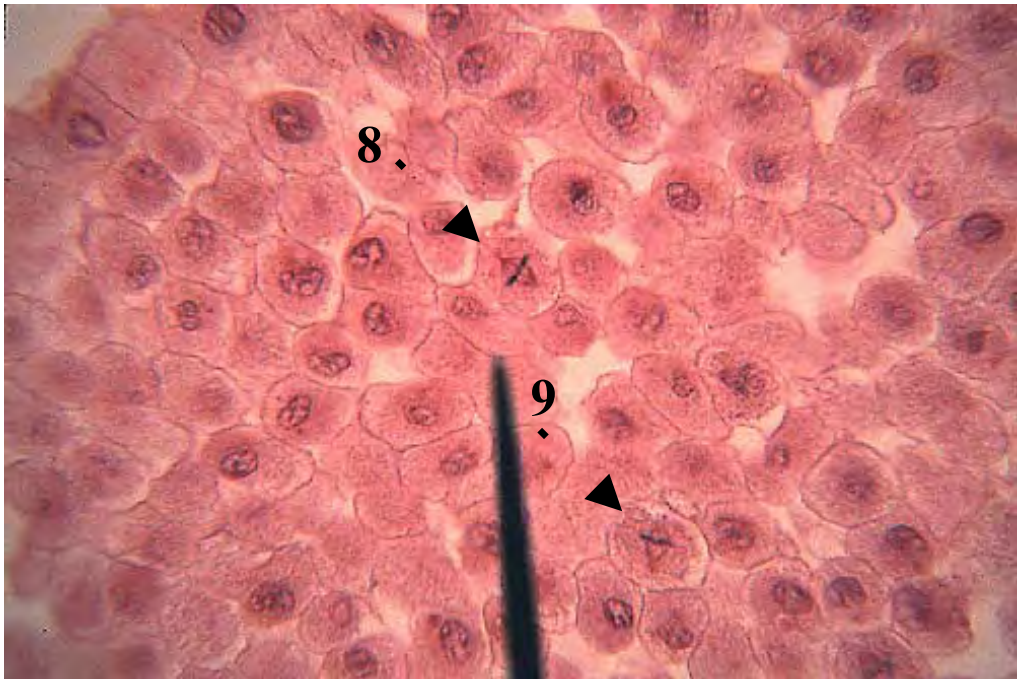
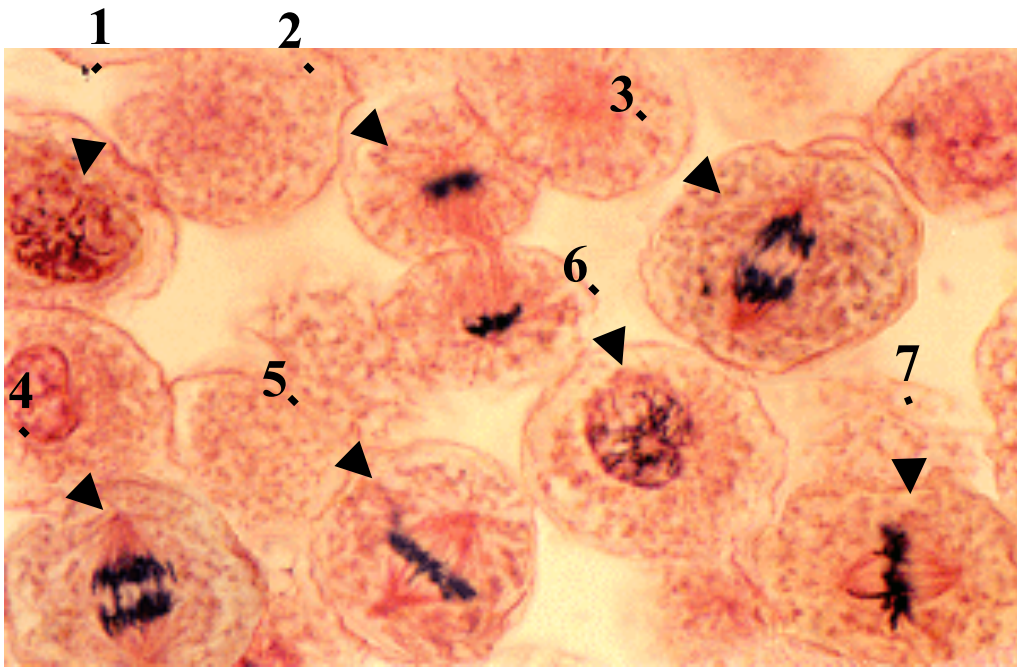


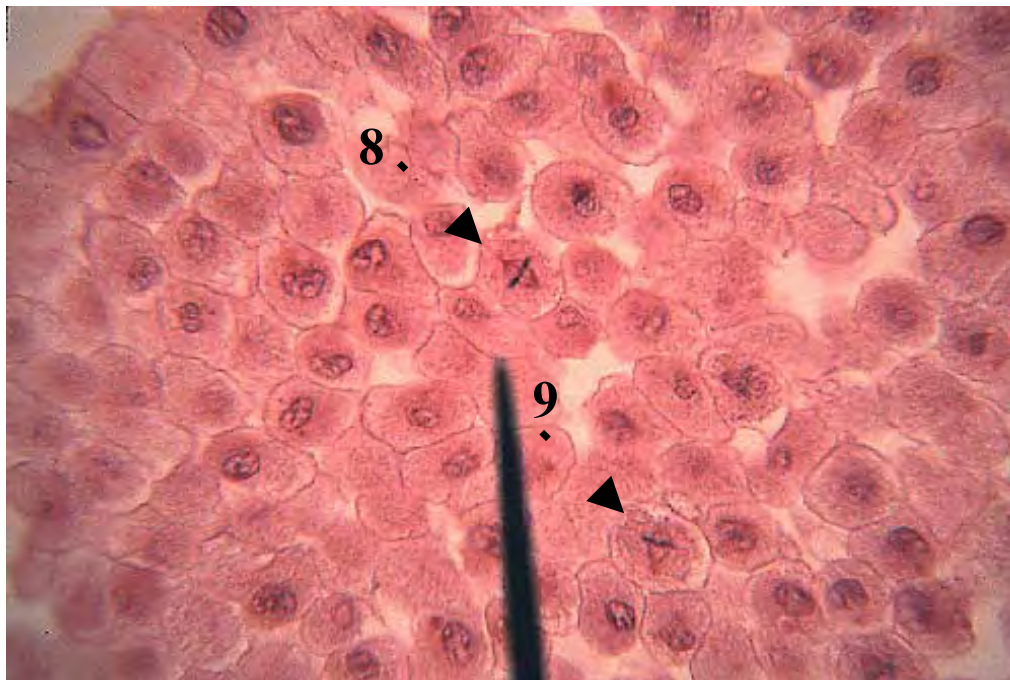
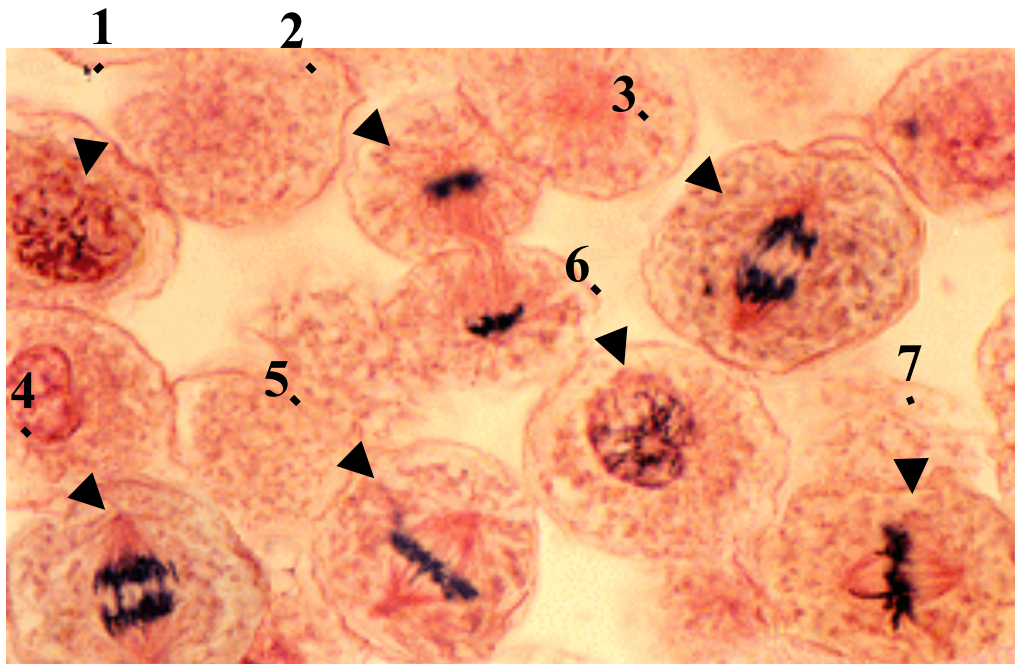
**TEST YOUR KNOWLEDGE:
Name the phase of mitosis seen on
the following slides.**



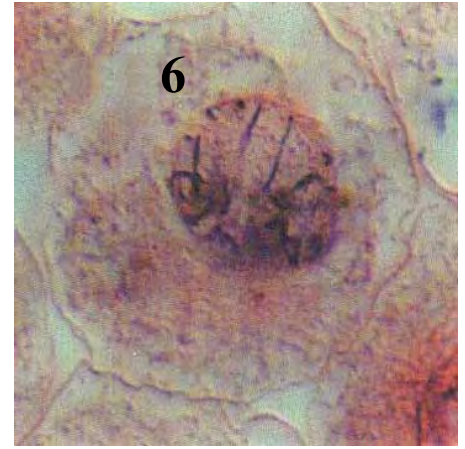
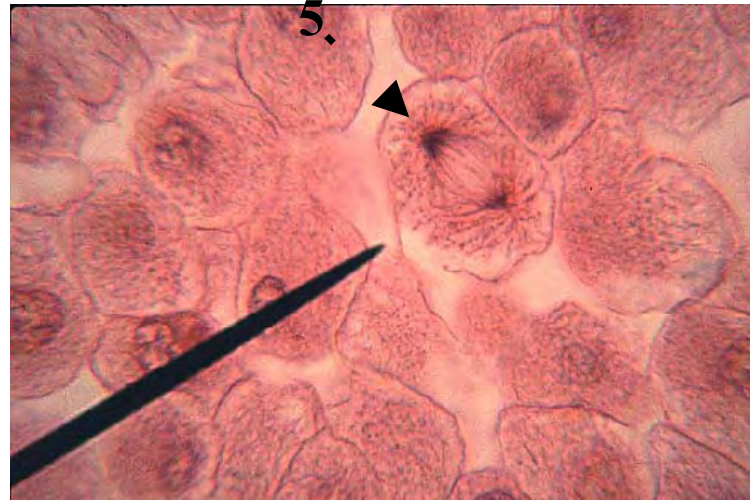
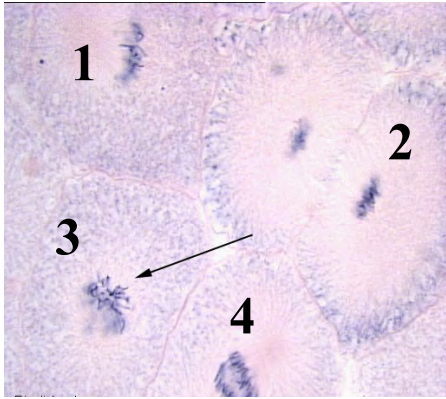


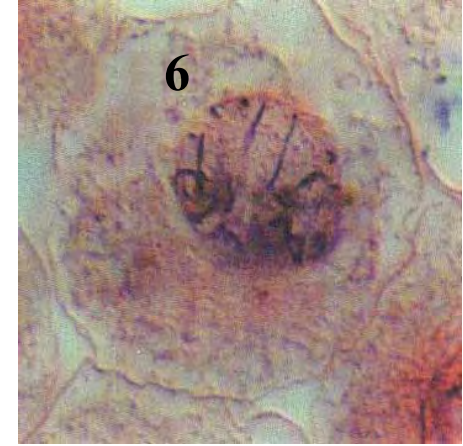
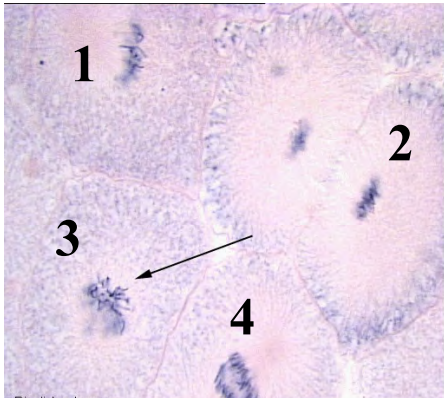
- 1 prophase
 2 anaphase
 3 metaphase
 4 telophase
 5 anaphase





- | | |
|---|-----------|
| 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!