

Biology 30 IB

Cells, Chromosomes, & DNA

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Unfinished!

Contents

1	Terms	3
2	Cell Division	3
2.1	Purpose	3
2.2	Chromosomes	3
2.3	Chromatid	3
3	Cell Cycle	4
3.1	Interphase	4
3.1.1	Gap 1 (G_1)	4
3.1.2	S Phase (S)	4
3.1.3	Gap 2 (G_2)	4
3.2	Mitotic Phase	5
3.2.1	Prophase	5
3.2.2	Metaphase	5
3.2.3	Anaphase	6
3.2.4	Telophase	6
3.2.5	Cytokinesis	6
4	Cell Properties	7
4.1	Biological Clock	7
4.2	Death & Aging	7

5	Natural Cloning	7
5.1	Twins	8
5.2	Identical Twins	8
5.3	Fraternal Twins	8
6	Unnatural Cloning	9
6.1	Plant Cloning	9
6.2	Animal Cloning	9
6.2.1	Mammal Cloning	10
7	Cancer	11
7.1	Metastasis	11
7.2	Tumors	11
7.3	Causes	11
7.4	Methods of Identification	11
8	Telomeres	12
8.1	Telomerase	12

1 Terms

- **Somatic cells** are all cells in the body **except sex cells** — sperm and egg cells
- **Cell division** is done by Eukaryotic cells — have a nucleus
- **Binary fission** is done by Prokaryotic cells — have no nucleus, such as **bacteria**

2 Cell Division

2.1 Purpose

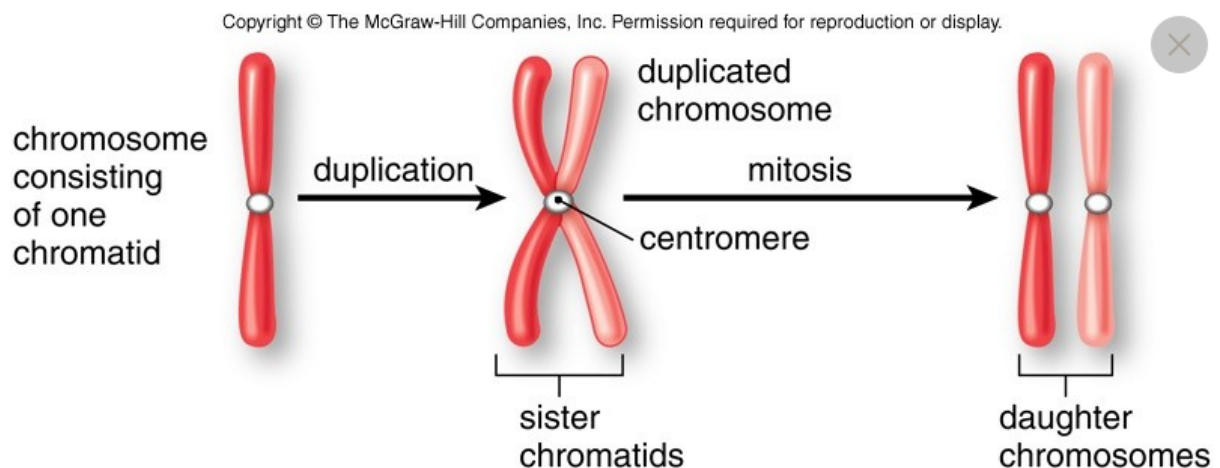
- Unicellular organisms (i.e. **zygote**) → Multicellular organisms
- Growth and maintenance of body cells — **replacement** of worn out cells

2.2 Chromosomes

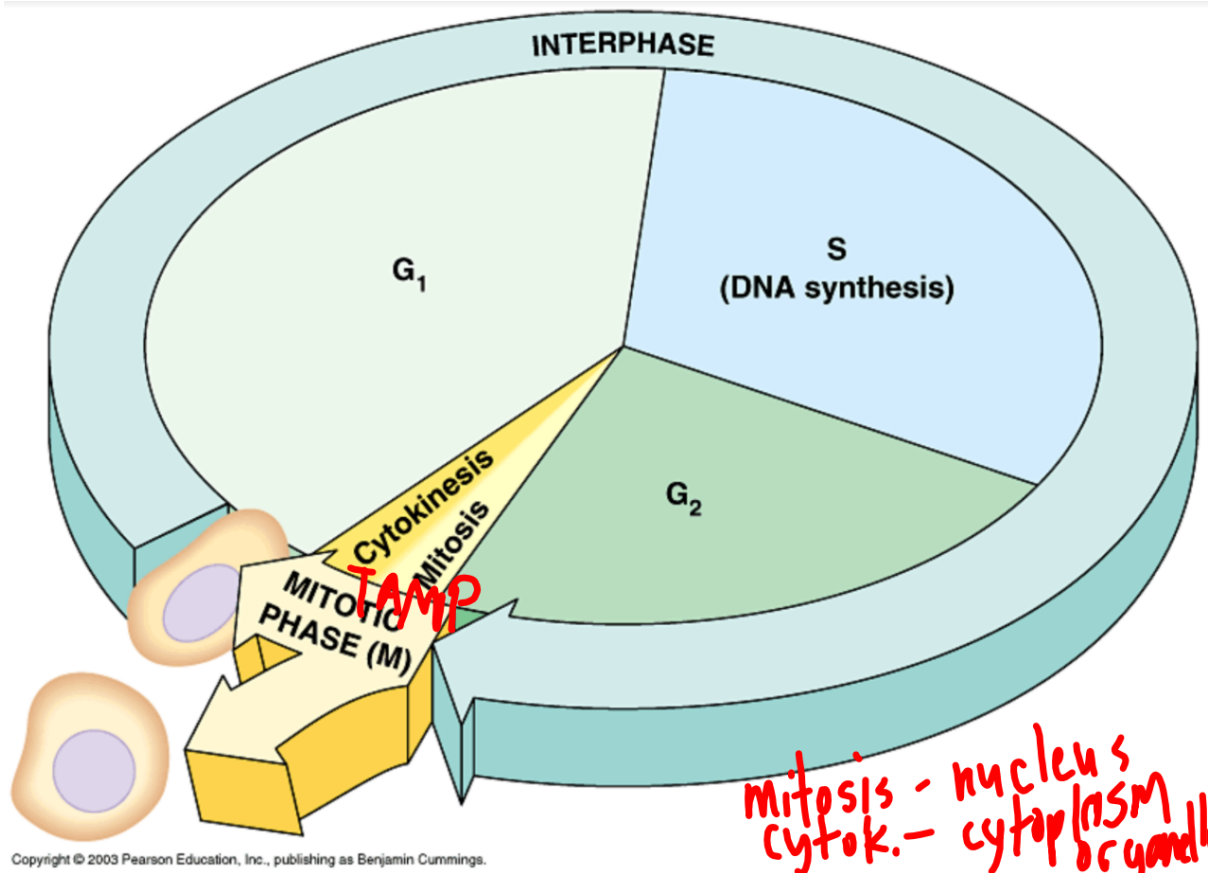
- Comprised of...
 - nucleic acids (DNA)
 - proteins
- Either...
 - **Uncondensed** aka. **Chromatin** = long, thin strands. invisible to microscope
 - **Condensed** = thick & shortened. visible to microscope

2.3 Chromatid

- The strand that makes up a normal chromosome
- In mitosis...
 - A chromosome duplicates into two **identical** chromatids, joined together by a **centromere**, to form a **duplicated chromosome**
 - These chromatids are referred as **sister chromatids** in this state
 - Each chromatid of a duplicated chromosome goes to each of the two new cells



3 Cell Cycle



A continuous cycle that involves all steps of a cell's life, especially cell division.

3.1 Interphase

- 90% of cell cycle
- All cell activity when not dividing

3.1.1 Gap 1 (G_1)

- Cell growth and general function
- After cell division, cells may be smaller than their parent. Cell growth is needed

3.1.2 S Phase (S)

- DNA is doubled
- Single(-chromatid) chromosome $\xrightarrow{\text{duplication}}$ double(-chromatid) chromosome

3.1.3 Gap 2 (G_2)

- Organelles are doubled, and proteins for the new cell are produced

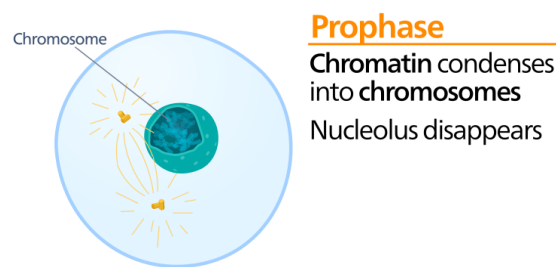
3.2 Mitotic Phase

Occurs in somatic cells.

Distribution of **nucleus and its contents**.

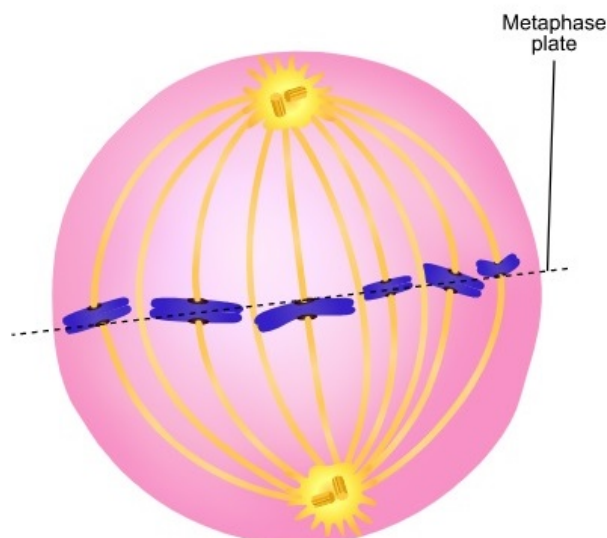
3.2.1 Prophase

- Chromatin condense — shorten & thicken — into chromosomes, becoming visible
- Nuclear membrane fades
- Animal cells only...
 - **Centrioles** move to opposite poles of cell. (N/S, E/W)
 - Two centrioles are at each pole, total four, for each cell
 - Centrioles deploy **spindle fibers**
- Without centrioles — such as plant cells — spindle fibers are still present and the cycle works the same



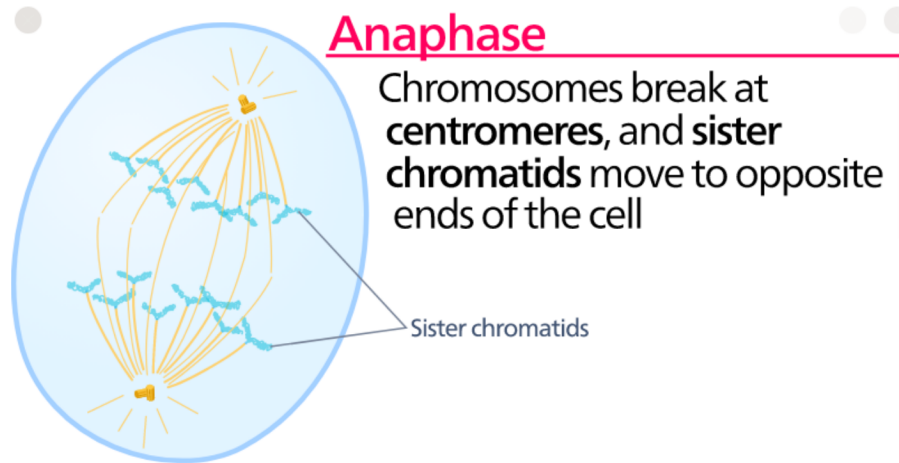
3.2.2 Metaphase

- **Equatorial plate** = center of cell
- Sister chromatids move towards equatorial plate
- Chromosomes attach to spindle fibers



3.2.3 Anaphase

- Centromeres divide
- (Now) chromatids move towards spindle fibers — i.e. opposite poles of cell



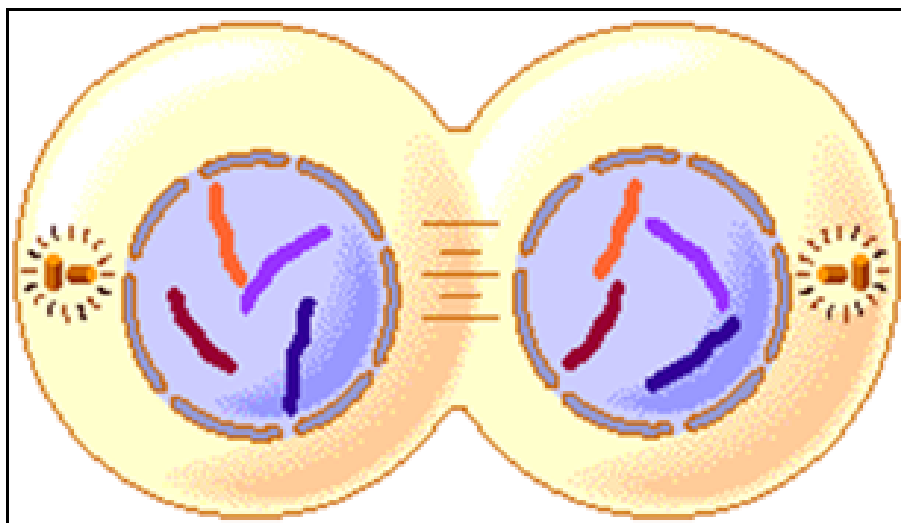
3.2.4 Telophase

- Spindle fibers dissolve
- Nuclear membrane forms around each mass of chromatin

3.2.5 Cytokinesis

Technically occurs at the end of telophase.

- **Division of cytoplasm** and **distribution of organelles** to "daughter" cells
- Involves **cleavage**, pinching off in the center as the cytoplasm moves to opposite poles
- In plant cells only, a **cell plate** is distributed, which develops into a new cell wall



4 Cell Properties

4.1 Biological Clock

Immature cells always have 50 division, regardless of...

- duration frozen
- stage/phase that cell division was suspended

4.2 Death & Aging

Cells may stop dividing due to...

- **Senescence** = aging, irreversible changes that eventually lead to death
- **Specialization** = the more specialized/differentiated a cell is, the less likely it will undergo mitosis

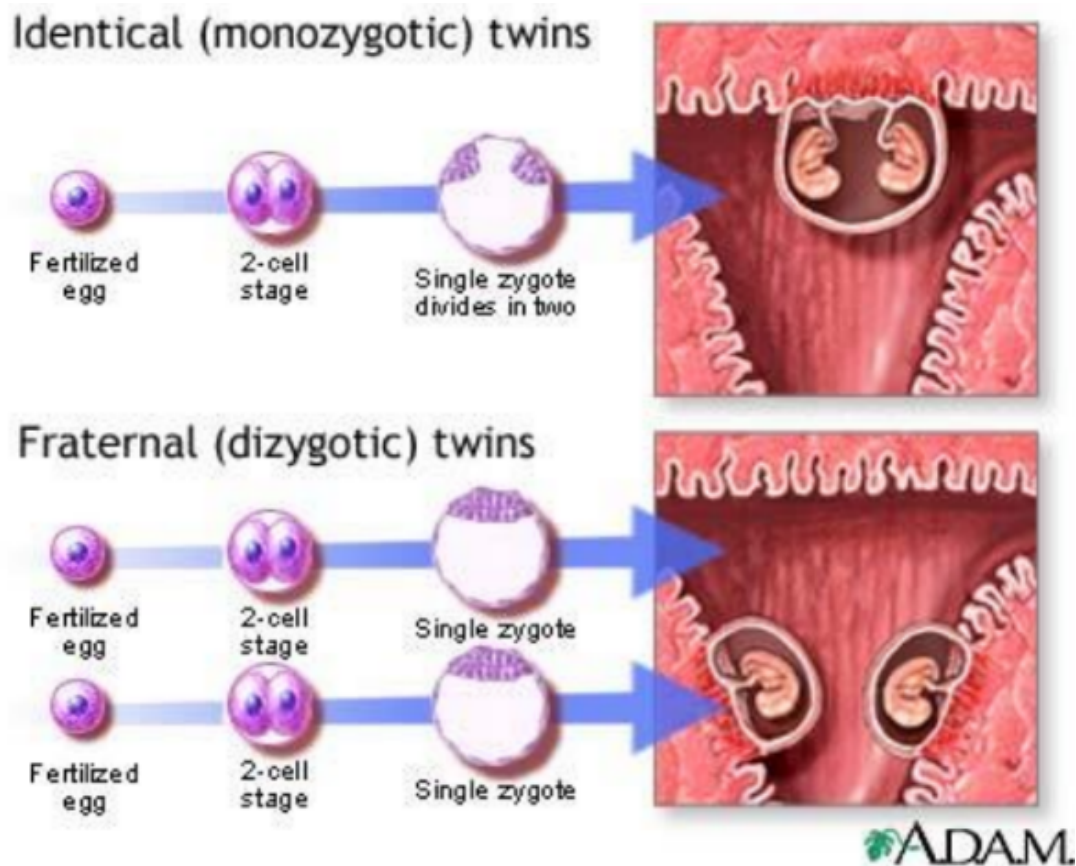
Cells that avoid aging are...

- **Spermatogonia** = sperm-producing cells, immature & unspecialized
- Cancer cells of a tumor, which do not become specialized

5 Natural Cloning

- Asexual/nonsexual reproduction
- Identical offspring from a single cell

5.1 Twins



5.2 Identical Twins

- Originate from single egg cell
- During mitosis, **one of the cells breaks free**; this cell forms a 2nd embryo
- If cell clusters remain separate, two babies with identical gene structures will develop
- Same gender, blood type, similar facial structure (nature vs. nurture)

5.3 Fraternal Twins

- Two different eggs fertilized by different sperm cells
- Not to be confused with identical twins — do not have identical genes

6 Unnatural Cloning

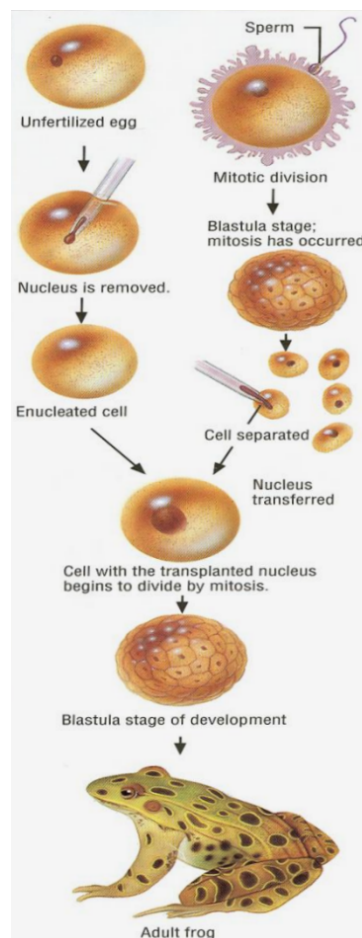
A **totipotent** nucleus is a nucleus that is able to bring a cell from **egg to adult**.

6.1 Plant Cloning

- useful, since cloned plants have predictable characteristics
- requires **delaying cell specialization**

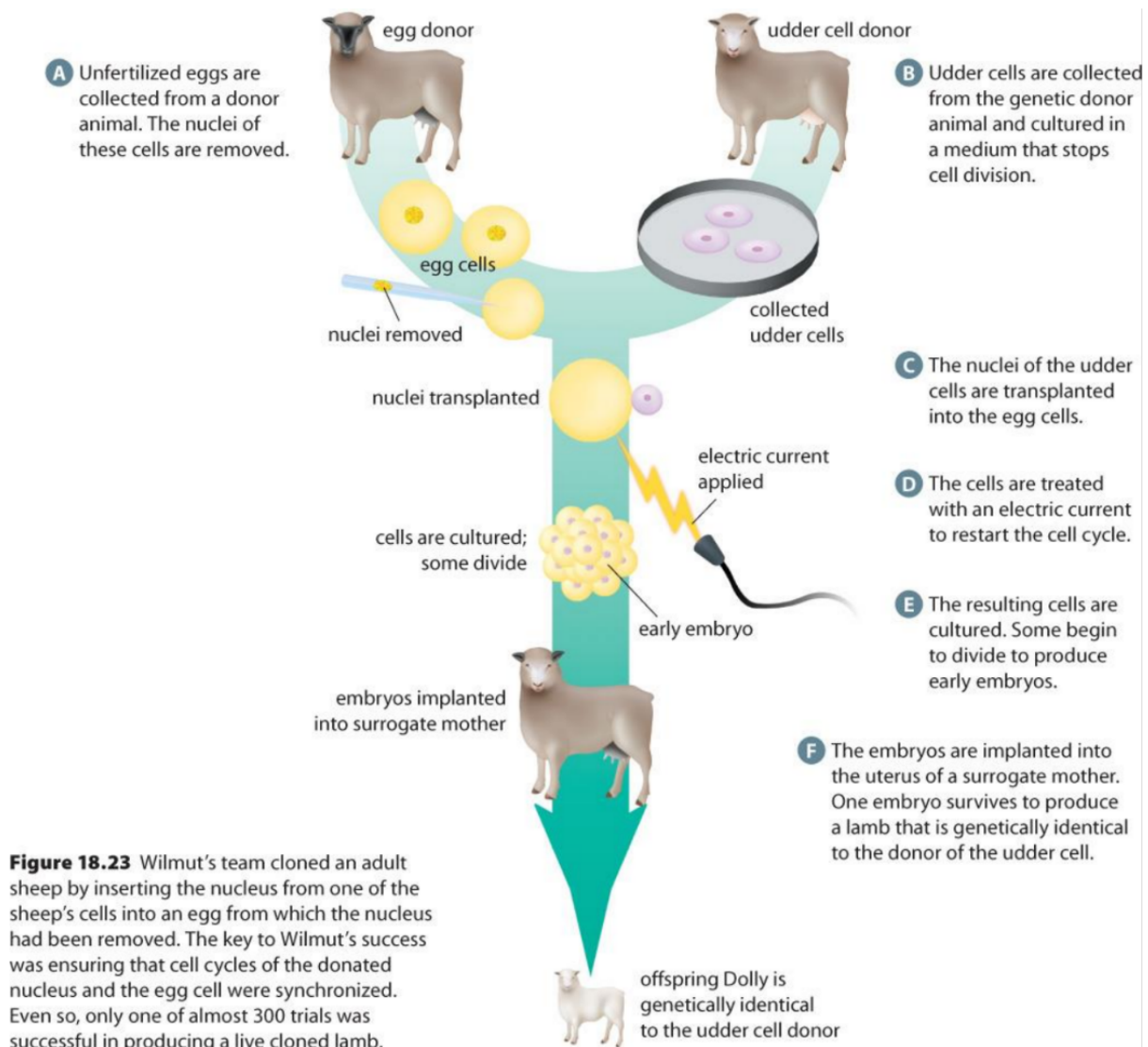
6.2 Animal Cloning

- With a micropipette, the nucleus is extracted from an unfertilized egg cell
The cell is now **enucleated** (no nucleus)
- Remove nucleus from a cell of another frog
- Insert egg cell nucleus into said cell
- If cell is in **blastula** stage — hollow ball of cells of an embryo, early embryo — then the cells divide into an adult frog, a clone of the frog that donated the **egg cell nucleus**
- If cell is past blastula — such as the later **gastrula** stage — the cells have **already specialized**, so they do not divide, and the embryo dies



6.2.1 Mammal Cloning

- More difficult
- Cells tend to be **more specialized**
- Nucleus transfer must be done before 8 cell stage of development
- Ensures nuclei are totipotent



7 Cancer

- Rapid, uncontrollable growth of cells
- Some are very slow, some pause and return after many years
- Reproduce without directions from adjacent cells
- Cannot specialize — making them inefficient

7.1 Metastasis

- Cancer cells can dislodge from a tumor and move to another area
- Difficult to isolate source of cancer

7.2 Tumors

A mass of cancerous cells within otherwise normal tissue.

- **Benign Tumor**
 - If cancerous cells remain at site
 - Do not cause serious problems
 - Can be removed by surgery
- **Malignant Tumor**
 - If cancerous cells metastasize — dislodge & travel — and cause impairment of other organs
 - Unusual number of chromosomes

7.3 Causes

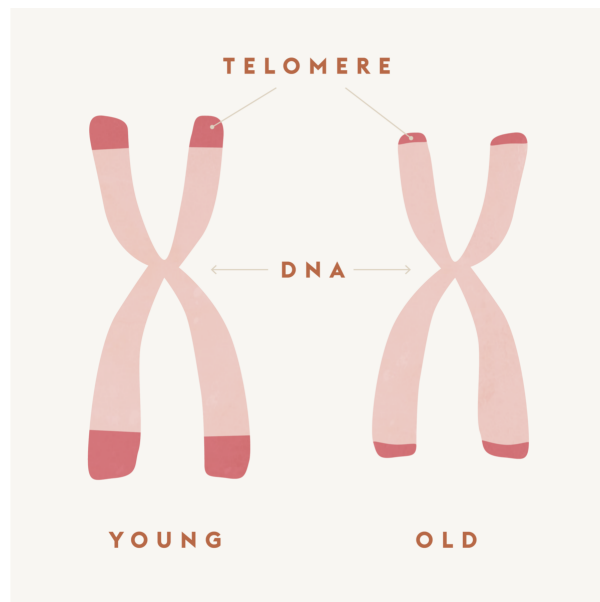
- x-rays
- chemical poisons
- asbestos
- fungi
- oncoviruses
- environmental factors (nature, e.g. diet)
- age
- inherited mutations

7.4 Methods of Identification

- x-rays
- cell biopsies
- infrared technology

8 Telomeres

- Caps at the end of chromosomes
- Reduce in length every cell cycle/division
- Clones — like Dolly — inherit their parents telomere length, shortening their life span compared to non-clones



8.1 Telomerase

- An enzyme that maintains telomere length, slowing cell death
- Not present in most normal cells
- Reactivated in cancer cells, explaining their immortality