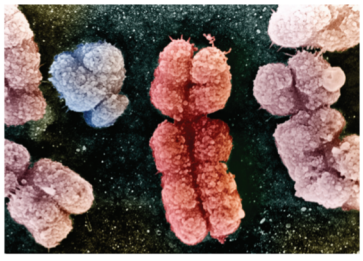
4.1 The Nature of Heredity

Genetic Material

- Genetics is the study of heredity and variation
- A typical human chromosome contains thousands of genes
- Genes are segments of DNA that code for a particular trait
- DNA stands for deoxyribonucleic acid



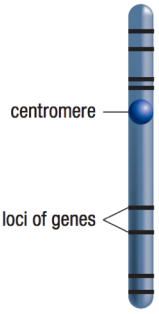
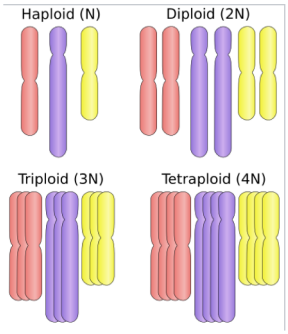
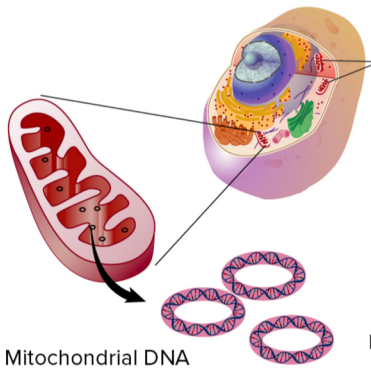


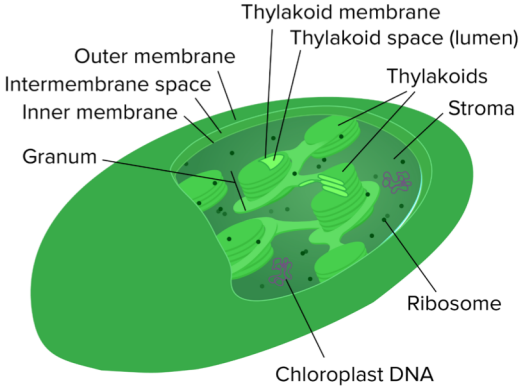
Figure 2 A typical human chromosome contains thousands of genes. Each gene is located at a different locus.

Chromosomes

- Found in the nucleus in eukaryotes
- Occur mostly in sets – haploid cells have half the normal number, diploid cells contain the normal number, while some cells contain 3 or more sets and are called polyploids
- 2-3% Pregnant woman & miscarriage
- 30 – 80% plants are polyploids, including 15% of angiosperm and 31% of fern
- Example: Apple (triploid, tetraploid), strawberry (Octaploid), potato (tetraploid)
- Mitochondria and chloroplast also contain small amounts of genetic material







Asexual Reproduction

- The production of offspring from a single parent by cell division (without the use of sex cells)
- Advantages:
  - Do not need to seek out a mate
  - Identical (invariable) offspring
- Disadvantages:
  - Invariable offspring means that if the environment changes, individuals may no longer be well adapted

Sexual Reproduction

- Offspring are produced from the fusion of two sex cells, usually coming from two different parent organisms
- Advantages:
  - Offspring are not identical to parents or to each other
  - Variability in offspring means that if the environment changes, some individuals may be better able to adapt and survive than their parents were
- Disadvantages:
  - Need to have different sexes (sex organs), mating calls or dances, etc…
  - Sex is biologically "costly" – attracting a mate can also attract predators (i.e brightly colored peacock)

Moose Antlers

4.2 Asexual Reproduction : Copies and Clones

Modes of Asexual Reproduction

- Strawberry plants can send out "runners"
- Hydra Jellyfish can produce offspring by outgrowths of their bodies, called "budding"

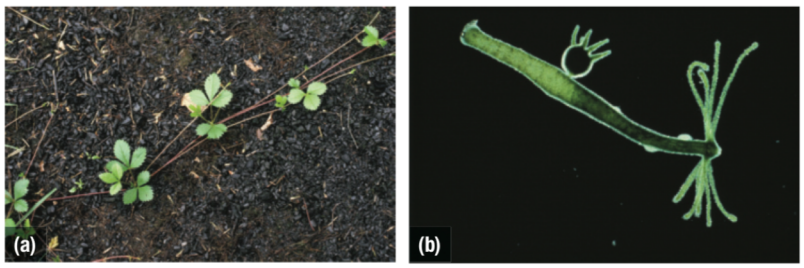


Figure 1 Many plants, (a) such as this strawberry, and animals, (b) such as the hydra, are capable of asexual reproduction, producing offspring from the direct outgrowth of their body.

Modes of Asexual Reproduction

- Female aphids producing only female offspring (without a male) in the spring
- Fungi can reproduce through fragmentation, when a piece breaks off and becomes independent

Figure 2 Female aphids can reproduce asexually, giving live birth to genetically identical female offspring.

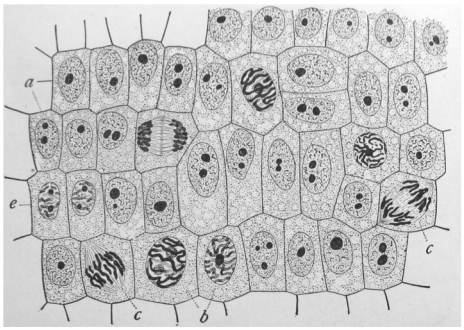
Complete **Table 1** by writing a short description of how each organism undergoes asexual reproduction. K/U

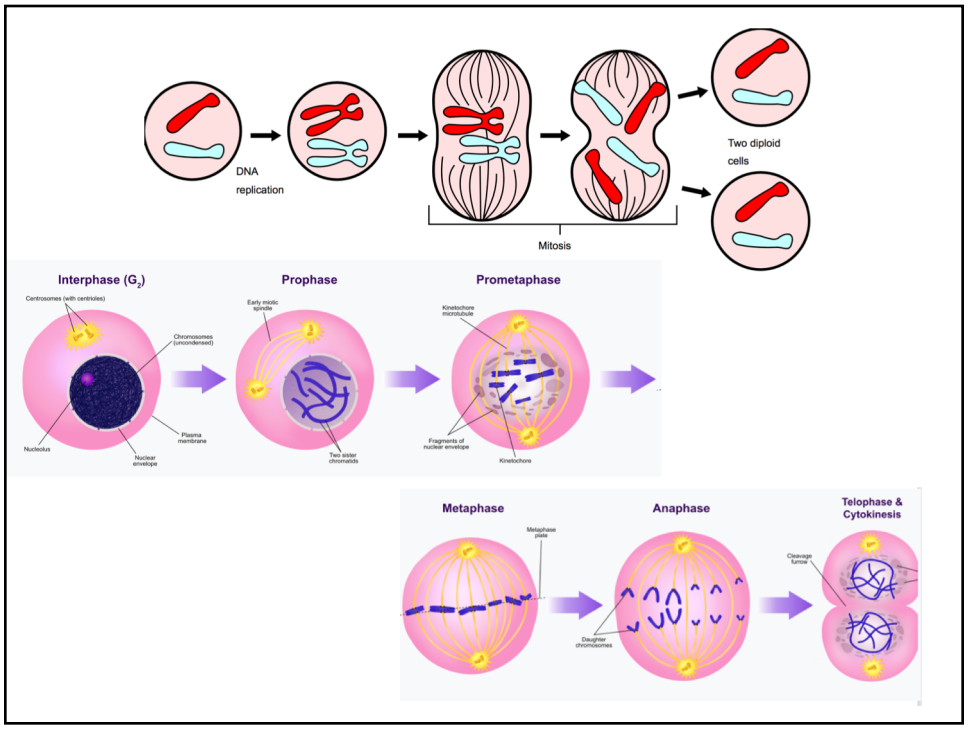
Table 1 Organisms that Undergo Asexual Reproduction

Type of organism	Mode of asexual reproduction
strawberry plants	(a)
hydrae	(b)
aphids	(c)
fungi	(d)

Cell Division

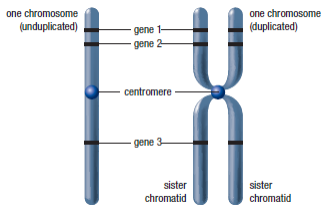
- Cells divide during mitosis (nuclear division) and cytokinesis (cytoplasmic division)
- Cell division produces two daughter cells that are genetically identical to each other and the parent cell

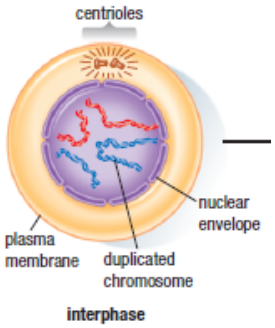




Interphase

- During interphase genetic material in the form of thread-like chromatin is duplicated
- This results in pairs of sister chromatids, attached at the centromere and containing exactly the same genes at the same loci (specific location of genes)

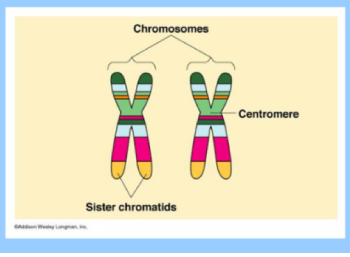




Chromosomes vs. Chromatin

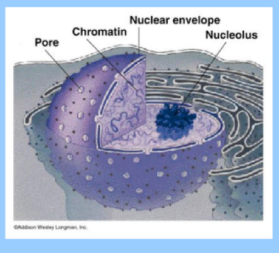
Chromosomes

- Tightly packaged DNA
- Found only during cell division
- DNA is not being used for macromolecule synthesis



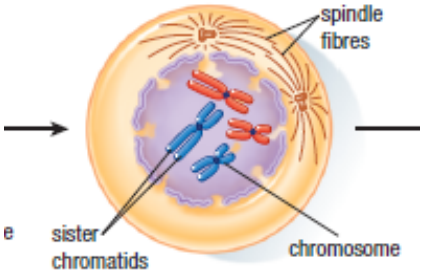
Chromatin

- Unwound DNA
- Found throughout Interphase
- DNA *is* being used for macromolecule synthesis



Cell Division - Prophase

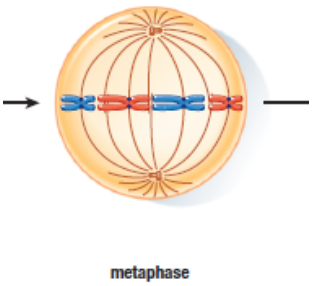
- During prophase the <u>chromatin shortens</u> and thicken and are visible under a microscope
- <u>Centrioles</u> (in animal cells) separate and move to opposite ends of the cell
- <u>Nuclear membrane</u> starts to dissolve
- Prophase is the <u>first</u> stage of cell division



prophase

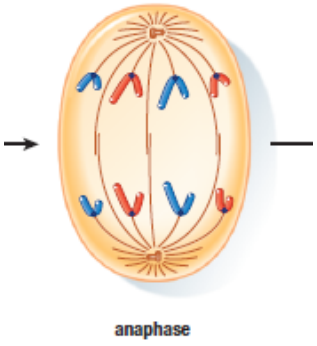
Cell Division - Metaphase

- Metaphase is the second stage of cell division
- Spindle fibers move and align chromosomes (each composed of sister chromatids) in the centre (equator) of the cell



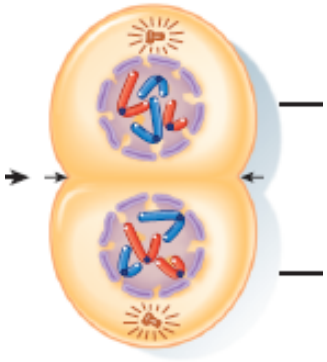
Cell Division - Anaphase

- This is the third phase of mitosis
- Centromeres divide
- Sister chromatids separate and move to opposite poles of the cell
- If mitosis proceeds correctly, the same number and type of chromosomes will be found at each pole of the cell



Cell Division - Telophase

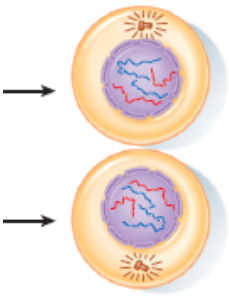
- This is the last stage of mitosis
- Chromosomes reach opposite poles of the cell and begin to unwind
- Spindle fibers dissolve
- Nuclear membrane forms
- Two daughter nuclei are now present



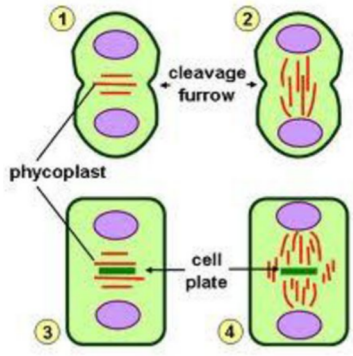
telophase

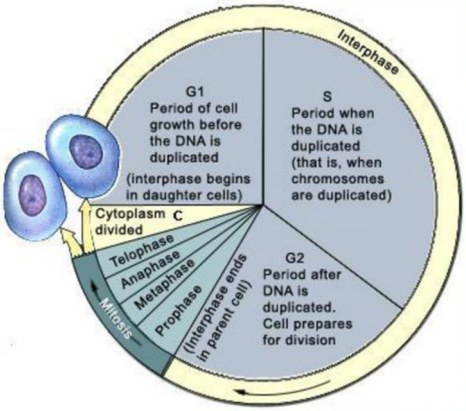
Cytokinesis

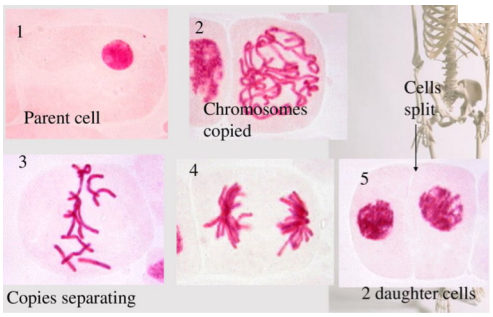
- Mitosis is immediately followed by cytokinesis, when the cell divides its cytoplasm and organelles, into two new daughter cells
- In many cells (protist, fungi and animal) a furrow develops, pinch off the cell into two parts
- In plant cells, a cell plate develops near equator; then become the cell wall



cytokinesis complete, cell enters interphase





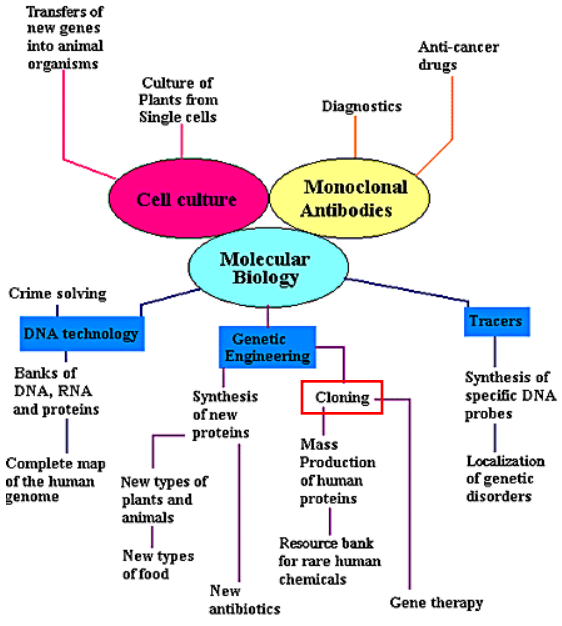


Crash course Video:

https://www.youtube.com/watch?v=L0k-enzoeOM

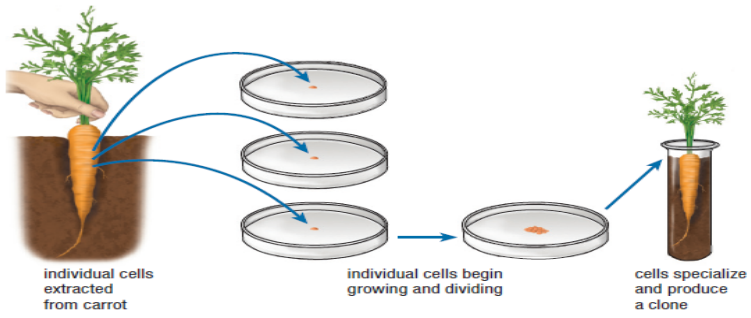
Biotechnology

- Biotechnology is the field of biology that involves the use of living things in engineering, industry and medicine
- Cloning: the process of producing one individual that is genetically identical to another, using a single cell or tissue, similar to mitosis



Plant Cloning

- In 1958, carrot plants were first cloned using single carrot cells
- Commonly used to produce strains of plants with identical characteristics
- Use in agriculture, plants with predictable traits can be cloned to produce larger crop yields.



Animal Cloning

- 1996, Dolly was the first mammal to be cloned from an <u>adult body cell.</u>
- The process involved <u>transferring an adult cell's nucleus into an enucleated egg cell</u> in place of the original nucleus

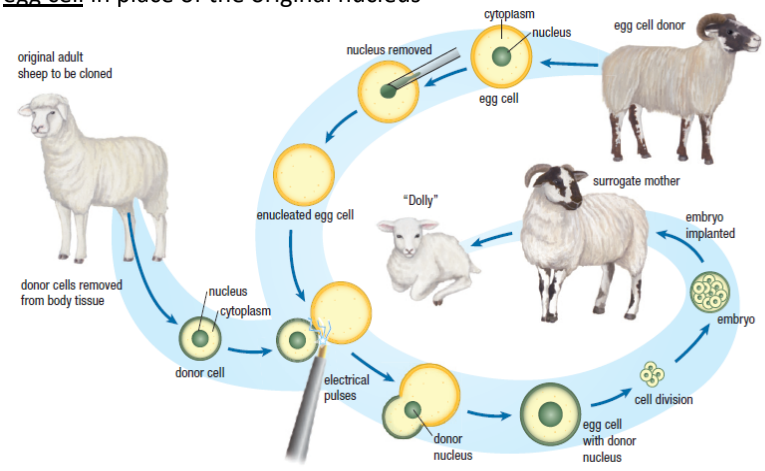


Figure 7 In 1996, Dolly was the first mammal to be cloned from an adult body cell. The process involved transferring an adult cell's nucleus into an egg cell in place of the original nucleus.

Applications and Implications of Cloning

- Agriculture and horticulture
- Mass production of livestock and crop plants
- Cloning genetically modified organisms
- Example: bacteria and yeast contain human genes that codes of insulin, use the genetic instructions to make human insulin, which is then purified and made commercial available to people suffering from diabetes.
- Cloning endangered species

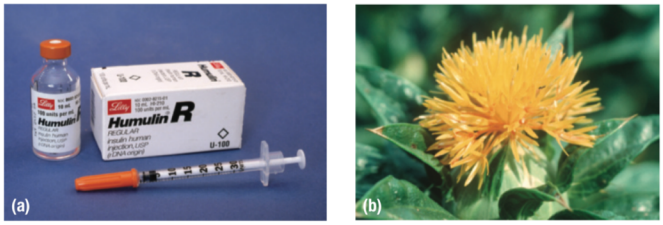


Figure 9 (a) Humulin is identical to human insulin and is produced by genetically engineered micro-organisms. (b) Now researchers have genetically engineered safflowers to produce the same substance. They hope this will reduce the cost of this very valuable drug.

Figure 11 In 2008, an American couple paid more than $150 000 to have their late pet dog Lancelot cloned. The puppy clone, named Lancelot Encore, was created by the South Korean biotechnology company, BioArts International.