Section Two: Cell Organization

. Multi cellular organisms can be categorized into several levels of organization

Level One Cell

. The basic unit of life

. Cells are specialized to perform particular functions

. Examples: nerve, epithelial, root hair and ciliated cells

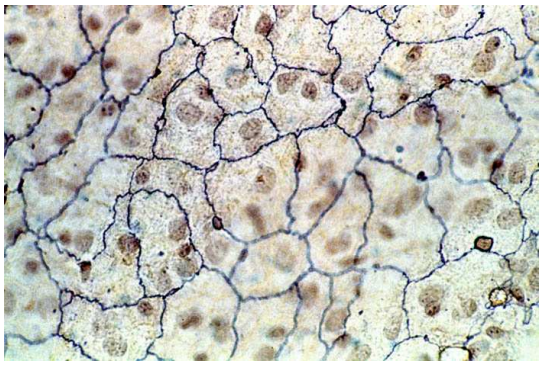
Level Two Tissues

. Groups of specialized cells performing a particular function

. 4 main tissues types in the body: nervous, connective, epithelial and muscle tissue

. Epithelial tissues form linings inside and outside the body and originate from a basement membrane

Epithelial tissues



Squamous

. Flat tessellated cells

. Form linings to organs

. Form capillary walls and line surfaces of blood vessels

Cuboidal

. Small, cuboidal cells

. Protive in function

. Found in scratched or abraded surfaces E.g. Skin

Ciliated

. Ciliated rectangular cells

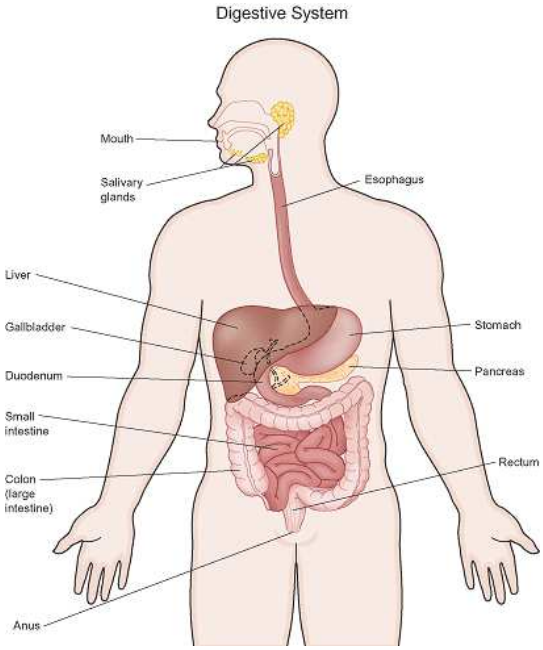
. Often have goblet cells which produce mucus

. Forms surface of tubes in the lungs and oviducts

Level Three Organs

. Groups of tissues grouped together

. E.g. Heart, leaf and Kidney



Level Four Organ System

. Several organs working together

. E.g. Respiratory system

Cell Division

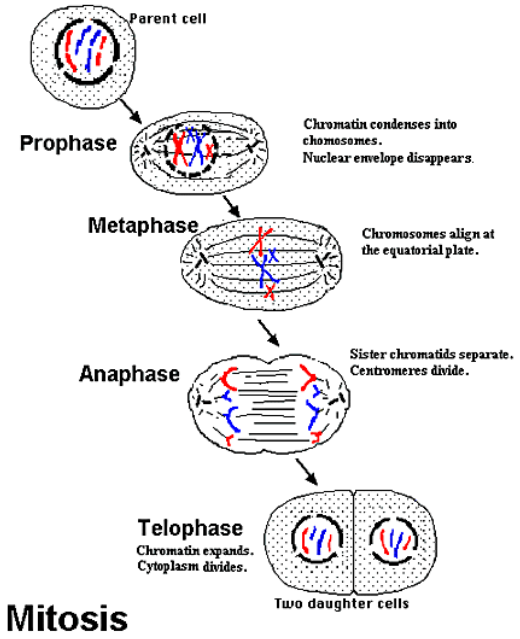
. There are two types of cell division

1. Mitosis

. Seen in somatic (body) cells, this produces genetically identical offspring

. Seen in asexual reproduction

. Produces diploid individuals



2. Meiosis

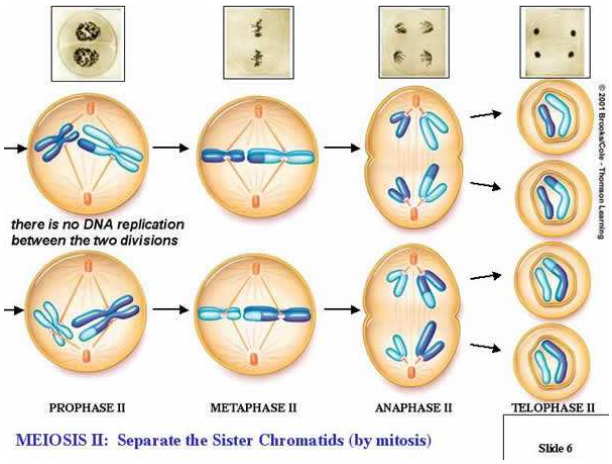
. Seen in gamete formation, this is a reduction division (chromosome number is halved to produce haploid gametes)

. Diploid

- Two identical sets of chromosomes in each wall, written as 2n, refers to chromosome number in the zygote

. Haploid

- Gametes will contain only one of each pair of chromosome (a single set), written as n



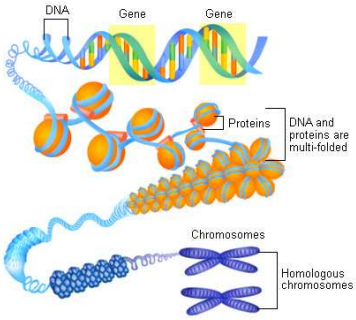
Chromosome structure

. Chromosomes in eukaryotic cells are made of:

(i) DNA (deoxyribonucleic acid)
(ii) Proteins
(iii) Small amounts of RNA

. Total length of DNA in the nucleus of a cell is about 2.2m long

. This enormous length must be coiled and folded to fit into the nucleus



. Chromosomes occur in pairs (homologous chromosomes) and during nuclear division they will condense into compact structure

. Each chromosome consists of a pair of chromatids joined at the mid point called the centromere, this connecting point is essential to chromosome separation during cell division

The protein component of a chromosome consists of:

Histone proteins

. Positively charged, occur in groups of 8 called an octamer

. Each octamer binds DNA to form a nucleosome, each nucleosome contains 146 base pairs

. Several nucleosomes form a nucleosome fibre

Scaffold proteins

. These are non histone proteins

. Each protein is formed from a nucleosome fibre which is coiled and looped around the non histone proteins

. The complex formed between the DNA and the histones is called chromatin

Polymerases

. Enzymes involved in:

(i) Transcription of genetic information during protein synthesis

(ii) DNA replication prior to the division of the chromosomes

. The transition from one phase to the next is controlled by chemicals called cyclins; these build up and attach to enzymes called cyclin dependant kinases (CDKs)

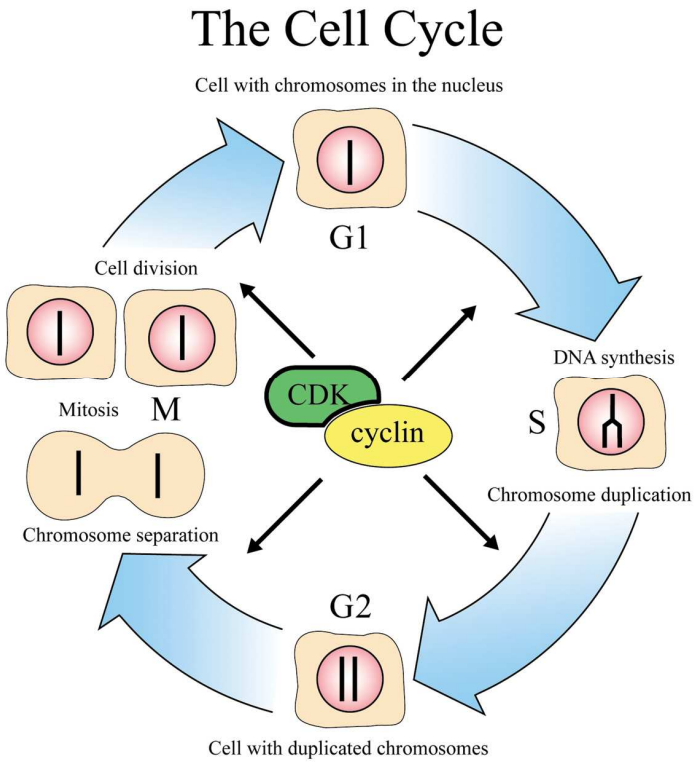
. A phosphate group is added (phosphorylation) to other proteins which change their shape and brings about the next stage in the cell cycle

The Cell Cycle

. A sequence of events involving several different phases during cell division

. The cycle is divided into 3 main stages:

(1) Interphase
(2) Mitosis
(3) Cytokinesis (division of cytoplasm)



1. Interphase

. Longest phase of the cycle

. Chromatin has a beaded appearance

. 3 distinct phases can be seen:

(a) G_1 Phase
(b) S Phase
(c) G_2 Phase

G_1 Phase

. A period of rapid growth

. New organelles are being synthesized

. Large amount of protein synthesis

. Metabolic rate of the cell s high

S Phase

. Synthesis of new DNA in the nucleus

. Histone proteins are built up

. Each chromosome becomes divided into two chromatids

G_2 Phase

. More cell growth takes place with organelle division

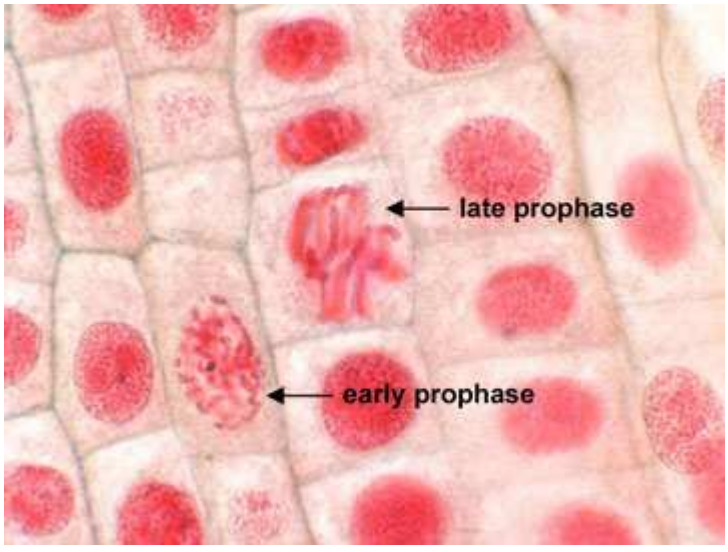
. Accumulation of energy stores

. Chromosomes begin process of condensation prior to cell division

2. Mitosis

. Nuclear division involving separation of sister chromatids and their distribution into the daughter nuclei

. 4 main stages: Prophase, Metaphase and Telophase



Prophase

. Chromosomes become shorter and thicker (condense)

. Nucleoli get smaller and disappear

. Centrioles migrate to opposite poles of the cell

. Microtubules radiate out from the centrioles (aster)

. Nuclear envelope now breaks up

. Spindle apparatus is formed between the two centrioles, composed of spindle fibres

Metaphase

. Chromosomes become attached to the spindle fibres on the spindle apparatus by their centromeres

. Chromosomes move up or down so they are aligned along the equator (metaphase plate) of the spindle apparatus

. Sister chromatids of each chromosome are now easily distinguished; each centromere is associated with one microtubule on the spindle apparatus

Anaphase

. Centromeres divide and spindle fibres shorten

. Centromeres are pulled to opposite poles

. This results in separation of the two chromatids

. Chromatids are now referred to as daughter chromosomes

Telophase

. Daughter chromosomes reach in the opposite poles of the cell

. Chromosomes begin to lengthen again and uncoil, losing their visibility

. Spindle apparatus breaks down

. Centrioles and nucleoli now re form

. Division of the nucleus is now completed

. The cell now undergoes Cytokinesis

Cytokinesis

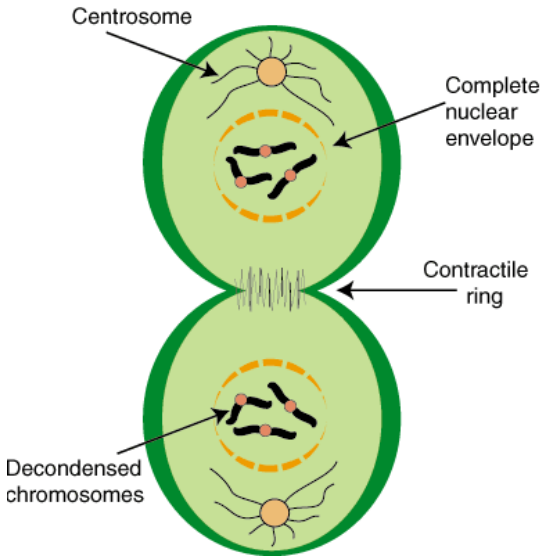
. Cell organelles such as mitochondria and ribosomes become evenly distributed around each nucleus

. An intucking of the cell surface membrane develops (furrow), this is termed cleavage

. Protein fibres in the cytoplasm called microfilaments are involved

. The furrow becomes deeper until eventually the two cells separate, each cell now enters Interphase again

. In plant cells, a cell plate is formed from fluid filled vesicles from the Golgi apparatus which produces two daughter cells



Asexual reproduction and natural cloning

. Involves only one parent individual

. Offspring produced are genetically identical to the parent (clones)

Advantages

. Large numbers rapidly produced

. No need for a mate

. Favorable genes can be passed on

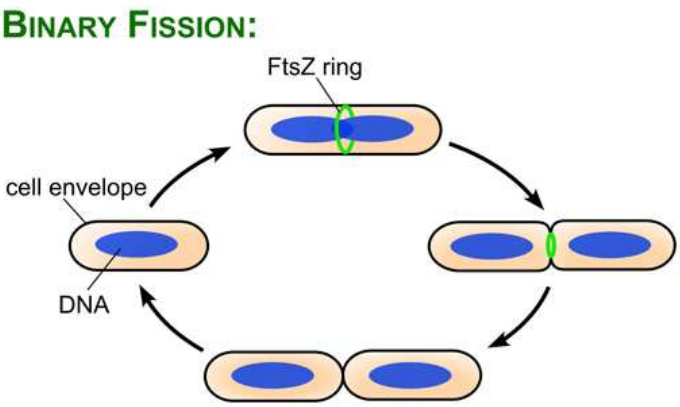
Disadvantages

. Offspring unable to adapt to a change in environment

Strategies

. Include binary fission, regeneration, spore production, budding and vegetative propagation

1. Binary Fission



. Seen in bacteria

. Involves mitosis followed by splitting of an individual

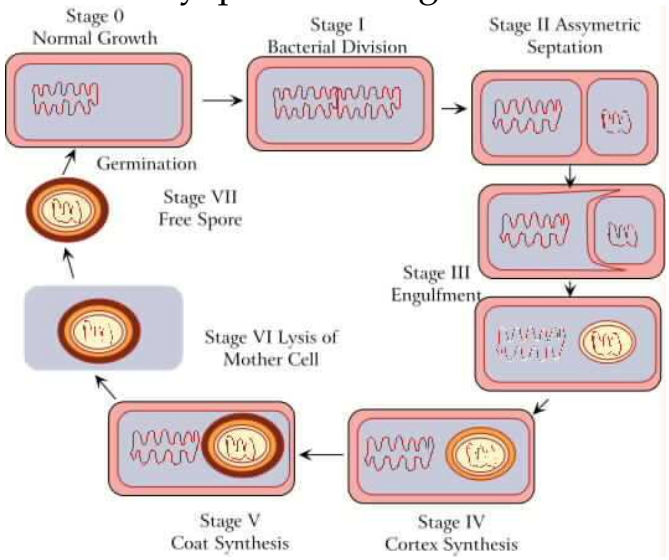
. Limited as a reproductive strategy

2. Sporulation

. Involves mitosis and the production of asexual spores

. Seen in fungi and plants such as mosses and ferns

. Spores can survive adverse weather conditions and easily spread over large areas



3. Budding

. An outgrowth from the parent organism produces a smaller but identical individual by mitotic cell division

. Seen in hydra and yeast cells

. The bud detaches from the parent and has an independent existence

4. Regeneration

. Also called fragmentation

. A dramatic form of asexual reproduction

. Organisms replace parts of the body which have been lost

. Seen in lizards and star fish

5. Vegetative Propagation

. A sophisticated version of reproductive budding, occurs in flowering plants

. Plants form new structures which develop into fully differentiated new plants

. The new plant is identical to the parent and eventually becomes independent

. Propagation involves only mitotic cell division and a new plant can be grown from the stem, leaf, bud or root of the parent, this is called cutting

vegetative propagation

. Vegetative propagation involves perennating organs, these contain stored food from photosynthesis, and they have two functions:

(a) Acts as a means of asexual reproduction
(b) Act as dormancy structures – allows survival in adverse weather conditions

Examples

- Runners in strawberries
- Stem and root tubers in potatoes
- Bulbs and corms in onions

Growth

. Definition: A permanent increase in the number of cells or mass or size of an organism

. Growth involves 3 individual distinct aspects:

- Cell division
- Assimilation
- Cell expansion

Cell division

. Mitosis is the basis of growth

. Cells enlarge before dividing again

Assimilation

. Resources need to produce new cellular material

. These come from photosynthesis in plants and nutrition in animals

Cell expansion

. The incorporation of a new cell material by assimilation into cells

. Produces a permanent increase in mass

. Measuring growth is difficult as the water content of a cell varies in time

. Dry mass is the best indicator of growth – gives an accurate picture of the amount of biological material present, main drawback is that specimens have to be killed to measure dry mass so no further growth can be measured

Growth patterns

. Growth curves show growth throughout the life of an organism, measured using linear dimensions

. Rapid mitosis begins at the start of life

. Down as organism grows and reaches maturity

. Mitosis continues until senescence (old age) but less frequently until death occurs

. There are two types of growth pattern:

(a) Continuous growth
(b) Discontinuous growth

Continuous growth

. Growth continues through out life, seen in plants and marine animals

Discontinuous growth

. Occurs in insects for example

. Grow in a process called ecdysis; growth occurs as a series of 'moults'

. Exoskeleton is shed; air is blown into the new exoskeleton when soft

. When hard, there is now space for new tissues and organs to produce an increase in size and mass

. Growth can also be measured using dry mass

. Largest amount of growth occurs during embryo development

. This produces differential growth – different parts of the organism grows at different rates

. In humans the nervous system in the head grows at the fastest rate.