Biology note for grade ten on unit two

UNIT TWO

HEREDITY

- The passing of traits (hair and skin color, nose shape) from parent to offspring is called heredity or inheritance.
- The study of heredity and variation in an organism is called genetics.

CHROMOSOMES, GENES AND DNA

Chromosomes

- Thread like structure in the nucleus of a cell consisting of a gene and it is one complete DNA molecule with its associated proteins.
- It come in pairs known as homologous pairs
- It widely varies in:
  - Appearance
  - Size
  - Staining properties
  - The location of centromere
  - The relative length of the two arms on either side of the centromere.
- The particular array of chromosomes that an individual possesses is called karyotype.
- Human karyotype shows 23 pairs of chromosomes, in 22 of the pairs, both chromosomes are the same size and shape regardless of whether you are a boy or a girl. These 22 pairs of chromosomes are known as the autosomes. They control almost everything about the way you look and the way your body works.
- The remaining pair of chromosomes is different for boys and girls.
  XY--------male
  XX---------female chromosomes
- In human X- chromosomes is larger than Y-chromosomes. This implies that X-chromosomes contains more genes than Y-chromosomes.
- X-chromosomes carry information about:
  - The way your blood clots
  - The formation of your teeth
  - Body hair and sweat glands
- Chromosomes are made up of a protein coat histone and DNA.

GENES

- Is a segment of DNA that controls the production of a protein

- ❖ Each gene is a small section of DNA
- ❖ They are also known as units of heredity.
- ❖ Responsible for determining specific characteristics of an organism.
- ❖ Located on a chromosome like beads on necklace
- ❖ A segment or part of a gene is called allele
- ❖ Alleles are the alternative forms of a gene
- ❖ The position that a gene occupies on a chromosome is known as loci.

DNA (Deoxyribonucleic acid)

What is DNA?

- ➢ DNA is a biological molecule which is constructed from smaller molecule known as nucleotides. Nucleotides is composed of :
  - Deoxyribose pentose sugar
  - Phosphate unit
  - Nitrogenous bases
    - ✓ Adenine(A)
    - ✓ Thymine (T)
    - ✓ Guanine (G)
    - ✓ Cytosine (C)
- ➢ DNA is a long molecule made up of two strands twisted together to make a spiral known as a double helix. The base link the two strands of the DNA molecule together

The human genome project (HGP) : it is a multinational research effort designed to identify and map the location of all human genes.

MITOSIS

- ❖ Is the process of cell division which results in the production of two daughter cells from a single parent. The daughter cells are identical to one another and to the original parent cell.
- ❖ The process have the following features
- ➢ Daughter cells and parent cells are equal number and identical type of chromosome
- ➢ Takes place during the division of somatic cells to produce other somatic cells
- ➢ It takes place during the life process
  - ✓ Growth
  - ✓ Replacement of worn out and damaged cells
  - ✓ Asexual reproduction in unicellular organisms
- ➢ Two daughter cells are produced from a single parent cells

- Diploid cells are produced

The process of mitosis occurs in 4 stages

1. Prophase
    - Nuclear membrane(envelope) begins to disappear
    - Nucleolus disappears
    - Chromatin begins to condense and become visible
    - Spindle fibers are formed between centrioles
2. Metaphase
    - The spindle fibers attach to the chromosome which line up along the cell's mid plane
    - The chromosome align at the equator
3. Anaphase
    - Chromatids separate at centromere and one group of chromosome move towards each pole
    - Sister chromatids separate at centromere and each chromosome move towards the opposite pole
4. Telophase
    - Chromosomes arrives at each pole
    - Chromosomes became long and thin losing ability to be seen clearly
    - Nucleolus reappears
      Cytokinesis

Cytokinesis is takes place and results in forming two daughter cells.

Cytokinesis is a division of cytoplasm.

The cell cycle

Is the entire sequence of events happening from the end of one nuclear division to the following three cycles.

A. Chromosomal cycle
    - DNA synthesis alternates with mitosis (karyokinesis or nuclear division) in it
    - DNA molecule replicate into two identical daughter DNA
    - The duplicated copies of the gene are ultimately separated
B. Cytoplasmic cycle
    - In the cell growth alternates with cytokinesis or cytoplasmic division

- During cell growth many other components of the cell (RNA, proteins and membranes) become double and the cell as a whole divided into two during cytokinesis
- Usually karyokinesis is following by the cytokinesis but sometimes the cytokinesis does not follow the karyokinesis and results into the multinuclear cell

C. Centrosome cycle
- It forms the third components of the cell cycle. In the reproduction of a new cell three steps are necessary. These are:

1. Replication (copies)
   - Results doubling of chromosomes
   - It is the first step
2. Nuclear division(karyokinesis)
   - To distribute hereditary materials for the new cells
   - It is the second step
3. Cytoplasmic division(cytokinesis)
   - It is the third step to produce new cells

MEIOSIS

- ❖ It is a division resulting in a reduction in chromosome number. Reductional division
- ❖ During meiosis the chromosome number of the parent cell is reduced by one-half
- ❖ It occurs in a reproductive organ namely:
  - ✓ Ovaries
  - ✓ Testes
  - ✓ Anthers
- ❖ It is concerned with the production of gametes(sex cells) during sexual reproduction
- ❖ It is a special form of cell division

FIRST AND SECOND MEIOTIC DIVISIONS

MEIOSIS I

- ➢ Pairing for each homologous chromosome. This is called synapsis
- ➢ Doubling of each homologous chromosome that forms a total of four chromatids called tetrads or bivalents
- ➢ Exchange of genetic material in a process called crossing over
- ➢ Separation of homologous chromosome, thus separation of maternal and paternal chromosome form each homologous pair

- Production of two haploid cells receiving half of the chromosome of the parental cells

PHASES OF MEIOSIS I

Prophase I: has shortening thickening and visible chromosome

Each chromosome consisting of two sister chromatids attached by centromere forming a tetrad or a bivalent for crossing over

Metaphase I: the tetras align themselves along the equator of the spindle on the homologous chromosome (the bivalent) do this together

- Crossing over occurs
- The centromeres of the two homologous chromosomes orientate towards opposite poles

Anaphase I: one pair of chromatids move towards the opposite poles of the cells

- The sister chromatids no longer remain in parallel alignment but diverge from one another

Telophase I: the divided haploid cell contains one of each pair of homologous chromosome (maternal or paternal) the new cells are not identical

- The cell starts to constricts across the middle

The separation of the homologous chromosomes has already been achieved by meiosis I.

- So the daughter cells go into prophase of meiosis II.

PHASES OF MEIOSIS II

Prophase II: chromosomes lie in two nuclei

- The nuclear membrane and nucleolus disappear and centrioles separate
- Centrioles have replicated and a new spindle is formed at right angles to the first one

Metaphase II: sister chromatids are arranged on the equatorial plane.

- The chromosomes arranged the selves on the spindle.

Ana phase II the sister chromatids separate and move to opposite poles.

- The chromatids become the chromosome of the daughter's cells. Telophase II four daughter cells are formed each containing nucleuses.
- The cell constricts across the middle.
- The spindle apparatus disappears.
- Chromosomes regain their thread like form.
- The cells go into the resting state phase inter.

B. Gametogenesis; it is the formation of gametes o sex cells in gonads (testes & ovaries) involving meiosis & differentiation.

[i]-Spermatogenesis

- It is the formation of male gamete or sperm cell I testes by meiosis &differentiation.
- It occurs in the somniferous tubules of the testes beginning from adolescence though out life.
- The epithelia of semniferous tubules undergo mitosis & meiosis; this is called spermatigonia that produce sperm.

[ii]-Oegenesis

- It is the formation of female gametes (egg cells) in the ovary by meiosis and differentiation.
- It occurs in the cells of germinal epithelium of the ovaries from the time of embryonic development of a female child menopause is attained.

2.2 MENDELIAN INHERITANCE

- Gregor Mendel (1822-1884)
  - Austrian monk and teacher
  - Studied the process of heredity in the selected features of the garden pea.
- He preferred to study garden pea because of the following reasons.

1- Peas are easy to cultivate
2- Peas have self pollinating flowers that can be easily controlled.
3- It has an easily recognizable character.
4- Peas have many contrasting varieties.

No have seven pairs of traits dominant x recessive of p1round

1. Seed shape smooth(RR) X wrinkled (rr) All smooth Rr
2. Height of pea Tall(TT)x short(tt) All tall(Tt)
3. Cotyledon color Yellow(YY) X green (yy) All yellow Yy
4. Seed coat color Yellow(yy) X green (yy) All grey yellow Yy
5. Pod shape Inflated (II) All inflated (Ii)
6. Pod color Green (GG) X yellow (gg) All green (Gg)
7. Flower position Axial (AA) X Terminal (aa) All Axial (Aa)

Example

Tall (TT) X short (tt)

Gametes = T.T X t.t

F1 generation = Tt then selfing

X	T	T
T	TT	Tt
t	Tt	Tt

TT,2Tt,tt

1:2:1 (genotype ratio)

3:1 (Phenotype ratio)

- Genotype- It is the hereditary make up of an organism.
- Phenotype: the outward appearance of an organism as a result of the action of genes.

Dominant & Recessive Trait

- Recessive: It refers to a gene or character that is masked when a dominant allele is present.
- Dominant: one gene may prevent the expression of an allele.
- Allele: one pair of a gene responsible for contrasting characters.

Test Cross

- ✓ One common genetic problem is that an organism which shows a dominant character can have two possible genotypes (homozygous dominant) or (heterozygous dominant). It is often necessary .however, to determine the genotype accurately; this may be achieved by crossing the organism of unknown genotype with one whose genotype is accurately known.

  Example 1

Let G=Allele for green Pod.

g=Allele for yellow Pod

Parent's phenotype → Green Pod x yellow Pod

Genotype → GG X, gg

Meiosis; meiosis

Gamete G g

F1 Genotype → Gg

Phenotype → green Pod

Parent phenotype Green pod X yellow pod

Genotype Gg X gg

Gamete meiosis meiosis

G g g

X	G	g
G	Gg	gg
g	Gg	gg

Phenotype =Green pod & yellow

Genotype =Gg & gg

=50% Gg & 50% gg

Ratio=1:1

- Punnet square :It is a kind of table or chart used to read the genotypic ratio of a given cross.

Mendelian genetic in people

a) D=dangly earlobes
d=Attached earlobes
Phenotype dangly attached
Genotype DD X dd
Gametes DD dd

All

X	D	D
D	Dd	Dd
D	Dd	Dd

All

Dd –Genotype
dangly –Phenotype
D

Dangly Attached

Dd X dd

Dd dd

X	D	d
d	Dd	dd
d	Dd	dd

Phenotype: 1:1

Dangly:attached

Dangly Dangly

Dd X Dd

Dd Dd

X	D	d
D	DD	Dd
d	Dd	dd

Phenotype: 3:1

Dangly: Attached

Example 2

If homozygous red cow is crossed with a homozygous white cow, the calves that result will all have roan coats, a mixture of red & white hairs.

R=red r=white

Red bull X white Cow

RR X rr

RR rr

R R genotype=Rr

r Rr Rr phenotype=roan

r Rr Rr

More about Human Inheritance

- Albinism is the lack of melanin pigment in the skin, hair & eyes. It is a problem mainly in areas where people having black skin live. This is because their skin is high level of melanin.
  - ✓ Melanin is a black pigmented substance in the skin that gives natural protection from the sun, people with paler skin have less melanin & more likely to suffer from skin damage by excessive radiation and sun.

- Albinism appears as a result of hidden recessive Alleles .It is characterized by;
  - Paler skin
  - Discolored hair

Aa X Aa parental genotype

Aa Aa possible gamete

	A	a
A	AA	Aa
a	Aa	aa

1AA:2Aa:laa genotype

3 normal I albino

Phenotype

Aa X aa

Aa aa

	A	A
a	Aa	Aa
a	Aa	Aa

I Aa=I aa genotype

I normal= I albino

AA X aa

AA aa

	A	A
a	Aa	Aa
a	Aa	Aa

All Aa=genotype

All normal

2.3 Heredity and Breeding

- Breeding is very important to produce a new variety with desirable traits such as:
  - ✓ High yield
  - ✓ Vigour &
  - ✓ Disease resistance

Benefits of breeding

- Getting plenty of milk or many eggs
- Producing animals that make lots of muscles to provide meat
- Ability of plants and animals to have drought and resistant capability

Selective breeding

A technique of breeding crop plants or animals with desirable trait or economically important traits with best possible traits