**BIOLOGY – GENETICS AND EVOLUTION SUMMARY – YEAR 10 SCIENCE**

**DEFINITIONS:**

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| Allele | A version of a gene eg: eye colour may have a brown allele and a blue allele |
| Haploid | Containing only half the normal number of chromosomes |
| Chromosome | Long, thread-like structures found in the nucleus , made up of genes |
| DNA | Deoxyribonucleic Acid – molecule that carries the genetic code or blueprint for making the organism  |
| Dominant | The gene which determines the outcome, represented by a capital letter, it is always expressed in the phenotype |
| Pedigree Chart | ‘Family Tree’ which shows genetic information about how characteristics have been passed on through generations |
| Gene | A portion of a chromosome that codes for a particular characteristic or trait |
| Diploid | Has the full amount of chromosomes |
| Heterozygous | Having two different alleles - one dominant and one recessive allele for a trait (‘mixed’) |
| Homozygous | Having both the same type of allele for a trait, ie: either both dominant, or both recessive |
| Inheritance/Heredity | The process of genetic transmission of characteristics from parent or ancestor to offspring.  |
| Genetics | The study of heredity, or how the characteristics of living things are transmitted from one generation to the next. The basic unit of heredity is the gene |
| Karyotype | A **karyotype** is a picture of the number and appearance of an individual’s chromosomes, and includes their length and banding pattern, usually displayed as pairs in descending order of size |
| Mutation | A change or abnormality in a gene or chromosome |
| Carrier | Another term for heterozygous or hybrid – has one dominant and one recessive allele for a characteristic |
| Punnett Square | Used to show the predicted outcomes of a genetic cross |
| Pure breeder | Homozygous genotype; has two of the same alleles for a characteristic |
| Recessive | The characteristic that is masked by a dominant allele; is only expressed if there is two recessive alleles |
| Sex-linked | The gene is carried on the X chromosome |
| Genotype | The letters that show what alleles an organism has, eg: BB or Bb or bb |
| Phenotype | The description of what the genotype means, eg: black hair, tongue roller, red flowers |
| Generation | Group of people born around the same time |
| XX | Female chromosomes |
| XY | Male chromosomes |
| Hybrid | Another word for heterozygous – has a dominant and a recessive allele |
| Gametes | Sex cells – sperm and eggs |

**DNA**

* DNA stands for Deoxyribonucleic Acid
* It makes up the genetic code of the organism; it contains the instructions needed to determine the characteristics of an organsim
* It is a very long molecule that looks a bit like a twisted ladder called a **double helix**
* Base A (adenine) always joins up with Base T (thymine)
* Base C (cytosine) always joins up with Base G (guanine)
* So, if one side of the ladder has a base sequence of CAACGGTTT, then the other side will be GTTGCCAAA

**SEX CELLS**

* Sex cells are sperm and eggs.
* Another name for sex cells is gametes
* At fertilization the male and female sex cells will provide ½ of the chromosomes each – so the offspring has genes from both parents
* The new cell formed when a sperm joins an egg will have 23 chromosomes from the mother and 23 chromosomes from the father, thus resulting in 46 chromosomes in total
* If the gametes did not carry half the normal number of chromosomes, the offspring would end up with double the right amount!

**MONOHYBRID CROSSES**

* Genes come in pairs
	+ One from the mother
	+ One from the father
* Both genes contain instructions for the same trait (ex. Hair colour)
* Possible codes for a particular gene
* One allele may code for brown hair
* The other may code for blonde hair
* The dominant allele is always expressed
* A monohybrid cross is a mating between 2 organisms involving only 1 gene.
* It allows predictions to be made about the possible genetic make up of the offspring
* A punnett square is usually used to display the predicted results of a monohybrid cross
* The original organisms that are crossed are the parents.

Example:

Fuzzy hair on dogs is dominant over straight hair. Calculate the expected genotypes and phenotypes of the offspring that could be produced when a heterozygous fuzzy dog breeds with a straight haired dog.



**SEX LINKED CROSSES**

* Humans have 23 pairs of chromosomes.
* One pair is responsible for determining the sex of the offspring.
* These chromosomes are called the sex chromosomes. There are two types - X and Y.

 **XX - Female**

 **XY - Male**

* Sperm cells can contain either a X or a Y chromosome, plus 22 others. Ova only contain X chromosomes, plus 22 others.
* All offspring get an X chromosome from their mother.
* It depends on which chromosome the father's sperm cell is carrying - X or Y - as to whether the baby is a boy or a girl.
* Certain characteristics in humans are linked to the sex chromosomes.

Sex linkage affects are seen mainly in males. The reason for this is that X and Y chromosomes are different sizes. There are a number of genes on the X chromosome that have no equivalent on the smaller Y chromosome, like colour vision and blood clotting.



**PEDIGREES**

* **Pedigrees** are a type of family tree containing genetic information
* They are used to determine the genotypes of individuals in a family and to better determine the probability of a child getting a trait.
* Multiple generations are considered in pedigrees.





Example: Trait: Falconi anaemia

* The **dominant** form isnormal bone marrow function - in other words, no anaemia.
* The **recessive** form is Falconi anaemia. Individuals affected show slow growth, heart defects, possible bone marrow failure and a high rate of leukemia.

A **typical pedigree** for a family that carries Falconi anemia.



**Ff**

**ff**

**Ff**

**Ff or FF**

**MUTATIONS:**

**Changes in the nucleotide sequence of DNA:**

* May occur in somatic (body) cells (aren’t passed to offspring)
* May occur in gametes (eggs & sperm) and can be passed to offspring

**Two ways in which DNA can be mutated:**

* Mutations can be inherited.
* Mutations can be acquired (Environmental damage or mistakes when DNA is copied)
* Mutations may occur by exposure to MUTAGENS, which are mutation-causing agents

Examples:

- Radiation such as X-rays, Gamma rays, UV light

- Chemicals such as benzene, asbestos

Chromosome mutations:

**May Involve:**

* + Changing the structure of a chromosome
	+ The loss or gain of part of a chromosome

**Four types exist:**

* + Deletion
	+ Inversion
	+ Duplication
	+ Translocation

Example: **Down Syndrome**

* + Chromosome 21 does not separate correctly.
	+ They have 47 chromosomes in stead of 46.

Gene Mutations:

**May Involve:**

* + Change in the nucleotide sequence of a gene
	+ May only involve a single nucleotide
	+ May be due to copying errors, chemicals, viruses, etc.

**Three types exist:**

* + Insertion
	+ Substitution
	+ Deletion

**EVOLUTION:**

* Evolution is the gradual development of different species from a common ancestor
* Natural Selection: Organisms that are best adapted to an environment *survive* and *reproduce* more than others
* Darwin’s Theory of Natural Selection occurs in four steps:
	+ Overproduction
	+ Variation
	+ Competition
	+ Selection
* Individuals with traits that are not well suited to their environment either die or leave few offspring.
* Evolution occurs when desired traits build up in a population over many generations and undesirable traits are eliminated by the death of the individuals.

**EVIDENCE FOR EVOLUTION –** key idea: evolution involves gradual changing of species (developing new species) over time from a common ancestor.

* Fossil Record - a record of the history of life on Earth; fossils of organisms that are a transition between extinct and current species show evidence of change in species over time
* Homologous Body Structures - similar anatomy in different types of animals because of common ancestor
* Vestigial Organs - “leftover” traces of structures that serve no purpose showing evidence of species changing over time.
* Embryology - embryos of all vertebrates are very similar early on suggesting a common ancestor
* Biochemical Evidence - DNA with more similar sequences suggests species are more closely related Eg: Humans and chimpanzees share more than 98% of identical DNA sequences. Closely related species suggest a common ancestor