Beckfoot

Subject: Biology

Topic: Genetic information, variation and relationships between organisms (1)

Year Group: 12

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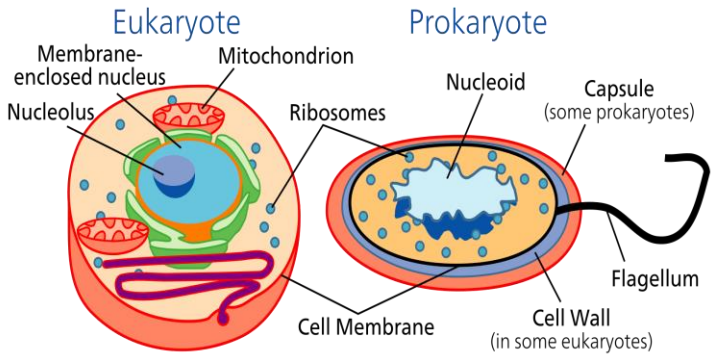
DNA, genes and chromosomes

	Feature	Prokaryotic cells	Eukaryotic cells
1	Size	Small (< 5 µm)	Larger (> 10 µm)
2	Uni/multicellular	Unicellular	Often multicellular
3	Organelles	No nucleus or membrane bound organelles	Nucleus & membrane bound organelles
4	DNA shape	Circular, without histones, free in cytoplasm	Linear associated with histones to form chromatin, in nucleus
5	Ribosomes	Small (70s)	Large (80s)
6	Cytoskeleton	No	Yes
7	Motility	Rigid rotating flagellum (flagellin)	Flexible waving cilia or flagellae (tubulin)
8	Cell division	Binary fission	Mitosis or meiosis
9	Reproduction	Asexual	Asexual or sexual
10	Metabolic pathways	Huge variety	Common pathways
11	DNA in other regions	NA	DNA present in chloroplasts & mitochondria resembling prokaryotic DNA

12	DNA is…	Definition
	a) Non overlapping	The genetic code is composed of nucleotide triplets. Three nucleotides in mRNA (a codon) specify one amino acid in a protein. Each base appears in only one triplet – each base is only read once.
	b) Degenerate	A genetic code in which a single amino acid may be coded for by more than one triplet code.
	c) Universal	The genetic code is the same in all living organisms – this is indirect evidence for evolution. All organisms use DNA to transcribe RNA, and translate that RNA into proteins. Every living organism uses that same system.



Investigating diversity (1)

1	Genetic diversity	The greater the number of different alleles that all members of a species possess, the greater the genetic diversity of that species.
2	Allele frequency	The number of times an allele occurs within the gene pool in a population, relative to all others at same locus
4	Gene pool	All the different alleles of all the genes of all the individuals in a population at any one time
4	Comparing genetic diversity	Within or between species; a) Frequency of measurable/observable characteristics b) Base sequence of DNA c) Base sequence of mRNA d) Amino acid sequence of proteins
5	Gene technology	Has caused a shift in methods of investigating genetic diversity from solely looking at observable features
6	Variation	Is caused by genetics (inherited) and environmental factors. Can be investigated quantitatively within a species by random sampling.

Key Vocabulary

1	Prokaryotic cell	Unicellular organisms that lack organelles or other internal membrane-bound structures. They do not have a nucleus, however generally have a single chromosome; a piece of circular, double stranded DNA.
2	Eukaryotic cell	Cells that contain a nucleus and organelles, and are enclosed by a plasma membrane. Eg: protozoa, fungi, plants and animals.
3	Genome	Full set of DNA found in organisms
4	Proteasome	Full range of proteins that can be synthesised from the genome
5	Gene	Short section of DNA that codes for amino acids, hence polypeptides and functional RNA
6	Chromosome	Thread like structures that consist of a DNA molecule tightly coiled around its associated proteins (histones)
7	DNA	Deoxyribonucleic acids
8	Histones	A protein that provides structural support to a chromosome. DNA wraps around histones in eukaryotic cells to form nucleosomes. This gives a compact shape
9	Chromatid	Each of the two thread-like strands into which a chromosome divides that are joined together by a single centromere prior to cell division
10	Allele	Alternative forms of a particular gene with different base sequences, and therefore different codes
11	Triplet	Three consecutive nucleotide bases which code for one amino acids
12	Locus	Location of a specific gene on a chromosome
13	Codon	A sequence of three DNA bases that codes for a specific amino acid
14	Nucleosome	A structural unit of a eukaryotic chromosome, consisting of a length of DNA coiled around a core of histones (approx. 8)
15	Chromatin	A complex of DNA and protein found in eukaryotic cells. Its primary function is packaging long DNA molecules into more compact, denser structures

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Topic: Genetic information, variation and relationships between organisms (2)

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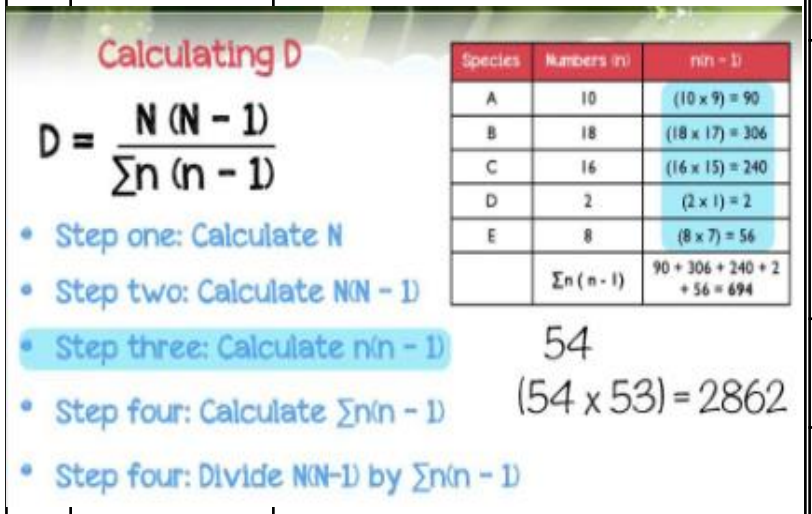
Biodiversity (see key vocab)

1	Simpson's index of diversity formula	A formula is used to quantify the biodiversity of a habitat. It takes into account the number of species present as well as the abundance of each species.



2	Reducing biodiversity	Farming techniques reduce biodiversity with methods such as; monoculture, use of herbicides & pesticides, hedgerow removal & woodland clearance
3	Conserving biodiversity	Conservationists protect biodiversity with methods such as; giving endangered species legal protection, creating protected areas & the environmental stewardship scheme. A balance between conservation & agriculture is needed
10	Quadrat	A frame, traditionally square, used in ecology to isolate a standard unit of area for study of the distribution of an item over a large area.

Investigating diversity (2)

SAMPLING METHODS (3 types)

1	Random sampling	Sampling a population to eliminate bias. Each member of the population is equally likely to be included. Random sampling with quadrats is used to examine differences between contrasting habitats within an habitat.
2	Quadrat technique	In each habitat, mark out a 10m x 10m square on the ground by laying one tape measure 10m lengthways and a second tape measure 10m at right angles to the first. Use a random number table or random number generator to select numbers from 1-10. Use pairs of numbers as x and y co-ordinates. Use the metre interval markings on each tape measure to locate the lower left hand corner of a frame quadrat.Take at least 10 quadrat samples in each area.
3	Stratified sampling	A proportionate number of observations is taken from each part of the population. Divide a habitat into zones which appear different and take samples from each zone.
4	Systematic sampling	Used where the study area includes an environmental gradient. A line transect is used to sample systematically along the environmental gradient. Eg: every 10 meters along a line running from seashore inland across a sand dune 
5	Sampling bias	When a sample is collected in such a way that some members of the intended population are more or less likely to be included than others. The data you collect may therefore not be accurate or represent the group.
6	Sample size	The number of observations in a sample.
7	Mean	A type of average where you add up all of the numbers then divide by how many numbers there are.
8	Median	A type of average where you place the numbers you are given in value order and find the middle number.
9	Mode	Type of average , the number that occurs the most often.

Key vocabulary

1	Biodiversity	The variety of organisms in an area, considered on a local or global scale
2	Species	A group of individual organisms with similar morphological, physiological and behavioural characteristics, whose members are able to interbreed to produce viable offspring
3	Habitat	The range of habitats in which different species live. Each habitat will be occupied by a range of organisms
4	Ecosystem	A community of living organisms in conjunction with the nonliving components of their environment, interacting as a system. These biotic and abiotic components are linked together through nutrient cycles and energy flows
5	Biodiversity	The range and variety of genes, species and habitats within a particular region. Made up of three components: genetic diversity, species diversity and ecosystem diversity.
6	Species diversity	Number of different species and number of individuals of each species within any one community
7	Species richness	The number of different species represented in an ecological community. It does not take account the abundances of species or their relative abundance distributions.
8	Variation	Differences between individuals. It can be interspecific (between different species) or intraspecific variation (between individuals of the same species). It is important for evolution.
9	Directional selection	Favours one extreme of the range of characteristics and the other extreme is selected against – shift in population curve
10	Stabilising selection	Favours the mean of the distribution because the extremes are at a selective disadvantage – frequency of mean phenotype increases
11	Polygenes	Group of genes that are responsible for controlling a characteristic.
12	Normal distribution curve	A bell-shaped curve produced when a certain distribution is plotted on a graph
13	Ecosystem diversity	Range of different habitats within a particular area

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Subject: Biology

Topic: Genetic information, variation and relationships between organisms (3)

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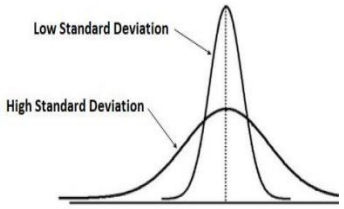
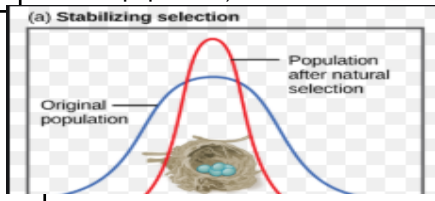
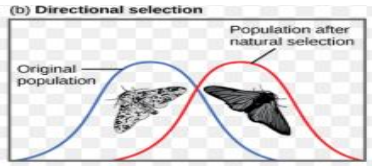
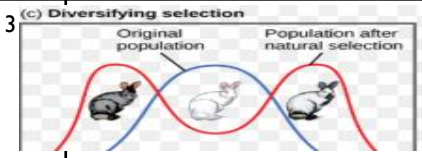
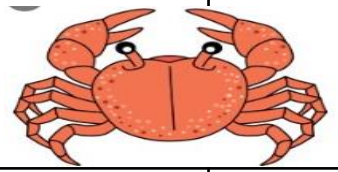
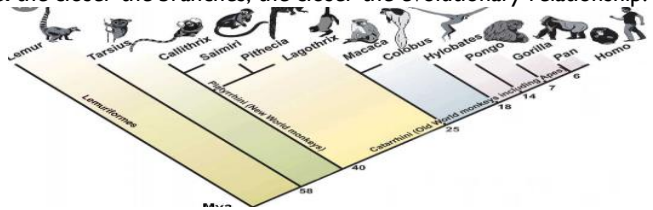
Standard deviation

1	A measure of how spread out about the mean your values are. The more spread out the data the higher it will be.	
2	Calculation	YOU DO NOT NEED TO KNOW THIS however must be able to use it $\sigma = \sqrt{\frac{\sum(X-\mu)^2}{n}}$ where, σ = population standard deviation $\sum$ = sum of... μ = population mean n = number of scores in sample.
3	**Low standard deviation-** indicates the data points are very close to the mean **High standard deviation-** indicates the data is spread out over a large range of values (this indicates a large amount of variation within a population)	
1		Robins typically lay four eggs, an example of stabilizing selection. Larger clutches may result in malnourished chicks, while smaller clutches may result in no viable offspring. Type of natural selection where population mean stabilizes on a non-extreme trait value
2		Light-colored peppered moths are better camouflaged against a pristine environment; likewise, dark-colored peppered moths are better camouflaged against a sooty environment. Thus, as the Industrial Revolution progressed in nineteenth-century England, the color of the moth population shifted from light to dark, an example of directional selection. The most common varieties of an organism are selected against
3		In a hyphothetical population, gray and Himalayan (gray and white) rabbits are better able to blend with a rocky environment than white rabbits, resulting in diversifying selection. Favours the survival of individuals at 2 different points within the range of variation, results in 2 different phenotypes

Classification & Courtship

1	The biological species concept	A species contains all organisms that are capable of breeding together to produce living, fertile offspring
2	Classification	The process of sorting living things into groups. It is a hierarchy of taxa; Domain, Kingdom, Phylum Class, Order Family Genus Species  Classifications are constantly been updated as new methods are discovered to infer relationships eg: DNA sequencing, amino acid sequencing or immunological comparisons Classifications are based on anatomical, physiological and behavioural characteristics
3	Binomial naming	A system which names species by their genus and species name. Rules for naming: The entire two-part name must be written in italics (or underlined when handwritten). The genus name is always written first. The genus name must be capitalized. Eg:  Common Name: Pebble Crab Genus: Xanthias Species: lamarckii Scientific Name: Xanthias lamarckii
4	Phylogeny	The study of evolutionary relationships between organisms. In a phylogenetic diagram branch tips represent species at the end of their specific lineage, branching points represent common ancestors & the closer the branches, the closer the evolutionary relationship. 

Key Vocabulary

1	Binomial naming system	Linnaeus' system to name species. 1st: Generic name (genus). 2nd: Specific name (species) E.g. Felix tigris
2	Hierarchy	Groups within larger groups; with no overlap between groups at each rank
3	Artificial classification	Process of classifying organisms based on differences useful at time e.g. colour, size, number of legs
4	Phylogenetic Classification	Process of classifying organisms based upon evolutionary relationships between organisms and ancestors
5	Analogous Characteristics	Characteristics with the same function not the same evolutionary origins. e.g. wings of butterflies and birds used for flight but originated in different ways.
6	Homologous Characteristics	Characteristics with similar evolutionary origins regardless of their functions in the adult of a species e.g. wing of a bird, arm of a human and front leg of a horse
7	Taxon	Each group within a phylogenetic biological classification (pl. taxa)
8	Courtship behaviour	A specialised behaviour that precedes the fertilisation of eggs by a male to ensure successful reproduction.
9	Classification	Organisation of living organisms into groups
10	Taxonomy	The practice of biological classification
11	Domain	Largest taxon either bacteria, archaea and eukarya
12	Kingdom	Second largest taxon of classification. Eukarya domain divides into Protoctista, Fungi, Plantae and Animalia.

Genetic diversity

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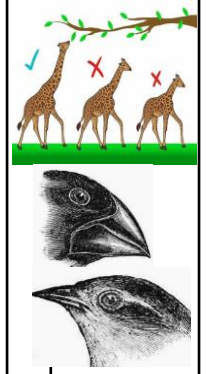
NATURAL SELECTION

1 Darwin's theory to explain the mechanism of evolution. The process by which organisms better adapted to their environment survive and reproduce and pass on their advantageous alleles to the their offspring, whilst those less well adapted fail to do so.

2 Random mutation



During natural selection, random mutation can result in new alleles of a gene, many are harmful, however some are beneficial and can lead to increased reproductive success. The advantageous allele is inherited by the next generation & increases in the population.

3 Stages of natural selection

A **Variation**
Differences between individuals within a species. This can be caused by inherited or environmental factors

B **Competition**
Individuals compete for food, shelter , mates etc

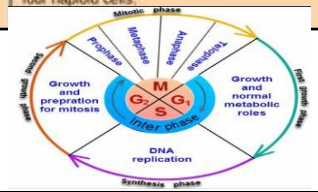
C **Survival of the fittest**
Those with advantageous alleles are more able to compete & survive

D **Reproduction**
Individuals that survive, produce offspring and pass on the advantageous allele/s to the next generation

Meiosis 1+11

	Stage	Event	Outcome
1	S phase	Nuclear envelope; Centrosomes (with centriole pairs); Chromatin	Chromosomes are duplicated during interphase. The resulting sister chromatids are held together at the centromere. The centrosomes are also duplicated.
2	Prophase I	Sister chromatids; Spindle; Chiasmata; Tetrad	Chromosomes condense, and the nuclear envelope fragments. Homologous chromosomes bind firmly together along their length, forming a tetrad. Chiasmata form between non sister chromatids. Crossing over occurs at the chiasmata. Spindle fibers emerge from the centrosomes.
3	Prometaphase I	Centromere (with kinetochore)	Homologous chromosomes are attached to spindle microtubules at the fused kinetochore shared by the sister chromatids. Chromosomes continue to condense, and the nuclear envelope completely disappears.
4	Metaphase I	Microtubule attached to kinetochore; Metaphase plate	Homologous chromosomes randomly assemble at the metaphase plate, where they have been maneuvered into place by the microtubules.
5	Anaphase I	Sister chromatids remain attached.; Homologous chromosomes separate.	Spindle microtubules pull the homologous chromosomes apart. The sister chromatids are still attached at the centromere.
6	Telophase I and Cytokinesis	Cleavage furrow	Sister chromatids arrive at the poles of the cell and begin to decondense. A nuclear envelope forms around each nucleus, and the cytoplasm is divided by a cleavage furrow. The result is two haploid cells. Each cell contains one duplicated copy of each homologous chromosome pair.
7	Prophase II		Sister chromatids condense. A new spindle begins to form. The nuclear envelope starts to fragment.
8	Prometaphase II		The nuclear envelope disappears, and the spindle fibers engage the individual kinetochores on the sister chromatids.
9	Metaphase II		Sister chromatids line up at the metaphase plate.
10	Anaphase II	Sister chromatids separate.	Sister chromatids are pulled apart by the shortening of the kinetochore microtubules. Non kinetochore microtubules lengthen the cell.
11	Telophase II and Cytokinesis	Haploid daughter cells	Chromosomes arrive at the poles of the cell and decondense. Nuclear envelopes surround the four nuclei. Cleavage furrows divide the two cells into four haploid cells.

12 The cell cycle comprises three key stages:
interphase (G1, S , G2),
nuclear division (mitosis or meiosis)
Cytokinesis



Meiosis

1	Type of nuclear division where chromosome number is halved
2	**Homologous chromosomes** Pair of chromosomes, 1 maternal & 1 paternal, that have the same gene loci & determine the same features. Not necessarily identical as may have different alleles. Capable of pairing during meiosis.
3	**Crossing over** The process whereby a chromatid breaks during meiosis and rejoins to the chromatid of its homologous chromosome so that their alleles are exchanged
4	**Chiasmata** A point at which paired chromosomes remain in contact during the first metaphase of meiosis and at which crossing over and exchange of genetic material occur between the strands.
5	**Recombination** Rrearrangement of genetic material, especially by crossing over in chromosomes
6	Random fertilization Combining of gametes (increases genetic diversity)

Key Vocabulary

1	Genetic diversity	The total number of genetic characteristics in the genetic makeup of a species. It is distinguished from genetic variability, which describes the tendency of genetic characteristics to vary. Genetic diversity serves a way for populations to adapt to changing environments (natural selection)
2	Gene mutation	A change to one or more nucleotide bases in DNA that could result in a change in genotype which may be inherited
3	Mutagen (Mutagenic agent)	A material or other factor which increases the normal mutation rate eg high energy radiation, chemicals
4	Chromosome mutation	A change that occurs in a chromosome. These changes are most often brought on by problems that occur during meiosis and can result in changes in the number of chromosomes in a cell or changes in the structure of a chromosome.
5	Polyploidy	The process of the genome doubling that gives rise to organisms with multiple sets of chromosomes.
6	Non-disjunction	The failure of one or more pairs of homologous chromosomes or sister chromatids to separate normally during nuclear division, usually resulting in an abnormal distribution of chromosomes in the daughter nuclei.
7	Mutation	Alteration in the nucleotide sequence of the genome of an organism, virus, or extrachromosomal DNA
8	Biotic factor	A factor created by a living thing or any living component within an environment in which the action of the organism affects the life of another organism. Eg: predator consuming prey
9	Abiotic factor	Non-living chemical & physical parts of the environment that affect living organisms and the functioning of ecosystems. Eg: weather
10	Independent segregation	During the formation of gametes, each gamete receives just one gene copy, which is selected randomly. Each pair of alleles segregates independently of the other pairs and all possible combinations of alleles can occur in the resulting gametes.
11	Independent assortment	The alleles of two (or more) different genes get sorted into gametes independently of one another. The allele a gamete receives for one gene does not influence the allele received for another gene. This is because homologous chromosomes line up in random orientations at the middle of the cell at metaphase as they prepare to separate, meaning that the same parent cell can produce different combinations of chromosomes in the daughter cells
12	Diploid	Cell or nucleus containing pairs of homologous chromosomes (two sets of chromosomes)
13	Haploid	Cell or nucleus containing single, unpaired chromosomes (a single copy of each chromosome)
14	Gamete	Reproductive (sex) cell that fuses with another gamete during fertilisation

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Protein synthesis (Transcription & Translation)

1	Protein synthesis- The process by which the genetic code codes for proteins in the cell. The template strand of DNA codes for mRNA in transcription, which is then translated into an amino acid sequence at the ribosomes. It is made up of 2 key parts: Transcription and translation

TRANSCRIPTION

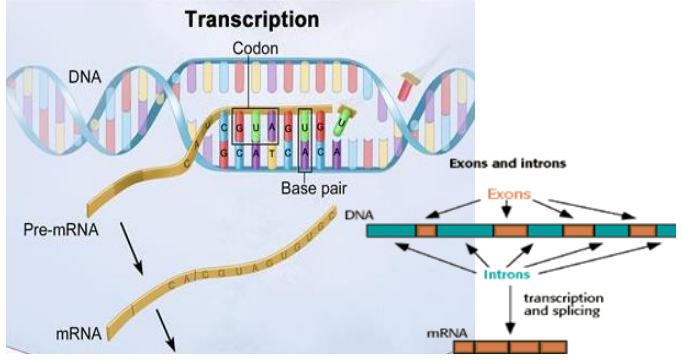
1	Formation of messenger RNA (mRNA) molecules from the DNA that makes up a particular gene. It is the first stage of protein synthesis.

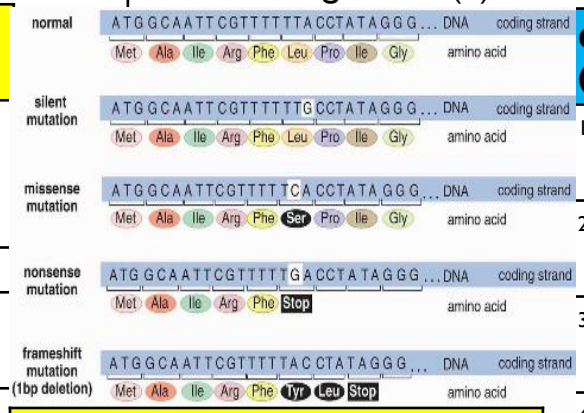
STAGES

2	DNA helicase (enzyme) breaks the hydrogen bonds between the DNA helix (double strands)
3	Free RNA nucleotide bases pair with the exposed DNA bases (template strand)
4	RNA polymerase (enzyme) forms covalent bonds between each nucleotide
5	mRNA strand is formed and breaks away from the DNA- this migrates out of the nucleus via nuclear pores whilst the DNA re-zips (reforms) itself back into a double stranded molecule

SPLICING

6	The process by which base sequences corresponding to the introns are removed and the functional exons are joined together. In prokaryotes this stage does not occur as transcription results directly in production of mRNA from DNA. In eukaryotes this stage does occur as pre-MRNA is produced from DNA, which needs to be spliced to mRNA.





Protein synthesis (Transcription & Translation)

TRANSLATION

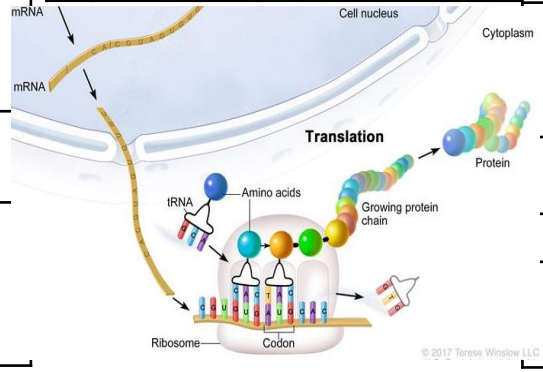
7	The latter part of protein synthesis when the mRNA is used as template to which complementary tRNA molecules attach and the amino acids link to form a polypeptide.

STAGES

8	mRNA attaches to ribosomes on the rough endoplasmic reticulum
9	Transfer RNA (tRNA) carries corresponding amino acids to each codon on the mRNA
10	The anti codon is a triplet of bases that form part of a tRNA molecule so the correct amino acid attaches to the polypeptide chain (process requires ATP)
11	Amino acid is transported by tRNA and attaches to ribosome
12	Amino acids join together by peptide bonds The process repeats until a stop codon is reached & the peptide folds into a tertiary structure

Causes of genetic variation (mutation)

1	Variation can arise due to mutation. Mutagenic agents can increase the rate of this.	
2	Substitution mutation	If a nucleotide is changed (substituted) in the DNA sequence
3	Nonsense mutation	If the base change results in the formation of a stop codon
4	Mis-sense mutation	The base change results in a code for a different amino acid completely
5	Silent mutation	The base change still codes for the same amino acid as before (as code is degenerate)
6	Deletion mutation	A nucleotide is lost from the DNA sequence, resulting in a 'frame shift' in translation
7	Variation in meiosis	Meiosis is also a cause of variation as it produces 4 daughter cells that are genetically different from each other. Independent segregation & assortment contribute to this variation (see key vocab)



Key Vocabulary

1	Chromatid	Thread-like strands, two of which are joined by a centromere to make up a chromosome
2	Autosome	A chromosome which is not a sex chromosome
3	Intron	Portions of DNA within a gene that do not code for a polypeptide. They are removed from pre-messenger RNA after transcription, in splicing
4	Exon	Portions of DNA within a gene that codes for proteins, joined together during splicing
5	Codon	A sequence of three adjacent nucleotides in mRNA that codes for one amino acid
6	Triplet	A sequence of three bases in DNA.
7	Nucleotides	Complex chemicals made up of one organic base, sugar & phosphate. Basic units of which the nucleic acids DNA and RNA are made
8	mRNA	Type of RNA that is a long strand arranged in a single helix and its base sequence is determined by the sequence of bases on a length of DNA
9	Template strand	Strand of DNA which is used during transcription to make mRNA. It runs in a 3' to 5' direction so mRNA is built in a 5' to 3' way
10	RNA polymerase	Enzyme that joins together nucleotides to form messenger RNA during transcription
11	tRNA	Type of RNA that has an anticodon which is complementary to a section (codon) of mRNA. Each molecule is specific to one amino acid.
12	Anti-codon	A sequence of 3 adjacent nucleotides on a molecule of transfer RNA that is complementary to a particular codon on a messenger RNA molecule
13	Ribosome	An organelle consisting of rRNA and proteins found in large numbers in the cytoplasm and on the RER of living cells. They bind to mRNA and use tRNA to synthesise polypeptides.
14	Polypeptide	A polymer consisting of a large chain of amino acids bonded together by peptide bonds.
15	Community	Organisms of all species that live in the same area
16	Population	A group of organisms of the same species occupying a particular space at a particular time that can potentially interbreed.