Topic 4 – Genetic information, variation and relationships

Key words

Universal – All life on earth uses nucleotides, and the same codons code for the same amino acids
Non-overlapping – each three nucleotides can only code for one amino acid
Degenerate – there are multiple triplets of DNA bases for each amino acid
Genome - the complete set of genes in a cell
Proteome – the full range of protein that a cell can produce
Locus – a place on a chromosome
Gene mutation – changes in the base sequence of chromosomes
Genetic diversity – the number of different alleles of genes in a population.
Hierarchy – smaller groups are placed within larger groups with no overlap between groups
Taxa – a group of organisms with in a hierarchy (for example phylum).
Biodiversity – the rage of habitats, from a small local habitat to the Earth.

1) **Prokaryotes** have DNA that is short and circular and no associate proteins (histones)
2) **Eukaryotic** cells have DNA that is long and linear with associated proteins (histones).
    a. Lots of the DNA does not code for polypeptide, there are lots of non-coding regions
    b. Within genes there are regions that code for amino acids called exons and non-coding regions called introns
    c. Introns are spliced out after transcription.
3) The **DNA** and **histone** together form a **chromosome**.
4) **Mitochondria** and **chloroplasts** contain DNA that is like the DNA in **prokaryotes** – it is shore circular and has no associated proteins.
5) A **gene** is a section of DNA that codes for amino acids that make up a protein or DNA
6) A **gene** can also code for RNA in ribosomes and tRNA.
7) 3 DNA bases called a **triplet** codes for one amino acid
8) **mRNA** is short, single stranded with no hydrogen bonds and contains uracil not thymine
9) **tRNA** has an amino acid binding side, an anticodon and contains uracil not thymine. Hydrogen bonds between bases make the tRNA fold into a clover- leaf structure.
10) **Transcription** is when DNA is as a template to produce mRNA
    a. In eukaryotes DNA is translated to pre-mRNA then introns are spliced out to form mRNA
    b. In prokaryotes DNA is translated straight to mRNA
11) During **transcription**
    a. RNA polymerase binds to a promoter region – which is a region just before the gene

b. As the DNA strand unwinds, the hydrogen bonds between nitrogen-containing organic bases break.
c. Free RNA nucleotides bind to complimentary DNA nucleotides
d. This creates a strand of mRNA.
e. In eukaryotes – introns are spliced out and the mRNA moves out to the cytoplasm through a nuclear pore.

12) During **translation**
    a. mRNA moves to a ribosome
    b. the ribosome attaches at the start of the mRNA.
    c. tRNA carrying an amino acid has an anticodon which binds to a complimentary codon on mRNA
    d. the amino acids bind together by a condensation reaction to form a peptide bond.
    e. The ribosome will then move along to the next codon and the next tRNA with the complimentary anticodon will bind
    f. This repeats until a polypeptide chain forms, that is then able to be folded into a protein
13) ATP is used to reattach amino acids to the tRNA
14) Base **deletion** is a mutation where one of the DNA nucleotides is deleted. This can cause frame shift.
15) Base **substitution** is a mutation where one of the DNA nucleotides is swapped for another nucleotide. This can be **silent**.
16) Due to the **degenerate** nature of the triplet code some mutations are silent, and the triplet can code for the same amino acid.
17) If the **mutation** disrupts the triplet code it can cause **frame shift**
    a. If the wrong amino acid is added this will change the **primary** structure of a protein
    b. Which will disrupt the, hydrogen bonds, disulphide bonds and the ionic bonds
    c. This means the **tertiary** structure of the protein will change.
    d. If the protein is an enzyme this will change the shape of the active site so no enzyme-substrate complexes can form.
18) **Mutations** happen randomly
19) When chromosomes don't separate evenly among daughter cells in meiosis this is called **non-disjunction**.
20) **Meiosis** produces daughter cells that are genetically different from one another.
21) During meiosis 2 divisions occur; meiosis 1 and meiosis 2
    a. In **meiosis 1 homologous chromosomes** are separated into daughter cells
    b. In **meiosis 2 chromatids** are separated into daughter cells
22) The cell starts off as **diploid** and the 4 daughter cells are **haploid**.
23) **Genetic diversity** in the daughter cells is created from
    a. **Independent segregation** of homologous chromosomes occurs in metaphase 1
        i. The paring of the maternal and paternal chromosomes is random.
    b. **Crossing over** between homologous chromosomes occurs in prophase 1.
        i. Genes at the same loci on maternal and paternal chromatids are exchanged between chromosomes.
24) **Genetic diversity** needs to occur for natural selection to happen.
25) **Natural selection** creates evolution
    a. The is a random mutation that causes an advantage
    b. This leads to reproductive success

    c. They are more likely to survive and reproduce and pass on the advantageous allele.
    d. As a result, over many generations the new alleles will increase in frequency in the population.
26) **Directional selection** is where either of the most extreme characteristic are advantageous. For example, antibiotic resistant bacteria, the bacteria that are most resistant are selected for.
27) **Stabilising selection** is when the mean characteristic is selected for. For example, birth weight, the mean birth weight is an advantage.
28) **Disruptive selection** is when both the extreme characteristics are selected for. This may eventually lead to the population being divided into 2 groups.
29) **Natural selection** results in a species that are better adapter to the environment.
30) Adaptations can be
    a. **Anatomical** – the structure of the body.
    b. **Physiological** – they way organisms use their physical features
    c. **Behavioural** – how organisms relate to one another and with the environment
31) Two organisms belong to the same species can interbreed to produce fertile offspring.
32) **Courtship** behaviour is in necessary for successful mating.
    a. Examples of courtship behaviour could be a sound, a gesture or an action.
    b. Courtship is important to allow members of the same species to recognise one another.
    c. Courtship behaviour also allows organisms to assess whether the mating will be successful
33) **Phylogenetic** classification system arranges species into groups based on their evolutionary relationships.
    a. The closer the branching on a phylogenetic tree the more recent common ancestor.
34) On **hierarchy** has the taxa: Domain, kingdom, phylum, class, order, family, genus and species.
35) The **binomial** name of consists of the genus and the species of each organism.
36) **Species richness** id a measure of the number of different species.
37) **Index of biodiversity** is the number of different species and the number of individuals of each species.
38) Index of biodiversity can be calculated with the formula: $d = \frac{N(N-1)}{\Sigma n(n-1)}$
    a. N = the total number of all organisms of all species
    b. n = the total number of individuals of each species
39) **Farming** techniques can reduce the biodiversity – for example just growing one crop in a field.
40) There must be a balance between feeding the population and conservation.
41) **Genetic diversity** can be compared by looking at
    a. Observable characteristics
    b. The DNA bases
    c. The sequences of mRNA
    d. The amino acid sequences.