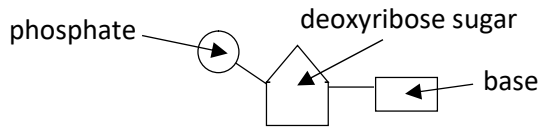
Unit 2 DNA & Genome

Summary Questions (ANSWERS)

DNA

Draw and label the three parts to a DNA nucleotide.



What molecule do DNA bases code for?

- Proteins

State the type of bonding between the bases.

- (weak) hydrogen

Explain which two parts of the nucleotide make up the backbone.

- Deoxyribose and phosphate

State what part of the nucleotide is at the 5' and the 3' end.

- Deoxyribose sugar at 3' end and phosphate at 5' end

Name the complementary base pairs.

- Adenine & Thymine, Cytosine & Guanine

Explain what is meant by antiparallel DNA.

- One strand runs from 5' to 3', the other strand runs 3' to 5'

State how many strands are in DNA.

- 2

State the name for the 3D structure of DNA.

- Double helix

Organisation of DNA

Explain the difference between prokaryotes and eukaryotes in terms of a nucleus.

- Eukaryotes have a nucleus, prokaryotes do not (genetic material is free floating)

State the type of chromosomal DNA organisation inside the nucleus.

- Linear

State the type of chromosomal DNA organisation in prokaryotes.

- Circular

State some examples of eukaryotes and prokaryotes.

- Eukaryotes (animal/plant/yeast cells), prokaryotes (bacteria)

State the only eukaryote that contains plasmids.

- Yeast cells

State the name for the extra circular pieces of DNA also found in prokaryotes.

- Plasmids

What name is given to the process where prokaryotes exchange these extra circular pieces of DNA to each other in the SAME generation?

- Horizontal gene transfer

State what type of chromosomal DNA is found in chloroplasts or mitochondria.

- Circular

What name is given to the molecule that linear chromosomes wrap around?

- Histone proteins

What type of organisms have these molecules?

- Eukaryotes

Why is it necessary to wrap linear chromosomes around these molecules?

- To prevent the chromosomes tangling

Draw a diagram of the linear chromosomes wrapping around these molecules.

DNA replication

State three substances needed for DNA replication.

- DNA template, free DNA nucleotides, Enzyme (DNA polymerase/ligase), primers, ATP

Compare replication in the lead and lag strand.

- Lead strand replicates continuously, lag strand replicates in fragments

State the name of the enzyme that replicates DNA.

- DNA polymerase

State the name of the molecule that starts DNA replication in both the lead and lag strand.

- Primer

State the direction that DNA always replicates from in terms of 3' and 5' ends.

- Replicates from 5' to 3' end

State the 6 stages of DNA replication.

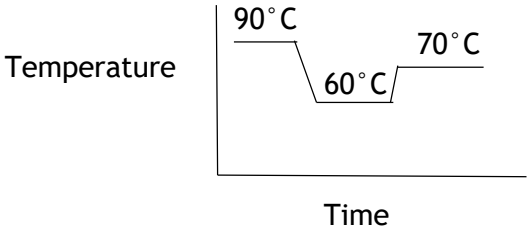
1. DNA double helix unwinds
2. Hydrogen bonds break between bases
3. Primers attach to the lead and lag strand
4. DNA polymerase adds free complementary DNA nucleotides to the 3' end
5. The lead strand replicates continuously & the lag strand replicates in fragments
6. Ligase joins the lag strand fragments together

PCR

Function/purpose of PCR?

- Amplify DNA

Draw the PCR 3 stages graph.



Explain why the PCR machine is heating to the following temperatures:

Heat to 90 degrees in PCR

- To separate strands OR break H bonds between bases (not just denature DNA)

Cool to 60 degrees in PCR

- To allow the primer to anneal to target DNA

Heat to 70 degrees in PCR

- To allow DNA synthesis to occur

State a practical application of PCR.

- Paternity/forensic cases

Name a molecule needed for DNA replication that is not needed for PCR.

- ligase

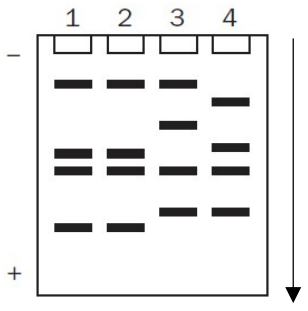
State the negative and positive control used in PCR.

- Negative = same set up but without DNA to prove there's no contamination
- Positive = same set up but with a different source of DNA known to create a specific band pattern to prove that the gel electrophoresis works properly

State the name of the technique that follows PCR where DNA is separated based on size using an electric current.

- Gel electrophoresis

Draw a diagram showing this technique.



Evolution

Name the two ways DNA can be transferred between organisms.

- Horizontal gene transfer & vertical gene transfer

State a definition for horizontal gene transfer.

- Plasmid passed between bacteria in the same generation.

State a definition for vertical gene transfer.

- Genetic information passed from parent to offspring/one generation to next

State which type of transfer is faster.

- Horizontal gene transfer

State which type of transfer offers variation in the offspring.

- Vertical gene transfer (sexual reproduction)

State what type of transfer bacteria passing on antibiotic resistance to each other through replicating their plasmids by the ORI region is an example of.

- Horizontal gene transfer

State what type of transfer a seed being produced from pollen and ovules during fertilisation is an example of.

- Vertical gene transfer

Define evolution.

- Gradual Change to an organism's gene pool (alleles) over a long period of time.

State whether evolution is a fast or slow process.

- Slow

Bioinformatics

Explain what is required in bioinformatics when analysing sequence data (DNA sequence).

- Computers and statistical analysis

From what organism did all life derive?

- A common ancestor

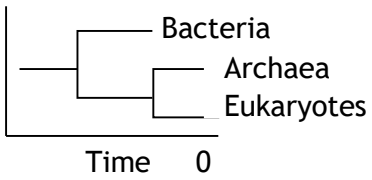
Starting with a common ancestor, list the sequence of evolution.

- Common ancestor, prokaryotes, photosynthetic prokaryotes, eukaryotes, multicellular organisms, land animals, vertebrate animals, land plants.

What name is given to graphs that look at evolutionary relatedness of different species?

- Phylogenetics trees/graphs

Name the three domains of life and draw the 3 domains on a phylogenetics tree.



State the two pieces of data needed for working out phylogenetic trees.

- Sequence data & fossil data

State the three pieces of information that can be observed when looking at phylogenetic trees.

- Work out evolutionary relatedness; sequence of events; time since divergence from common ancestor

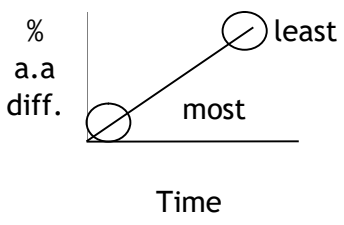
Complete the following sentence:

If organisms have more similar sequence data, they will diverge more recently and be more related.

What name is given to a second evolutionary graph where the number of amino acids that differ from humans is plotted to see who humans are most and least like?

- Molecular clock graph

Draw a diagram of this graph and circle who we are most and least related to.



State two uses of personalised medicines/genomics.

- Pharmacogenetics & find out likelihood of inheriting a disease

State one issue with personalised medicine.

- Discovering a mutation in a person's DNA bases will not necessarily lead to a disease (e.g. cancer)

Mechanisms of evolution

State the random mechanism for how alleles can increase/decrease over time.

- Genetic drift

State 2 causes of this random mechanism.

- Founder effect & neutral mutations

What type of population size is particularly susceptible to this mechanism?

- Small populations

Use the red and yellow ladybirds as an example.

- The original population has a mixture of red and yellow ladybirds. After genetic drift has occurred, the founder/colonising population is not representative of the original populations (e.g. only red ladybirds).

Explain how closely the new population resembles the original population following this random mechanism.

- Not representative of the original population

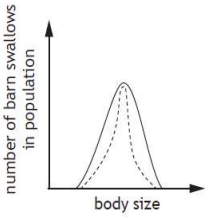
Name the two random mechanisms for how alleles evolve and state what type of alleles they are selecting for.

- Natural selection, selects alleles that increase survival
- Sexual selection, selects alleles that increase reproductive success

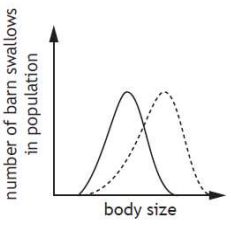
Define natural selection (2 marks).

- Non-random selection of alleles that increase the organism's chances of survival, these alleles are then passed on to the next generation.

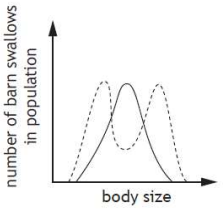
Draw a graph of the three types of selection pressure.



Stabilising



Directional

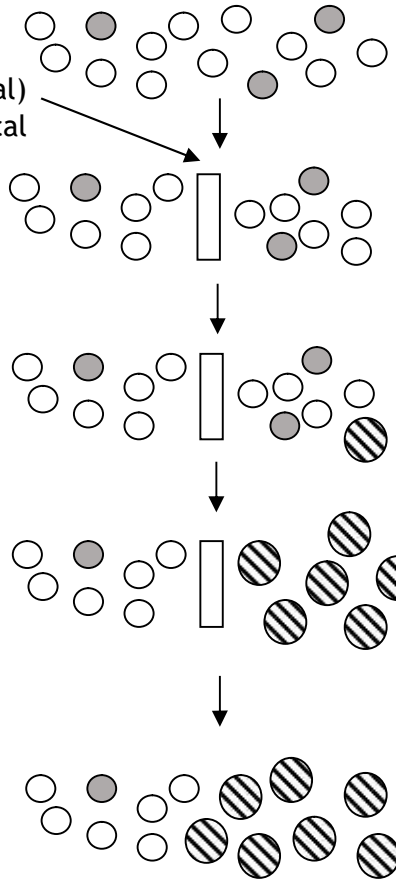


Disruptive

State the difference in terms of isolation types between Allopatric and sympatric speciation.

- Allopatric speciation = geographical isolation barrier
- Sympatric speciation = ecological or behavioural isolation barrier

State the 4 stages of speciation and draw a diagram to summarise these stages.



Allopatric (e.g. geographical) OR sympatric (e.g. ecological or behavioural)

Variation in alleles exists in initial population.

Isolation prevents gene flow/interbreeding between sub-populations.

Mutation occurs on one side and is advantageous.

Natural selection selects those with an increased selection pressure (advantage) for **survival;** therefore they can **reproduce and pass on successful alleles**.

Deleterious alleles are removed from the gene pool.

New species cannot interbreed to produce fertile offspring.

Explain the importance of isolating mechanisms.

- They prevent gene flow/interbreeding between sub-populations

Describe the role of mutations in terms of speciation (2 marks).

- Random mutation will occur on one side of the barrier. Natural selection chooses those that are advantageous.

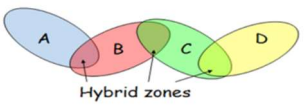
Describe the evidence that suggests the two groups are now separate species.

- They would not be able to interbreed to produce fertile offspring

State the term given to areas where closely related species interbreed, producing hybrids.

- Hybrid zones

Draw a diagram which depicts hybrid zones.



What process removes hybrids from the gene pool?

- Natural selection

State one way hybrids are disadvantageous.

- They are infertile or less fit/strong

Stem cells

State the two roles of any stem cell.

- Mitosis/self-renewal to make more stem cells
- Differentiate to make specialised cells

Define differentiation.

- Genes are turned ON or OFF to make specific proteins.

State the term given to plant stem cells.

- Meristems

Are stem cells specialised or unspecialised?

- Unspecialised

Name two examples of specialised cells in animals.

- Red blood cell, sperm cell, muscle cell, nerve cell, etc.

State the two types of stem cells and state which type is multipotent/pluripotent.

- Adult stem cells = multipotent (few types)
- Embryonic stem cells = pluripotent (lots of types)

State three locations of adult stem cells.

- Skin, bone marrow, liver, muscle

Give a use of adult stem cells.

- Growth and repair of tissues

Describe a therapeutic use of embryonic stem cells.

- Make skin for skin grafts, make pancreatic cells for diabetes, etc.

Describe a research use for embryonic stem cells.

- Aids scientific understanding of cell function (e.g. mitosis, differentiation, etc)
- Provides model cells for studying drugs or disease

Describe an ethical consideration regarding the use of embryonic cells.

- Using embryonic stem cells destroys the embryo

Explain why there is a need for tight regulation of embryonic stem cell use in research.

- To prevent the illegal sale of organs on the black market

Genome

Explain what is meant by the term genome.

- An organism's total hereditary genetic information

Explain the term intron and exon within the genome.

- Intron = non-coding region of the genome
- Exon = coding region of the genome (codes for proteins)

Name two roles of introns.

- Regulates transcription
- Transcribed but not translated

State three differences between DNA and RNA

- DNA is double stranded; RNA is single stranded
- DNA has deoxyribose sugar; RNA has ribose sugar
- DNA has a thymine base; RNA has a uracil base

State the three types of RNA.

- mRNA, tRNA & rRNA

State the type of RNA that is an exon and the types of RNA that are introns.

- mRNA is an exon
- tRNA & rRNA are introns

Proteins

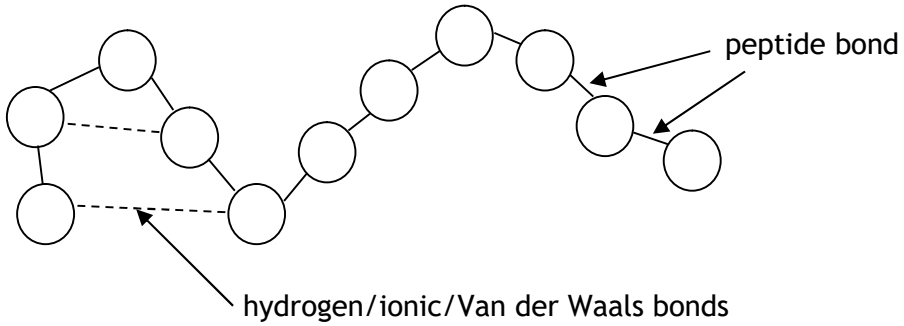
State the name of the bond between amino acids.

- Peptide

State the name of another interaction that holds proteins in their specific 3D shape.

- Hydrogen bonds, ionic bonds or Van der Waals bonds

Draw a diagram to summarise the two types of bonding in proteins.



Protein synthesis

State the name and location of the first and second stage of protein synthesis.

- Transcription, in the nucleus
- Translation, at the ribosome

State the name of the molecule that is made from DNA during transcription.

- The primary transcript.

State the 2 roles of RNA polymerase during transcription.

- Unwinds the DNA and breaks H bonds between bases of the 2 DNA strands
- Adds free complementary RNA nucleotides to make the primary transcript

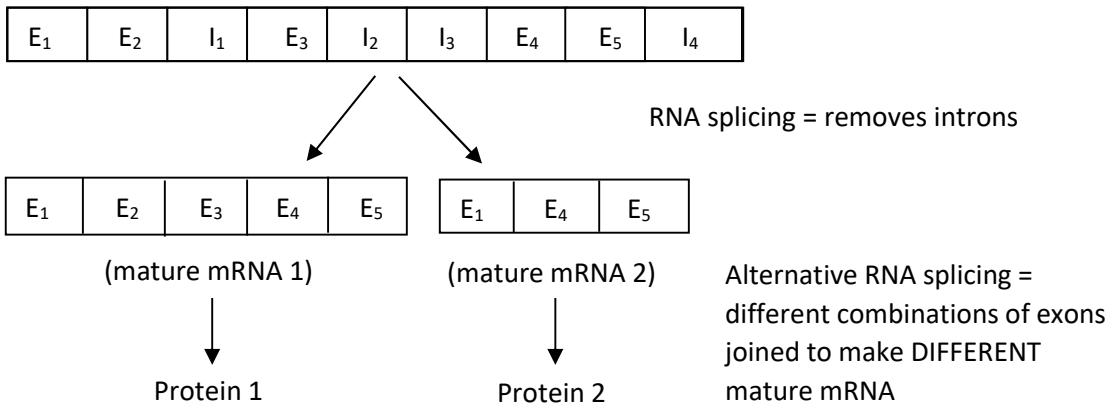
Does the primary transcript contain introns/exons or both?

- Both (introns and exons).

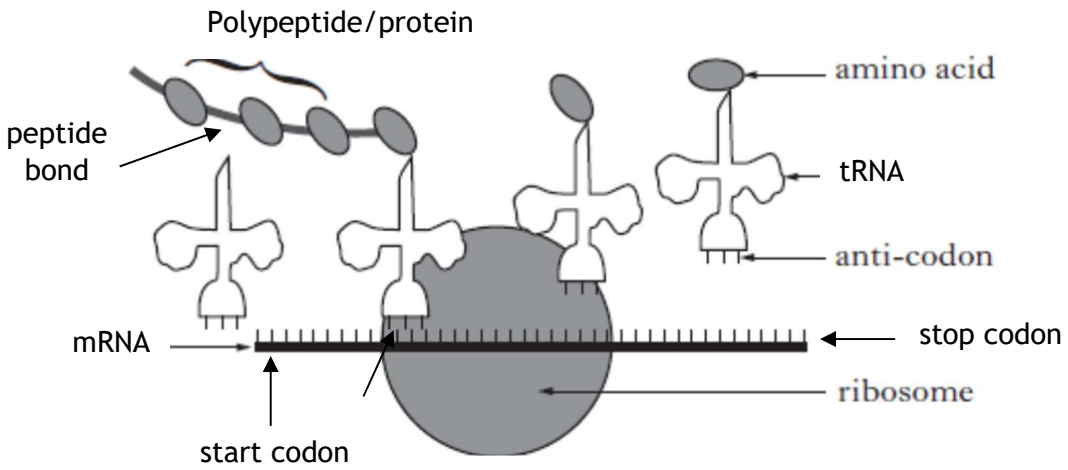
What molecule is made from the primary transcript that only contains exons?

- Mature mRNA

State what happens during RNA splicing and alternative RNA splicing using a diagram.



Translation: draw a diagram and label the key features.



State two molecules that make up the ribosome.

- rRNA & protein

State the function of mRNA.

- Takes complementary genetic code from the nucleus to the ribosome

State the 2 roles of tRNA.

- Binds to specific amino acids
- Takes specific amino acids to the ribosome
- tRNA anticodons align with mRNA codons at the ribosome

State what causes translation to commence and finish.

- Start codon and stop codon

State one type of post-translational modification.

- Add PO_4 (phosphate), add carbohydrate or cut and combine protein

State what type of organisms can undergo post-translational modifications.

- Eukaryotes (e.g. animal, plant or yeast cells)

Mutations

State the three types of mutations.

- Single gene (DIS)
- Chromosome structure (TIDD)
- Chromosome number (polyploid)

Define single gene mutations.

- Random change to the base sequence

State the three types of gene mutations and give an example of each using a normal code that you have created.

- Deletion, insertion and substitution

  Normal base sequence;

  CCG TAG GGA CAG TTA

  Deletion;

  ↓
  CGT AGG GAC AGT TA

  Insertion;

  ↓
  CCG TAA GGG ACA GTT A

  Substitution;

  ↓
  CCG TAG GGA CTG TTA

Define a frameshift mutation and state what type of single gene mutations are frameshift.

- A mutation that affects all amino acids after the mutation
- Created by deletion and insertion mutations

State the difference between mis-sense and nonsense substitutions.

- Mis-sense only affects one amino acid (minor effect)
- Nonsense creates a premature stop codon (major effect)

Explain the effect of a nonsense mutation on the protein produced.

- The premature stop codon creates a shortened, non-functional protein to be produced

Explain what is meant by a splice site mutation.

- A single gene mutation on the splice sites on chromosomes resulting in an intron being left in mature mRNA

Explain the effect of a splice site mutation on the protein produced.

- The introns contribute to protein folding so the protein will now be non-functional

Explain what is meant by expansion of the sequence repeats and give an example of a condition caused by this.

- An insertion mutation with a repeated codon of varying length e.g. 30-60 codon repeats inserted
- Can cause Fragile X Syndrome or Huntington's Syndrome

Explain why changing the base sequence affects the function of the protein (2 marks).

- Changing the base sequence
- Changes the amino acid sequence
- Changing the protein's structure
- This affects protein function/protein non functional.

Define chromosome structure mutations.

- Random changes to order of genes

Give an example of each of the four types of chromosome structure mutations.

- Normal chromosome; Gene A Gene B Gene C Gene D
- Translocation; Gene A Gene B *Gene Z* Gene C Gene D
- Deletion; Gene A Gene B Gene D
- Inversion; Gene A *Gene D* *Gene C* *Gene B*
- Duplication; Gene A *Gene B* *Gene B* Gene C Gene D

State what is meant by polyploidy.

- Organisms contain at least 1 extra set of chromosomes/more than 2 sets of chromosomes

What process causes polyploidy organisms?

- Non-disjunction

What effect does non-disjunction have on chromosome number?

- Increases chromosome number

Are animals or plants more susceptible to being polyploid?

- Plants

Explain why polyploid organisms have hybrid vigour in the evolution of food.

- They have disease resistance/increased growth compared to normal crops

Describe one example of the importance of polyploidy in evolution.

- Additional sets of chromosomes can mask harmful mutations which is an evolutionary advantage

Draw a diagram summarising two crops producing a hybrid which is made fertile by non-disjunction creating a polyploid offspring.