Essay 1: Why offspring from the same parents are different in appearance (Phenotypes)

Topics: Meiosis (Y1 Genetic variation causes), Inheritance (Y2 Parental Genotype to F1 Genotype + phenotype), Genetic Code (Y1 Translation and Transcription into phenotype) Gene Expression (Y2 Epigenetics, RNAi etc. Changes to phenotype), Protein Structure (Y1 Specific sequences into specific shape so variation)

Essay 2: Energy transfers which take place inside living organisms (Usage of ATP)

Topics: Nucleic Acids (Y1 ATP structure and function), Respiration (Y2 Aerobic Oxidative Phosphorylation + Krebs) Anaerobic (Glycolysis + NAD regeneration), Photosynthesis (Y2 Photophosphorylation + usage in Calvin), Plant Transport (Y1 Example ATP in active transport), Muscles (Y2 Sliding filament model w/ ATP hydrolysis)

Essay 3: Describe how the structures of different polymers are related to their function (Using polymers)

Topics: Bio Mols (Carbs, Proteins + Nucleotide polymerisation, use as starting sentence for each polymer), Cell Structure (Y1 Carbs - Plant Cellulose Cell Wall), Blood Glucose Homeostasis (Y2 Carbs - Liver Glycogen to Glucose), Enzymes (Y1 Proteins - Specific shape), Muscles (Y2 Proteins – Sarcomere Proteins), Nucleic Acids (Y1 DNA (+RNA?) structure + function)

Essay 1: For two organisms to reproduce, meiosis must occur to produce gametes as the daughter cells, in comparison to somatic cells solely dividing by mitosis. Meiosis is unique to mitosis, as one diploid parent cell will form four haploid daughter cells which are all genetically unique. These gametes are genetically varied due to crossing over and independent assortment. Crossing over during Metaphase I is when sections of non-sister chromatids swap when in a bivalent at a chiasmata point, forming recombinant genes. During Metaphase I, chromosomes in homologous pairs align on either side of the equator before being pulled by their centromeres by the spindle apparatus into separate cells in Anaphase and Telophase. Independent assortment is the random alignment of bivalents on either side of the equator, as the cell produced from Meiosis I will have a random selection of the maternal and paternal chromosomes. After gametes have been produced by these process and sexual reproduction forms a diploid zygote which will form the offspring, independent assortment, crossing over and the random fertilisation of the gametes which fertilised from form a genetically unique cell. This is relevant because the offspring will now vary in appearance to the parents.

Once genes are inherited by an organism, how the genotype of the organism is expressed depends on the gene and which alleles were inherited. A phenotype is the expression of the genotype, with the genotype being the combination of the maternal and paternal alleles of a gene. Alleles can be dominant and recessive, meaning if two different alleles are both in a genotype known as a heterozygote, only the dominant allele will be expressed in the phenotype in typical monohybrid inheritance. This is relevant as if the two parents were carriers of a recessive allele but express the dominant phenotype, the offspring can inherit a homozygous recessive genotype to have a different appearance to the parents. Furthermore there are more complicated ways in which alleles are expressed such as sex linkage which can cause phenotypes in offspring to vary from parents. In the example of Haemophilia, in which clotting factor 8 in blood doesn't function, the Y allele is paternally inherited and the X^h allele is inherited from a maternal carrier, so the offspring has a different

1-✓✓ 2-✓✓ R* 3-✓✓ R 4-✓✓ R-/15max B-✓✓ E-✓✓ QWC-✓✓✓ 22

phenotype from the parents.

Genetic information from this inheritance is stored as molecules of deoxyribose nucleic acid, or DNA. Alleles, or variations of a gene, become expressed as a phenotype through transcription and translation of this DNA. In transcription inside the nucleus, DNA helicase breaks hydrogen bonds between complementary base nucleotide pairs of the two DNA strands, exposing the nucleotides. Free RNA nucleotides will bind to the template strand at the 3' end of exposed DNA and RNA polymerase will form a sugar-phosphate backbone of the new pre-mRNA transcript. Pre-mRNA will be spliced, removing non-coding intron regions, then the coding mRNA will be translated after leaving the nucleus through nuclear pores at a ribosome. mRNA triplet codons will complementary base pair at the ribosome with the anticodon of a tRNA associated with an amino acid. As codons bind with tRNA, the amino acids with the tRNA will form peptide bonds between each other to form a polypeptide sequence. A STOP codon on the mRNA will cease translation and a the specific protein formed will be used in the body and expressed in relation to the specific gene, which is relevant as the specific genetic sequence the offspring will have will cause the proteins formed in this offspring will be different to the parents.

Gene expression can also be altered by factors such as mutations or epigenetics. A gene mutation is when there is a change in the base sequence of DNA and includes many variations such as substitution, addition, deletion, duplication, inversion and translocation. Whereas some can be silent mutations, in which the new mRNA sequence that would be transcribed from the mutated DNA would still code for the same amino acid due to the degenerate code, other mutations can either cause a change in a set number of coded amino acids or cause a frame shift. Mutations such as duplication, where one or more bases are repeated, shift the triplet codes of the whole base sequence so that the whole amino acid sequence is affected. Epigenetics involves the epigenome, which involves the histone octamers DNA is coiled around to form nucleosomes and the acetyl groups which attach to histones, and methyl groups which are added to cytosine. Methyl groups cause DNA to be more tightly packed so transcription is harder, and acetyl groups make DNA more loosely packed so transcription is easier, inhibiting or activating gene expression. This is relevant as epigenetic changes are solely caused by environmental factors and mutations increase with mutagen exposure, both of which will vary from offspring to parent, so offspring will express different genes and look different.

Finally, the offspring appears different due to the specific nature of the proteins produced from translation when the gene is expressed. From the specific polypeptide chain coded for from mRNA, the chain starts to twist into (alpha)-helices or (beta)-pleated sheets in specific places due to hydrogen bonds in the secondary structure, and hydrogen bonds, ionic bonds and disulphide bridges forming a specific 3D shape in the tertiary structure. A combination of these polypeptide chains can combine to form proteins at the quaternary level. These proteins have a variety of functions, with fibrous proteins having a structural function so form a large part of the overall organism. This is relevant as different proteins would be coded for between offspring and parents, so if these structural proteins vary then the structure and appearance of the parent and offspring will vary.

Essay 2: ATP, adenosine triphosphate, is the molecule by which most energy is transferred inside living organisms. ATP is a phosphorylated macromolecule, formed from a ribose sugar attached to adenine and 3 phosphate groups in a row. ATP has the function of being an immediate energy source in a cell due to the unstable bonds between the phosphate groups, but cannot act as a long term energy storage molecule. The hydrolysis of ATP into ADP and a phosphate group released 30.7kJ of energy, which is a small and manageable quantity. For long term storage, the