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| **8.1.U1** | |  |  | | --- | --- | | **7.1.U1** | **DNA structure suggested a mechanism for DNA replication.**   * Outline the features of DNA structure that suggested a mechanism for DNA replication. | | **7.1.U2** | **Nucleosomes help to supercoil the DNA.**   * Draw and label the structure of a nucleosome, including the H1 protein, the octamer core proteins, linker DNA and two wraps of DNA. * Explain the levels of supercoiling (DNA→ nucleosome → beads on a string → 30nm fiber →  unreplicated interphase chromosome → replicated metaphase chromosome). |  |  |  | | --- | --- | | **7.1.U3** | **DNA replication is continuous on the leading strand and discontinuous on the lagging strand.**   * Compare replication on the the leading strand and the lagging strand of DNA. * Explain why replication is different on the leading and lagging strands of DNA. * Outline the formation of Okazaki fragments on the lagging strand. | | **7.1.U4** | **DNA replication is carried out by a complex system of enzymes.**   * Outline the role of the following proteins in DNA replications:  helicase, topoisomerase (AKA gyrase), single stranded binding proteins, primase, DNA polymerase III, DNA polymerase I, and DNA ligase. |  |  |  | | --- | --- | | **7.1.U5** | **DNA polymerases can only add nucleotides to the 3’ end of a primer.**   * Explain the need for RNA primers in DNA replication. * Explain what is meant by DNA replication occurring in a 5' to 3' direction. | | **7.1.U6** | **Some regions of DNA do not code for proteins but have other important functions.**   * Define “coding sequences” and “repetitive sequences” of DNA. * Outline five functions of non-coding DNA sequences found in genomes, one of which must be the telomere. |  |  |  | | --- | --- | | **7.1.A1** | **Rosalind Franklin and Maurice Wilkins’ investigation of DNA structures by X-ray diffraction.**   * Outline the process of X-ray diffraction. * Outline the deductions about DNA structure made from the X-ray diffraction pattern. | | **7.1.A2** | **Tandem repeats are used in DNA profiling.**   * Define VNTR. * Explain why VNTR are used in DNA profiling |  |  |  |  | | --- | --- | --- | | **7.1.A3** | | **Use of nucleotides containing dideoxyrubonucleic acid to stop DNA replication in preparation of samples for base sequencing.**   * Outline the process of DNA sequencing, including the role of chain terminator nucleotides, fluorescence, and electrophoresis. | | **7.1.S1** | **Analysis of results of the Hershey and Chase experiment providing evidence that DNA is the genetic material.**   * State the experimental question being tested in the Hershey and Chase experiment. * Explain the procedure of the Hershey and Chase experiment. * Explain how the results of the Hershey and Chase experiment supported the notion of nucleic acids as the genetic material. | |  |  |  |  |  | | --- | --- | --- | --- | | **7.1.S2** | | | **Utilization of molecular visualization software to analyze the association between protein and DNA profiling.**   * Identify nucleosome structures using molecular visualization software. * Outline the mechanism of histone-DNA association. | | **7.1.** **NOS** | | **Making careful observations-Rosalind Franklin’s X-ray diffraction provided crucial evidence that DNA is a double helix.**   * Describe Rosalind Franklin’s role in the elucidation of the structure of DNA. | | | **7.2.U1** | | **Gene expression is regulated by proteins that bind to specific base sequences in DNA.**   * Define gene expression. * State two reasons why gene expression must be regulated. * Outline the environmental regulation of the breakdown of lactose in E. coli. * Outline the role of enhancers, silencers and promoter-proximal elements in regulation of gene expression. | | | | | **7.2.U2** | | **The environment of a cell and of an organism has an impact on gene expression.**   * Describe the use of twin studies to measure the impact of environment on gene expression. * Outline two examples of environmental influence on gene expression. | | | |  |  |  | | --- | --- | | **7.2.U3** | **Nucleosomes help to regulate transcription in eukaryotes.**   * Outline the effect of methylation of nucleosome tails on rates of gene expression. * Outline the effect of acetylation of nucleosome tails on rates of gene expression. | | **7.2.U4** | **Transcription occurs in a 5’ to 3’ direction.**   * Describe the initiation of transcription, including the role of the promoter, transcription factors, the TATA box and RNA polymerase. * Describe elongation of transcription, including the role of nucleotide triphosphates and the direction of transcription. * Describe termination of transcription, including the role of the terminator. |  |  |  | | --- | --- | | **7.2.U5** | **Eukaryotic cells modify mRNA after transcription.**   * List two major differences in gene expression between prokaryotic cells and eukaryotic cells. * Describe the three post-transcriptional modifications of pre-mRNA in eukaryotes. | | **7.2.U6** | **Splicing of mRNA increases the number of different proteins an organism can produce.**   * Describe the process of alternative RNA splicing. * Outline an example of alternative splicing the results in different protein products. |  |  |  |  | | --- | --- | --- | | **7.2.A1** | | **The promoter as an example of non-coding DNA with a function.**   * Outline the role of promoter DNA. | | **7.2.S1** | **Analysis of changes in the DNA methylation patterns.**   * State the effect of DNA methylation on gene expression. * Compare methylation patterns in twins using superimposed images of dyed chromosomes. | |  |  |  |  | | --- | --- | --- | | **7.2.** **NOS** | | **Looking for patterns, trends and discrepancies- there is mounting evidence that the environment can trigger heritable changes in epigenetic factors.**   * Define epigenetic and epigenome. * List types of epigenetic tags. * Discuss the role of reprogramming and imprinting on epigenetic factors. | | **7.3.U1** | | **Initiation of translation involves assembly of the components that carry out the process.**   * Outline the process of translation initiation. | | | | **7.3.U2** | | **Synthesis of the polypeptide involves a repeated cycle of events.**   * Outline the process of translation elongation, including codon recognition, bond formation and translocation. * State the direction of movement of the ribosome along the mRNA molecule. | | |  |  |  | | --- | --- | | **7.3.U3** | **Disassembly of the components follows termination of translation.**   * Outline the process of translation termination, including the role of the stop codon. | | **7.3.U4** | **Free ribosomes synthesize proteins primarily for secretion or use in lysosomes.**   * State the difference between free and bound ribosomes. * List destinations of proteins synthesized on free ribosomes. |  |  |  | | --- | --- | | **7.3.U5** | **Bound ribosomes synthesize proteins for use primarily within the cell.**   * List destinations of proteins synthesized on bound ribosomes. * Outline how a ribosome becomes bound to the endoplasmic reticulum. | | **7.3.U6** | **Translation can occur immediately after transcription in prokaryotes due to the absence of a nuclear membrane.**   * Compare the timing and location of transcription and translation between prokaryotes and eukaryotes. |  |  |  | | --- | --- | | **7.3.U7** | **The sequence and number of amino acids in the polypeptide is the primary structure.**   * Describe the primary structure of a protein, including the type of bonding involved. | | **7.3.U8** | **The secondary structure is the formation of alpha helices and beta pleated sheets stabilized by hydrogen bonding.**   * Describe the secondary structure of a protein, including the type of bonding involved. * Identify the alpha-helix and beta-pleated sheet in images of protein structure. |  |  |  |  | | --- | --- | --- | | **7.3.U9** | **The tertiary structure is the further folding of the polypeptide stabilized by interactions between R groups.**   * Describe the tertiary structure of a protein, including the types of R group interactions involved. * Explain how the chemical characteristics of R groups in the polypeptide chain affect protein folding. | | | **7.3.U10** | | **The quaternary structure exists in proteins with more than one polypeptide chain.**   * Outline the quaternary structure of protein folding. * Describe the structure of a conjugated protein, including the  prosthetic group. |  |  |  |  | | --- | --- | --- | | **7.3.A1** | | **tRNA-activating enzymes illustrate enzyme-substrate specificity and the role of phosphorylation.**   * State the role of the tRNA activating enzymes. * Outline the process of attaching an amino acid to tRNA by the tRNA activating enzyme. | | **7.3.S1** | **The use of molecular visualization software to analyze the structure of eukaryotic ribosomes and tRNA molecules.**   * Describe the structure of the ribosomes, including the small and large subunits and the names and roles of the tRNA binding sites. * Use molecular visualization software to view and identify the small and large subunit and tRNA binding sites of the ribosome. * Outline the structure of tRNA molecules. * Use molecular visualization software to view and identify the anticodon and amino acid binding site of a tRNA. | |  |  |  |  | | --- | --- | --- | | **7.3.S2** | | **Identification of polysomes in electron micrographs of prokaryotes and eukaryotes.**   * Outline the structure of a polysome. * Identify the beginning of an mRNA strand in a micrograph of polysomes. | | **7.3.** **NOS** | **Developments in scientific research follow improvements in computing- the use of commuters has enabled scientists to make advances in bioinformatics applications such as locating genes within genomes and identifying conserved sequences.**   * Define bioinformatics. * Outline why computers are necessary for genome analysis. * List seven species for which the entire genome has been sequenced. | |   **Metabolic pathways consist of chains and cycles of enzyme-catalyzed reactions.**   * Contrast metabolic chain reaction pathways with cyclical reaction pathways. |
| **8.1.U2** | **Enzymes lower the activation energy of the chemical reactions that they catalyze.**   * Define activation energy. * Explain the role of enzymes in lowering the activation energy of a reaction. |

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| **8.1.U3** | **Enzyme inhibitors can be competitive or non-competitive**.   * Define enzyme inhibitor. * Contrast competitive and noncompetitive enzyme inhibition. * Outline one example of a competitive enzyme inhibitor and one example of a noncompetitive enzyme inhibitor. |
| **8.1.U4** | **Metabolic pathways can be controlled by end-product inhibition.**   * Describe allosteric regulation of enzyme activity. * Outline the mechanism and benefit of end-product inhibition. |

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| **8.1.A1** | **End-product inhibition of the pathway that converts threonine is isoleucine.**   * Illustrate end-product inhibition of the threonine to isoleucine metabolic pathway. * State the consequence of an increase in isoleucine concentration. |
| **8.1.A2** | **Use of databases to identify potential new anti-malarial drugs.**   * Outline the reasons for development of new anti-malarial drugs. * Explain the use of databases in identification of potential new anti-malarial drugs. |

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| **8.1.S1** | **Distinguish different types of inhibition from graphs at specified substrate concentration.**   * Explain why the rate of reaction with increasing substrate concentration is lower with a non-competitive inhibitor compared to a competitive inhibitor. |
| **8.1.S2** | **Calculating and plotting rates of reaction from raw experimental results.**   * State two methods for determining the rate of enzyme controlled reactions. * State the unit for enzyme reaction rate. * Given data, calculate and graph the rate of an enzyme catalyzed reaction. |

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| **8.1.** **NOS** | **Developments in scientific research follow improvements in computing- developments in bioinformatics, such as the interrogation of databases have facilitated research into metabolic pathways.**   * Outline the use and benefits of the bioinformatics technique of chemogenomics in development of new pharmaceutical drugs. | |
| **6.6.U1** | | **Cell respiration involves the oxidation and reduction of electron carriers.** |
| **8.2.U2** | | **Phosphorylation of molecules makes them less stable.** |

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| **8.2.U3** | **In glycolysis, glucose is converted to pyruvate in the cytoplasm.** |
| **8.2.U4** | **Glycolysis gives a small net gain of ATP without the use of oxygen.** |

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| **8.2.U5** | **In aerobic cell respiration pyruvate is decarboxylated and oxidized, and converted into acetyl compound and attached to coenzyme A to form acetyl coenzyme A in the link reaction.** |
| **8.2.U6** | **In the Krebs cycle, the oxidation of acetyl groups is coupled to the reduction of hydrogen carriers, liberating carbon dioxide.** |

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| **8.2.U7** | **Energy released by oxidation reactions is carried to the cristae of the mitochondria by reduced NAD and FAD.** |
| **8.2.U8** | **Transfer of the electrons between carriers in the electron transport chain in the membrane of the cristae is coupled to proton pumping.** |

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| **8.2.U9** | **In chemiosmosis protons diffuse through ATP synthase to generate ATP.** | |
| **8.2.U10** | | **Oxygen is needed to bind with the free protons to maintain the hydrogen gradient, resulting in the formation of water.** |

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| **8.2.U11** | | **The structure of the mitochondrion is adapted to the function it performs.** |
| **8.2.A1** | **Electron tomography used to produce images of active mitochondria.** | |

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| **8.2.S1** | **Analysis of diagrams of the pathways of aerobic respiration to decide where decarboxylation and oxidation reactions occur.** |
| **8.2.S2** | **Annotations of a diagram of mitochondrion to indicate the adaptations to its function.** |

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| **8.2.** **NOS** | **Paradigm shift-chemiosmotic theory led to a paradigm shift in the field of bioenergetics.** | |
| **8.3.U1** | | **Light-dependent reactions take place in the intermembrane space of the thylakoids.** |
| **8.3.U2** | | **Light –independent reactions take place in the stroma.** |

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| **8.3.U3** | **Reduced NADP and ATP are produced in the light-dependent reactions.** |
| **8.3.U4** | **Absorption of light by photosystems generates excited electrons.** |

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| **8.3.U5** | **Photolysis of water generates electrons for use in the light-independent reactions.** |
| **8.3.U6** | **Transfer of excited electrons occurs between carriers in thylakoid membranes.** |

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| **8.3.U7** | **Excited electrons from Photosytem II are used to contribute to generate a proton gradient.** |
| **8.3.U8** | **ATP synthase in thylakoids generates ATP using the proton gradient.** |

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| **8.3.U9** | **Excited electrons from Photosytem I are used to reduce NADP.** | |
| **8.3.U10** | | **In the light-independent reaction a carboxylase catalyzes the carboxylation of ribulose-bisphosphate.** |

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| **8.3.U11** | **Glycerate 3-phosphate is reduced to triose phosphate using a reduced NADP and ATP.** |
| **8.3.U12** | **Triose phosphate is used to regenerate RuBP and produce carbohydrates.** |

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| **8.3.U13** | **Ribulose bisphosphate is reformed using ATP.** |
| **8.3.U14** | **The structure of the chloroplast is adapted to its function in photosynthesis.** |

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| **8.3.A1** | | **Calvin’s experiment to elucidate the carboxylation of RuBP.** |
| **8.3.S1** | **Annotation of a diagram to indicate the adaptations of a chloroplast to its function.** | |

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| **8.3.** **NOS** | **Developments in scientific research follow improvements in apparatus- sources of 14C and autoradiography enabled Calvin to elucidate the pathways of carbon fixation.** |