Protein metabolism

Science, Genetics

Proteins play an important role in the human body. The DNA molecule controls the synthesis of proteins. The DNA contains genes which are sequences of nucleotides and bases. Proteins are used for growth and repair. Proteins are made up of amino acids linked together by peptide bonds. Firstly 'amino acid synthesis' is the set of biochemical processes by which the various amino acids are produced from other compounds. The substrates for these processes are various compounds in the organism's diet, not all organisms are able to synthesise all amino acids. Proteins are made in the ribosome's organelles in the cytoplasm. So to start the process of protein synthesis DNA’s code must be copied and taken to the cytosol. In the cytoplasm the code must be read so that the amino acids can be assembled to make proteins. This is the start of protein synthesis. There are 3 different types of RNA: * mRNA (messenger RNA) (Applin, D (1997)) states, “ DNA employs a message to take instructions to where they are needed. This messenger is a substance called messenger RNA (mRNA) * rRNA (Ribosomal RNA) along with protein makes up the ribosome * tRNA (Transfer RNA) transfers amino acids to the ribosome’s where proteins are synthesised Since DNA is part of a larger molecule which contains chromosomes that are unable to move from the nucleus it needs something else to send a “ coded message". These are messenger RNA molecules. (Baker, M (2004)) states, “ In the process of transcription, DNA is used as a template to produce a molecule of mRNA. This occurs in the nucleus. " RNA synthesis transcription is the first step of gene expression, in which a particular segment of DNA is copied into RNA by the enzyme RNA polymerase. During transcription, a DNA sequence is read by an RNA polymerase, which produces a complementary,

antiparallel RNA strand, also unlike DNA replication where DNA is synthesised, transcription does not involve an RNA primer to initiate RNA synthesis. Fig. 1 to show the structure of RNA. This is a single stranded molecule which contains the base Uracil (U) DNA consists of four nucleotide bases [adenine (A), guanine (G), cytosine (C) and thymine (T)] that are paired together (A-T and C-G) to give DNA its double helix shape. There are three main steps to the process of DNA transcription. Transcription requires the enzyme RNA polymerase. RNA Polymerase Binds to DNA. DNA is transcribed by an enzyme called RNA polymerase. Specific nucleotide sequences tell RNA polymerase where to begin and where to end. RNA polymerase attaches to the DNA at a specific area called the promoter region. This process uses mRNA to copy a template strand of DNA. In order for this to happen the DNA double helix must be ‘ unzipped’ (Pickering, W (1996)) states, “ Original ‘ parent’ DNA is unwound exposing each single chain of bases". The DNA strand is read from the 3’ to the 5’ end. And the mRNA is made from the 5’ to the 3’ end. During transcription only the exons (coding parts of DNA) are copied and introns (non coding) are ignored. The mRNA strand, once complete detatches itself from the DNA strand and exits the nucleus via the nucleus pores and enters the cytoplasm. During transcription RNA polymerase binds to the DNA to unwind the DNA strand and allow RNA polymerase to transcribe only a single strand of DNA into a single stranded RNA polymer called messenger RNA (mRNA). (Baker, M (2004)) states, “ In the process of transcription, DNA is used as a template to produce a molecule of mRNA. This occurs in the nucleus. " The strand that serves as the template is called the antisense strand. The strand that is not

transcribed is called the sense strand. Like DNA, RNA is composed of nucleotide bases. RNA however, contains the nucleotides adenine, guanine, cytosine and uracil (U). When RNA polymerase transcribes the DNA, guanine pairs with cytosine and adenine pairs with uracil. Promotors are regions on DNA that show where RNA polymerase must bind to begin the Transcription of RNA called the TATA box. Specific base sequences act as signals to stop. RNA polymerase moves along until it reaches a terminator sequence. At that point, RNA polymerase releases the mRNA polymer and detaches from the DNA. This is known as the termination signal. Translation which is the process through which cellular ribosomes manufacture proteins, in which messenger RNA is sequentially decoded by transfer RNA (tRNA). The mRNA now leaves the nucleus , each 3 base sequence codes for a single amino acid. Ribosomes read mRNA 3 bases or 1 codon at a time to construct the proteins. mRNA transcript start codon AUG attaches itself to the small ribosomal subunit. A ribosome is made up of 40% rRNA and 60% protein. A larger subunit of the ribosome can accommodate 2 codons of the mRNA. When the large subunit attaches itself the mRNA consequently runs through the middle of the ribosome. The start codon (AUG) attaches itself to the complimentary anticodon on tRNA at the P site on the ribosome. The 2nd tRNA molecule arrives at the A site on the ribosome carrying complimentary Amino Acid (A. A2). Each tRNA contains one specific amino acid in the cytoplasm. The anticodon and codon bind temporarily by hydrogen bonds. This causes the 2 amino acids to be held next to each other long enough for peptide bonds to be formed. This is known as elongation. The end product is a primary structure of a protein. Appendix 1 shows a popular protein shake

and Appendix 2 shows the ingredients in this protein shake. This same website (www. vitalady. com/comparison. htm) states “ Taking double doses won't hurt, it just costs more. " This claim can cause the consumer to believe that there is no limit on how much protein one can consume in a sitting. For many years athletes and other people have been using protein supplements/shake to improve their performance and increase the effectiveness of each workout. The results that these athletes achieve are from training all day, everyday. This can cause misleading evidence since the majority of results seen by athletes are associated with protein supplements use. Protein shakes have been associated with rapid muscle mass and strength. Muscles are composed of protein. Proteins are used for muscle growth and repair so it makes sense to utilise protein shakes however there is no solid scientific evidence backing this up. The amount of protein each person can take in depends on the needs of each individual however it typically ranges from 34/56g per day. This can be shown in the table on the following website about dietary guidelines. (http://www. health. gov/dietaryguidelines/dga2005/report/HTML/D1_Tables. htm) Increasing protein intake may be necessary after a workout however after breaking down proteins in the body amino acids are released. This will result in a higher concentration of amino acids in the blood. A recent study shows “ People with high concentrations of homocysteine, an amino acid in the blood, may have an increased risk of stroke" http://www. news-medical. net/news/2005/01/13/7296. aspx. These results contradict the claim that no harm can be done from increased amount of protein intake. The major commercial claim of protein supplements increasing athletic performance

and muscle mass are partly true. Scientific evidence proves that protein is for growth and repair in muscles however these commercial companies over exaggerate the results that can be obtained and don’t warn consumers about the health hazards. Another popular claim from these companies is that these protein supplements can contribute to achieving lean body mass. Scientifically, protein will aid with the growth of muscles and lean body mass is achieved from an individual’s calorie intake. The most harmful claim being made is the safety of protein and there is no limit on how much protein an individual can consume. In todays market protein supplements are full of amino acids with protein. High concentrations of amino acids can be detrimental to a persons health. Appendix 1 http://www. vitalady. com/cgi-bin/commerce. cgi? preadd= action&key= 3602X005 Appendix 2 http://www. vitalady. com/cgi-bin/commerce. cgi? preadd= action&key= 3602X005 Bibliography Applin, D (1997). Key Science New Edition. Cheltenham: Stanley Thornes ltd. P146. Baker, M (2004). AS Biology Revision and Summary Book. London: Hodder&Stoughton P87 Baker, M (2004). AS Biology Revision and Summary Book. London: Hodder&Stoughton P85 Fig. 1 www. chemistry. tutorvista. com Pickering, W (1996). Revise through diagrams, BIOLOGY. Oxford: Oxford University Press. 44. http://www. health. gov/dietaryguidelines/dga2005/report/HTML/D1_Tables. htm http://www. vitalady. com/cgi-bin/commerce. cgi? preadd= action&key= 3602X005 www. vitalady. com/comparison. htm http://www. news-medical. net/news/2005/01/13/7296. aspx