07 - 5. Synthesis of DNA, RNA & Protein

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© SPMM Course sequences that are non-coding (called introns) at various positions. The introns contain three types of sequences (satellite, mini and microsatellite: see the graph below). All introns are removed from the mRNA before it leaves the nucleus and start protein synthesis. Humans have 3 × 109 bp of total chromosomal DNA but among these the protein-coding genes constitute only 32 000 bp. 5. Synthesis of DNA, RNA & Protein Replication refers to the production of new DNA copies from template copies of DNA. Synthesis of RNA from nuclear DNA is called transcription. This takes place in the nucleus of the cell. Such transcripted RNA initially contains the 'junk' sequences – introns – that do not code for polypeptides. This unprepared RNA is called heterogeneous nuclear RNA or hnRNA. This hnRNA then undergoes splicing aided by nucleosomes in the nucleus to remove non-coding sequences and results in messenger RNAs (mRNA). tRNAs (transfer RNAs) are also synthesized from DNA in the nucleus in a separate process. Translation refers to the production of proteins from RNA. This takes place in the cytoplasm, aided by ribosomes. Ribosomes can be seen attached to rough endoplasmic reticulum. As tRNAs that are synthesized in the nucleus enter the cytoplasm, they are attached to specific amino acids according to the codon sequences. This energy dependent process is called amino acid activation, catalyzed by a specific amino acid activating enzyme (aminoacyl-tRNA synthetase) in the presence of Mg2+. There is a separate aminoacyl-tRNA synthetase enzyme for each kind of amino acid. The energy stored in such activated amino acids is used in making peptide bonds during protein translation. Translation takes place in the cytoplasm on ribosomes where specific mRNAs are involved. tRNAs with their aminoacids, sequentially bind to various sites along the mRNA in a zipper like fashion. Translation includes three steps – initiation, elongation and termination. The ribosome contains two sites – Peptidyl P site where methionine-containing tRNA initially binds and aminoacyl A site where each new incoming tRNAs with activated amino acids can bind. In elongation step, amino acids are added one by one in a sting like fashion to produce proteins. Chain termination is signaled by one of the three codons UAA, UGA or UAG. Modification refers to posttranslational changes in a protein molecule before it becomes functionally active. Following protein synthesis (sometimes simultaneously as the protein is being synthesized) posttranslational modifications take place to transport the synthesized proteins to appropriate cellular sites. These modifications take place in endoplasmic reticulum and golgi bodies. The Golgi complex is a

dynamic system acting as a temporary protein repository that gives off vesicles and vacuoles for further processing and transport. These processes include covalent modifications, protein folding and tagging with signal peptides to dispatch to appropriate cellular destinations. Glycosylation, proteolysis, phosphorylation, gamma carboxylation, prenylation, ubiquitation, polyamination and nitration are some of the recognized posttranslational chemical modifications. This process is essential in tagging wrongly

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