Eukaryotic Gene Expression

Gene Expression: The process in which the information within a gene is used, first to synthesise RNA, through transcription, and then to a protein, through translation, eventually to affect the phenotype of an organism.

Central Dogma of Molecular Biology: The principle of directional informational flow from DNA to RNA to protein.

Transcription: The process, in which a complementary RNA copy is made under the direction of the template strand of a specific region of the DNA molecule, catalysed by the enzyme RNA polymerase.

Translation: The process, in which a polypeptide chain is synthesised by ribosomes using genetic information encoded in an mRNA template

DNA \rightarrow pre-mRNA \rightarrow mature mRNA <u>tRNA & rRNA</u> polypeptide

Gene: A section of the DNA that contains the information in the form of a specific sequence of nucleotides to direct the synthesis of one polypeptide chain or RNA. It is a unit of inheritance located in the locus on the chromosome which specifies a particular character of an organism.

Characteristic	RNA	DNA COMMIN
Substituent	Made of polynucleotides, basic units: ph	osphate and the pentose sugar,
	nitrogenous base	esar
Bond	Have a sugar-phosphate backbon, juine	d by phosphodiester bonds
Synthesis	h sis 🤇 🕽	
	Syntherised by complementary by e pair	ing of nucleotides using a template
Nitrogeneus	avie nade	A, G, T, C
bases	Pas	
Size & mass	Smaller molecular mass (20k to 2000k	Larger molecular mass (100k to
	Da)	150000k Da)
No. of	1 polynucleotide chain	2 polynucleotide chains
subunits		
3D structure	Almost always single-stranded, helical	Always a double-stranded helical
	molecule, which can be folded into a	molecule which forms a double helix.
	complex tertiary structure eg. tRNA	Coiled around histone proteins
Monomers	Ribonucleotides	Deoxyribonucleotides
Pentose	OH group attached on 2'Carbon	H attached on 2' Carbon
sugar		
Chemical	Less stable – more reactive partly due	More stable – more resistant to
stability	to ribose having an additional reactive	spontaneous enzymatic breakdown
	2' OH group	due to deoxyribose lacking 2'OH group
Purines :	A: U ≠ G:C ≠ 1:1 (Ratio cannot be	A:T = G:C = 1:1
pyrimidines	predicted as RNA is single-stranded,	(Chargaff's rule)
	without a complementary strand)	
Basic forms	Several basic forms: messenger RNA,	Only one basic form
	transfer RNA, ribosomal RNA, small	
	nuclear RNA, small interfering RNA	

		are removed and the remaining group is added to the free 3' OH group of the growing RNA chain via phosphodiester bond
	Re-annealing of DNA and proofreading	 RNA polymerase reanneals the unwound DNA behind it, dissociating the growing RNA chain from the template It carries out proofreading functions and is responsible for the removal of incorrectly inserted ribonucleotides
Termination		 RNA polymerase transcribes a terminator sequence in the DNA Triggers the release of the RNA chain and dissociation of the RNA polymerase from the DNA Transcribed terminator codes for a polyadenylation sequence (AAUAAA)

Exons: protein-coding sequence in the gene

Introns: long sequences of nucleotides inserted between exons that do not code for any portion of the polypeptide, ie. are non-coding sequences

Post-transcriptional Modification			
Modification	Process	Function	
Addtion of 5' Methylguanosine cap	The 5' end of the new pre-mRNA molecule is modified by addition of a cap that consists of a methylated guanine (G) nucleotide/ methylguanosine triphosphate	 Protects mRNA from degradation by nucleases and phosphatises that degrade the RNA from the 5'end during its transport from the nucleus to the cytoplasm 5' cap structure 5' end of the mRNA which serves as the assembly point to recruit the small subunit of the tibos me for translation to begin Helps distinguish mRNAs from the other types of RNA molecules 	
Addition of 3' poly(A) tail	Immediately after the pre-mRNA is cleaved by an endonuclease at a site 10-35 nucleotides after the AAUAAA poly(A) sequence, the 3' end of the pre-mRNA is modified by addition of a series of ~200 adenine (A) nucleotides, referred to as the poly(A) tail. Catalysed by poly(A)-polymerase	 3' poly(A) tail protects the mRNA from degradation by nucleases Make mRNA a more stable template for translation Required to facilitate the export of mRNA out of the nucleus via nuclear pores 	
RNA splicing	RNA splicing occurs after the release of pre-mRNA from RNA polymerase, during which, introns are removed while remaining exons are spliced/ligated together to form mature mRNA . Requires hydrolysis of ATP	 Provides for variation as different combination of exons could results in different types of polypeptides synthesised 	

Genetic code:

- consists of information in the form of **3 nucleotide bases** called **codons of mRNA**
- also the triplet bases in the non-template/non-transcribed strand of DNA