Mollecular and Cellular Biology

Lecture – 2

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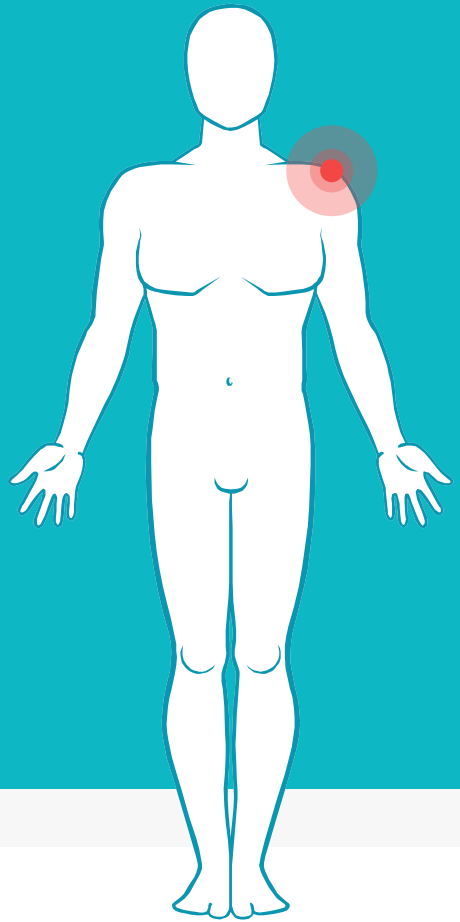

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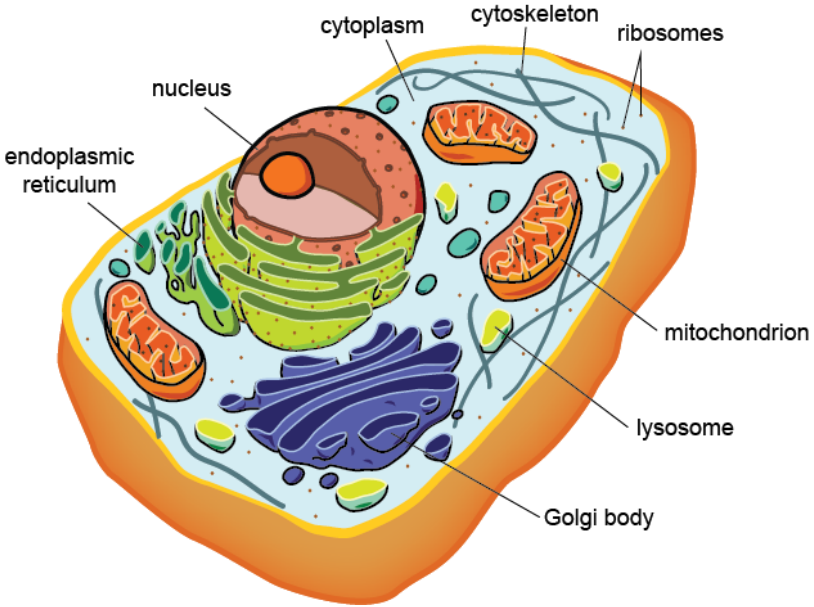
1. Cell

Let’s learn about Eukaryotes, Prokaryotes and Cell Division

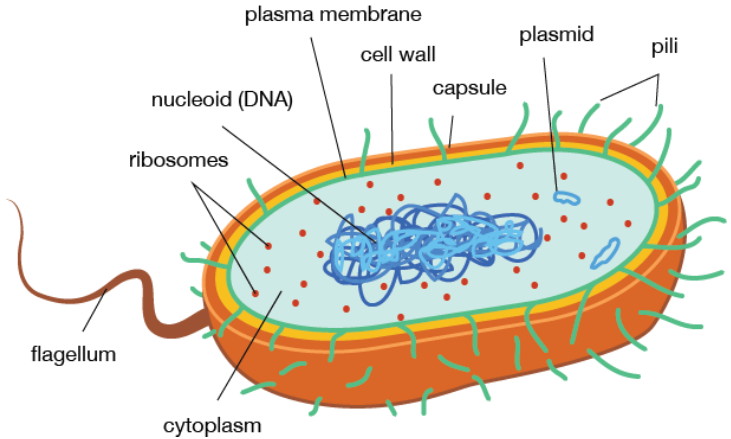
Eukaryotic Cells



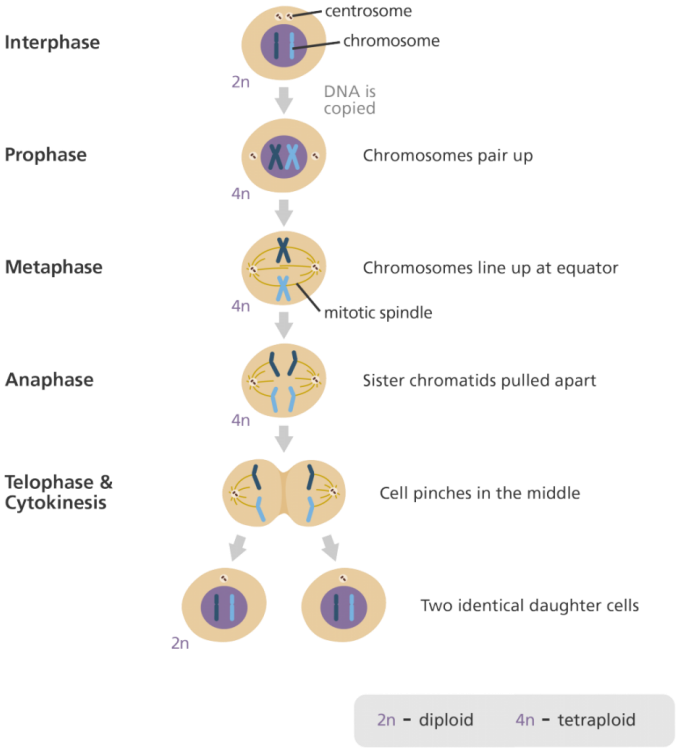
- Single or Multi Cell
- Are called Eukaryotes
- Have Nucleus
- Have membrane bounded organelles
- Have chromosomes inside Nucleus
- Seen in most of the life forms

Prokaryotic Cells

- Single Cell organism
- Are called Prokaryotes
- No Nucleus
- No other membrane bounded organelles
- One piece of rolled up DNA floating in cellular fluid
- Mostly some forms of very ancient Bacteria



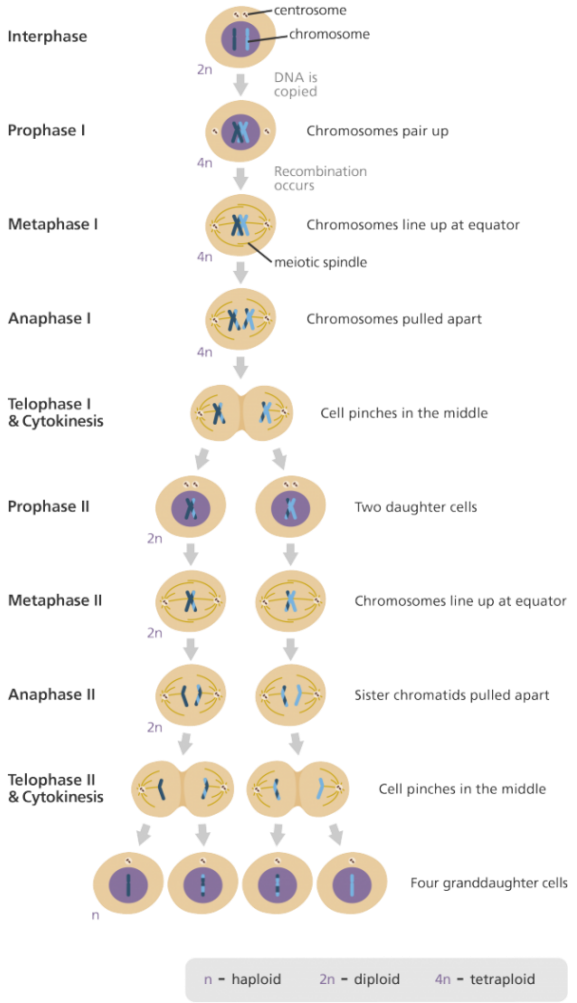
Mitosis Cell Division



- Happens in Somatic Cells (general body cells)
- Cell and chromosome, both gets divided only once
- No cross over
- Takes part in healing and repair

Meiosis Cell Division

- Happens in Germ Cells
- Cell is divided twice, but chromosome only once
- Cross over happens
- Takes part in formation of gametes and maintenance of chromosome number in the race

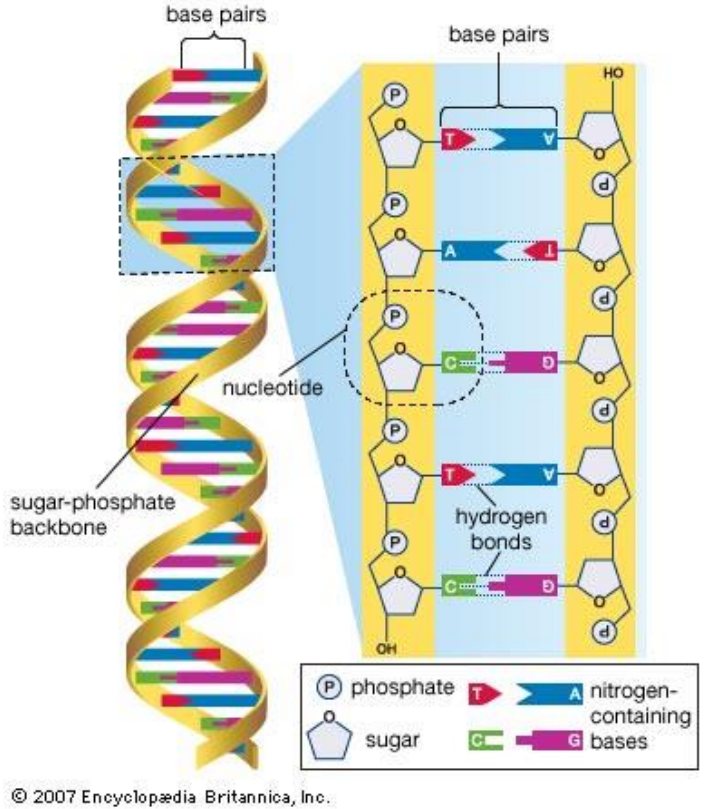


2. DeOxyRiboNucleic Acid (DNA)

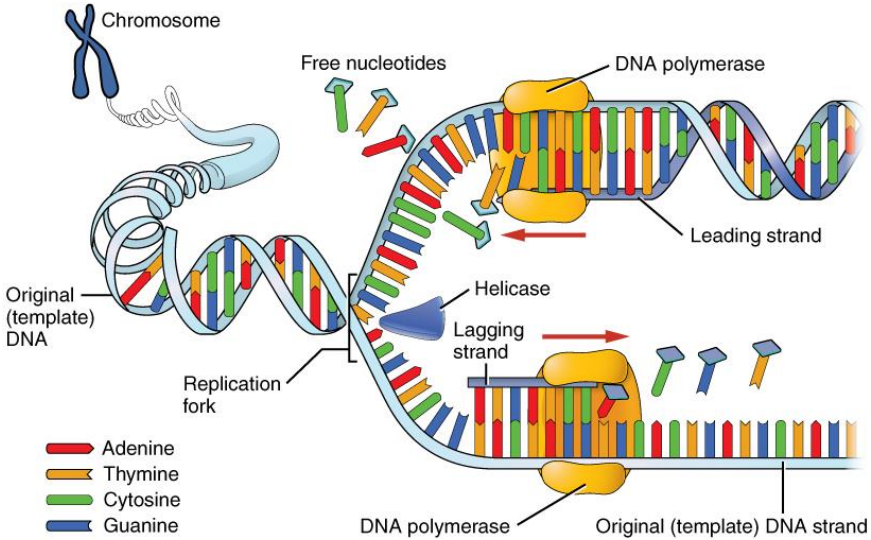
Carrier of genetic instructions

DNA Structure

- Double Helix Structure (Watson and Crick, Nature 1953)
- Two complimentary antiparallel strands, one runs from 5' to 3' end and another runs from 3' to 5' end
- 3 major parts – Nitrogenous Base, 5-Carbon Deoxyribose Sugar and Phosphate Group
- Four nitrogenous bases – Adenine (A), Cytosine (C), Guanine (G), Thymine (T)
- A-T is Double Hydrogen Bond and G-C is Triple Hydrogen Bond
- DNA is more stable than RNA due to its Deoxyribose Sugar Structure



DNA Replication



- Initiation
  - Helicase enzyme unwinds DNA strands
  - Replication fork is created
  - RNA Primer is created by Primase enzyme
  - Primer is starting point of elongation
- Elongation
  - New DNA Strand grows 1 base at a time as complimentary of leading strand (5' to 3')
  - DNA Polymerase enzyme controls it
  - Complimentary strand of lagging strand is created in small fragments called Okazaki Fragments (3' to 5')
- Termination
  - Exonuclease enzyme removes all the primer sequences from new strands
  - Again, DNA Polymerase fills the gaps
  - DNA Ligase enzyme seals all the gaps

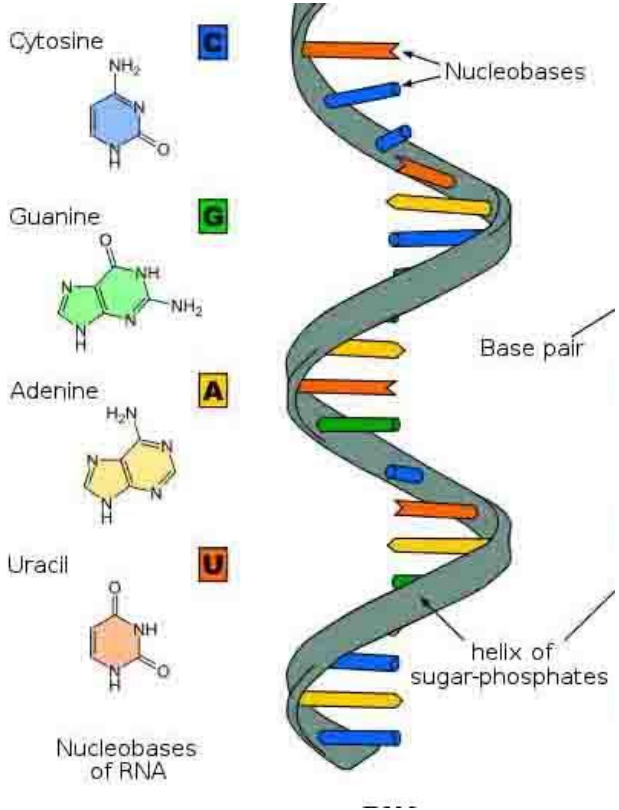
*** DNA Replication is Semi-Conservative, because, in new sets of DNA, one strand is newly created but the other strand comes from the ancestor.**

3. RiboNucleic Acid (RNA)

Protein Coding and Carrier

RNA Structure

- Single Helix Structure
- Single Strand which generally runs from 5' to 3'
- 3 major parts – Nitrogenous Base, 5-Carbon Ribose Sugar and Phosphate Group
- Four nitrogenous bases – Adenine (A), Cytosine (C), Guanine (G), Uracil (U)
- A-U is Double Hydrogen Bond and G-C is Triple Hydrogen Bond
- RNA is less stable than DNA due to its Ribose Sugar's structure



RNA Types

Messenger RNA (mRNA)
Carries a genes coding message for protein from Nucleus to Ribosome

Transfer RNA (tRNA)
Transfers specific amino acid sequence to ribosome to form Protein

Ribosomal RNA (rRNA)
Protein and rRNA combinedly forms ribosome

Non-Coding RNA
Not translated into protein. Ex – tRNA, rRNA

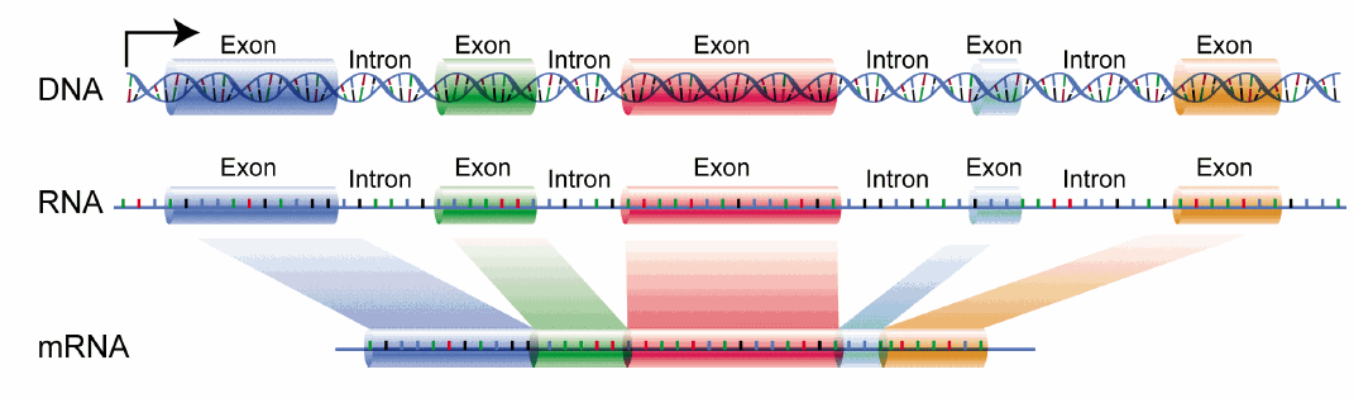
Catalytic RNA
Catalyze chemical reaction.

Double Stranded RNA
Contains complementary strands like DNA. Induces gene exrpression.

4. Gene Structure

A basic structure of Eukaryotic Gene Gene

Eukaryotic Gene Structure



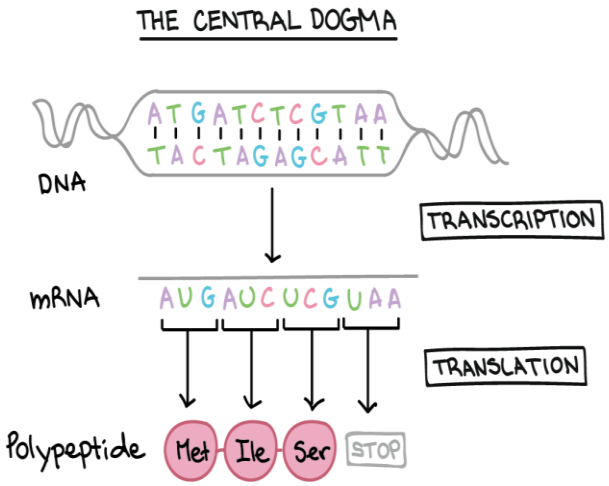
- Two major parts – Exon & Intron
- Exon – Takes part in protein coding and production
- Intron – Does not take part in protein coding, part of pre-mRNA but gets filtered out in matured mRNA

5. Central Dogma

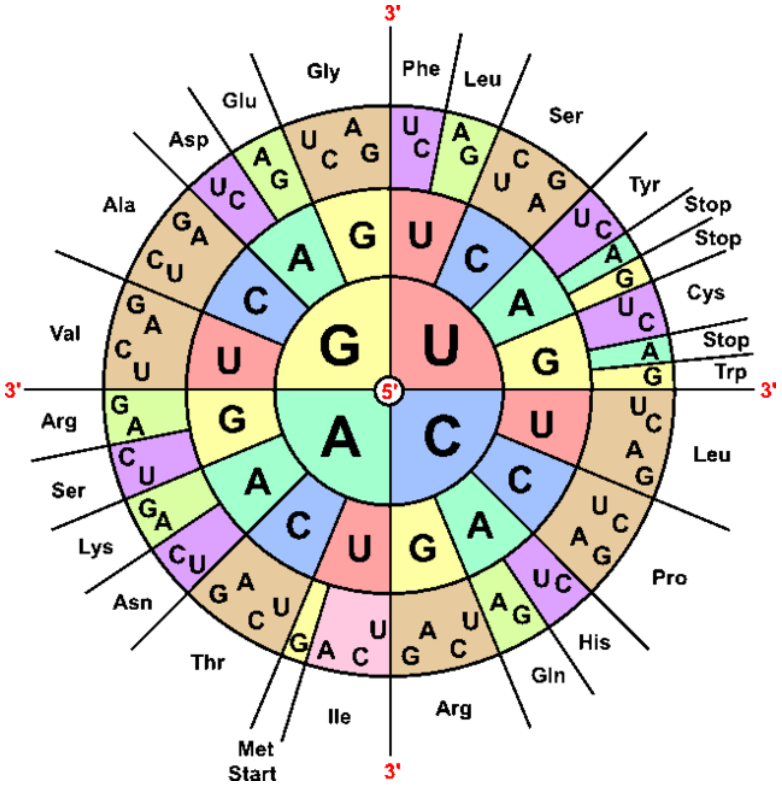
Producing Protein from DNA

Major Steps of Central Dogma

- Transcription
  - RNA Polymerase enzyme attaches to the start of the gene
  - mRNA is created (complimentary to DNA strand RNA Polymerase is attached)
  - mRNA is processed, unnecessary sections are removed (introns)
  - mRNA moves out of nucleus into cytoplasm
- Translation
  - mRNA binds to Ribosome
  - Ribosome reads code in mRNA (triplets/codons)
  - tRNA brings Amino Acid corresponding to codon
  - Chain of Polypeptide / Amino Acid is formed
  - Chain folds in different 3D shapes and produces different types of Proteins



Genetic Codes in Translation (Codons)



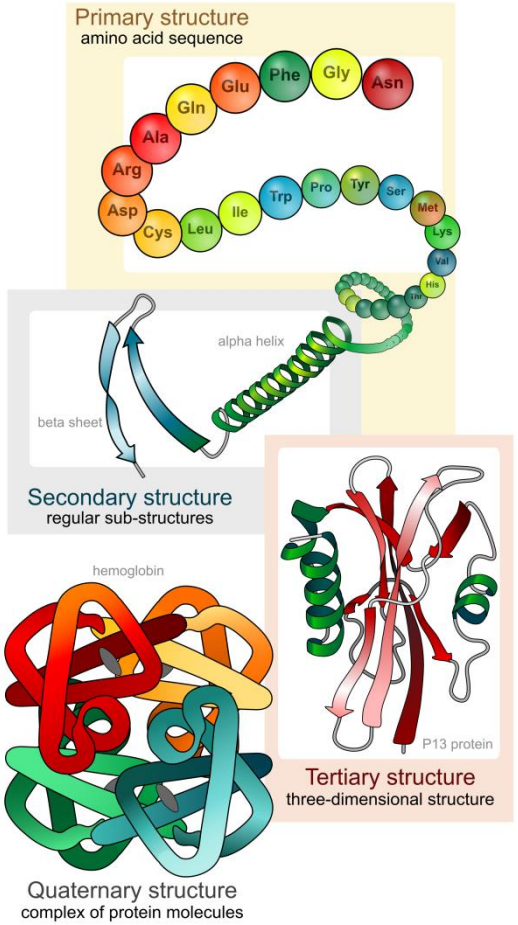
- **Start Codon – AUG**
- Start Codon codes Methionine
- **Stop Codon – UAA, UAG, UGA**
- 64 Combinations Possible
- 20 Amino Acids
- More than 1 combination can code single Amino Acid (Ex – UUU, UUC both codes -Phe-)

6. Protein

3D Structure with different formation of Amino Acid chain

Protein Overview

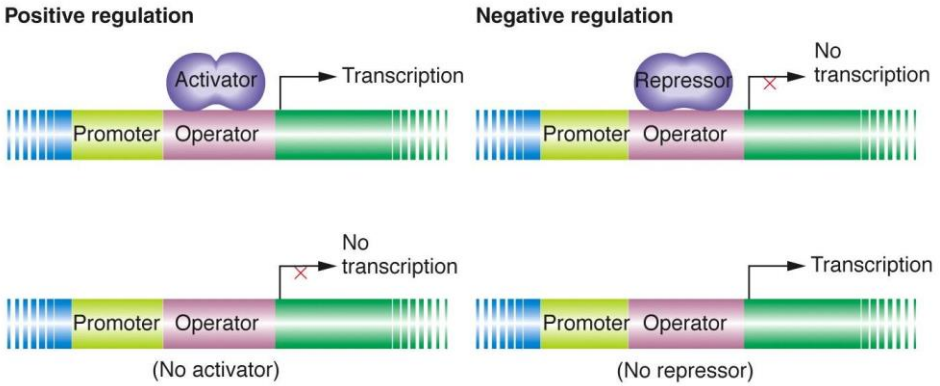
- Chains of 20 types of Amino Acid
- Performs most of the cell functions
  - Regulates gene expression
  - Acts as enzymes which catalyze chemical reactions
  - Forms structures
- Folds into 3 dimensional structures
- Function of a protein is determined by its structure



7. Gene Regulation and Alternative Splicing

Study different gene regulations and splicing method

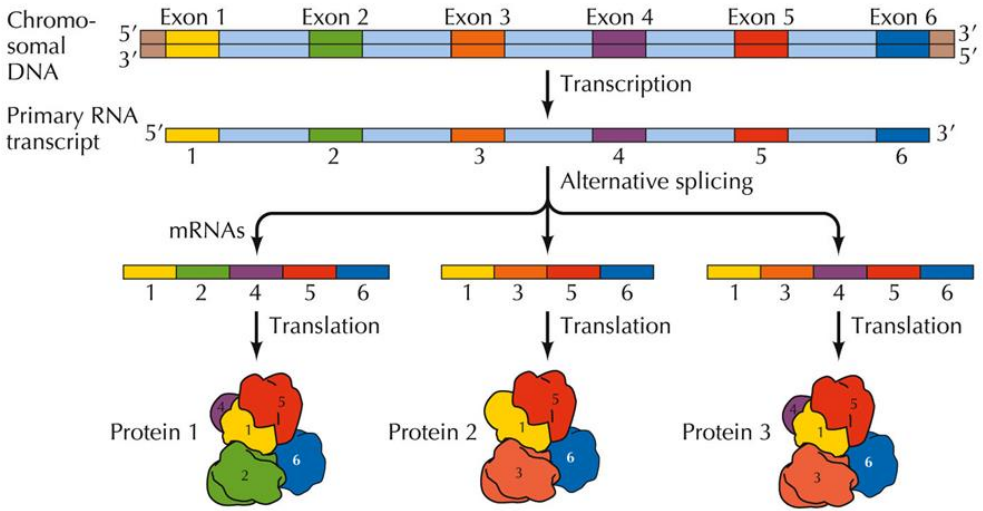
Regulating Gene Expression



- Gene regulation refers to the mechanism of inducing or repressing the expression of a gene
- 2 types of regulation – Positive & Negative
- Positive Regulation works with Activator
  - * Operator + Activator = Transcription
  - * Operator – Activator = No Transcription
- Negative Regulation works with Repressor
  - * Operator + Repressor = No Transcription
  - * Operator – Repressor = Transcription

Alternative Splicing

- DNA has genes
- Genes has regions – Exons & Introns
- Pre-mRNA has both introns and exons
- Matured mRNA has only exons
- Different combinations of exon regions form different protein, this is alternative splicing
- Alternative Splicing is the process in which one gene produces many different proteins



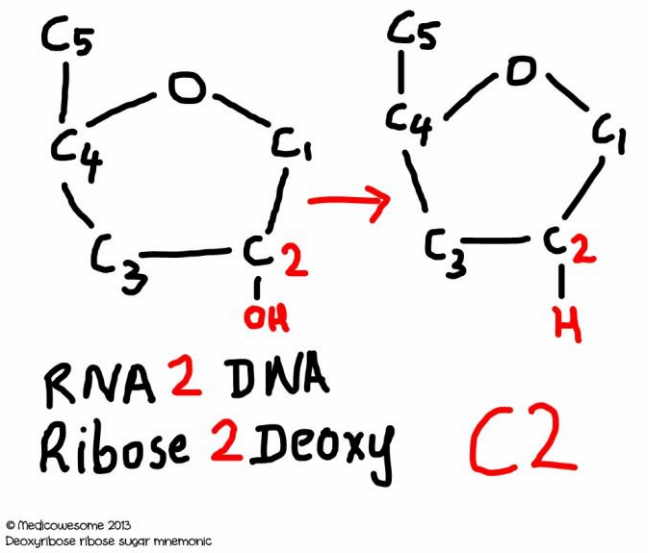
8. Miscellaneous Terms

Some comparisons, terms etc.

Phenotype VS Genotype

- Phenotype is the physical expression of a gene
- Genotype is the genetic structure
- Example – Eye color is phenotype, and the gene responsible for eye color is genotype.

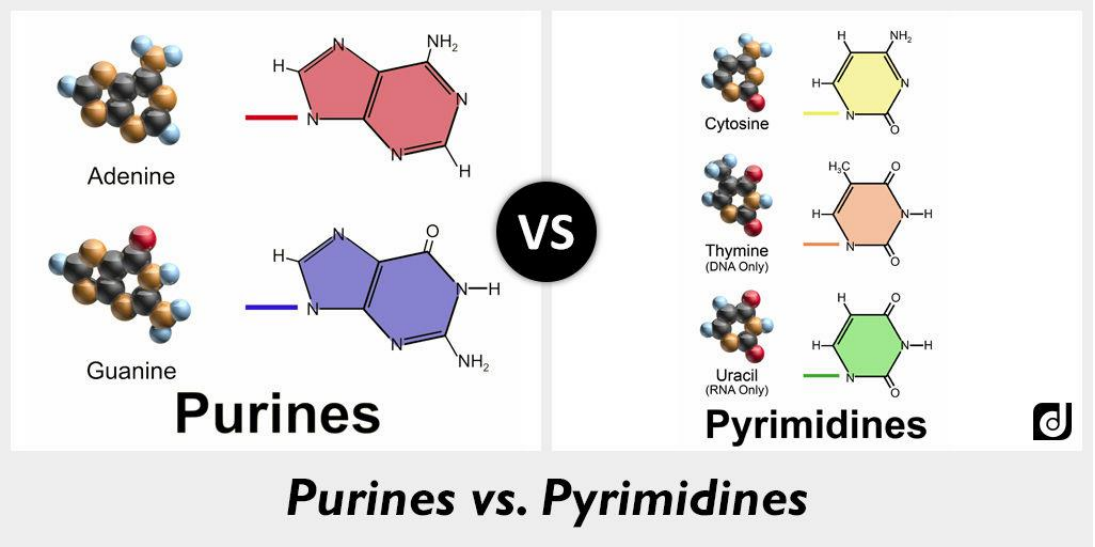
Deoxyribose VS Ribose Sugar



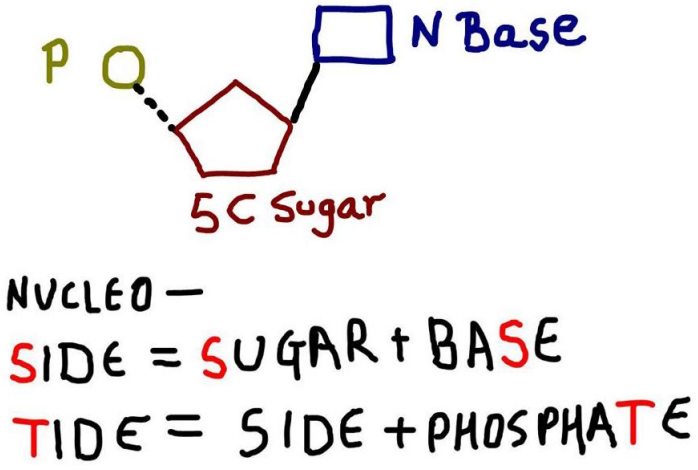
- DNA has deoxyribose sugar
- RNA has ribose sugar
- DNA is more stable than RNA due to the sugar structure stability

Purine VS Pyrimidine

- Purines have double ring
- Pyrimidines have single ring



Nucleotide VS Nucleoside



- Nucleoside = Base + Sugar
- Nucleotide = Base + Sugar + Phosphate

3-7 Years Average

Lifespan of a Human Hair

1 Cm

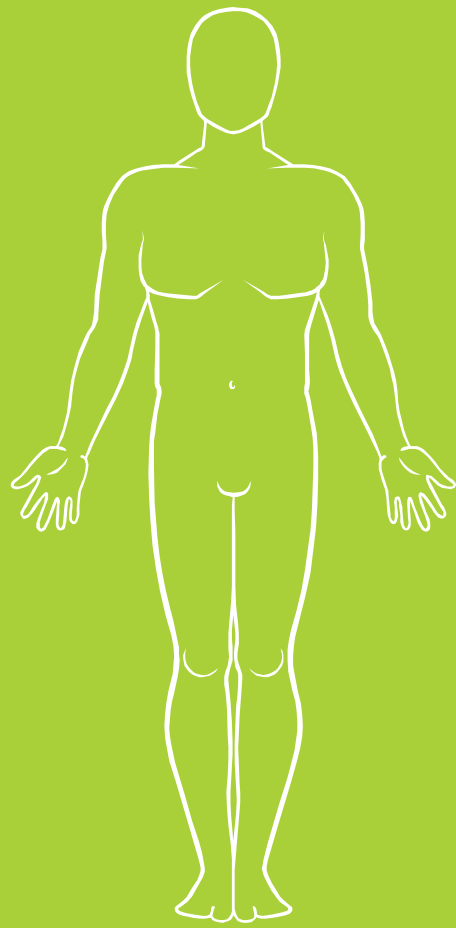
Taller in the morning than in the evening

32 Million

Bacteria lives in every inch of your skin

Human Tongue

Strongest muscle in the body



Motivated?

Youtube Links

- DNA Structure – https://www.youtube.com/watch?v=C1CRrtkWwu0
- DNA Replication – https://www.youtube.com/watch?v=TNKWgcFPHqw
- Central Dogma – https://www.youtube.com/watch?v=gG7uCskUOrA