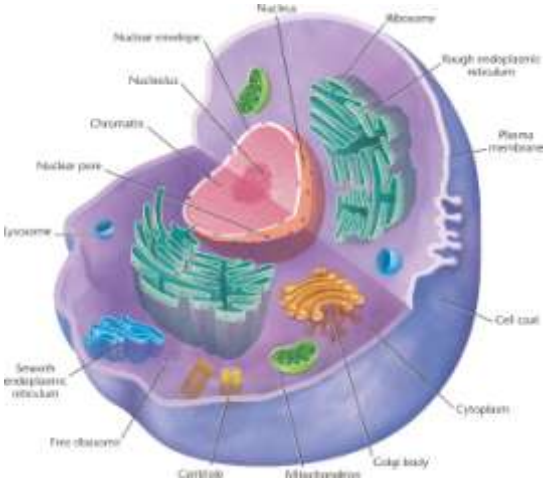
DNA and Protein Synthesis

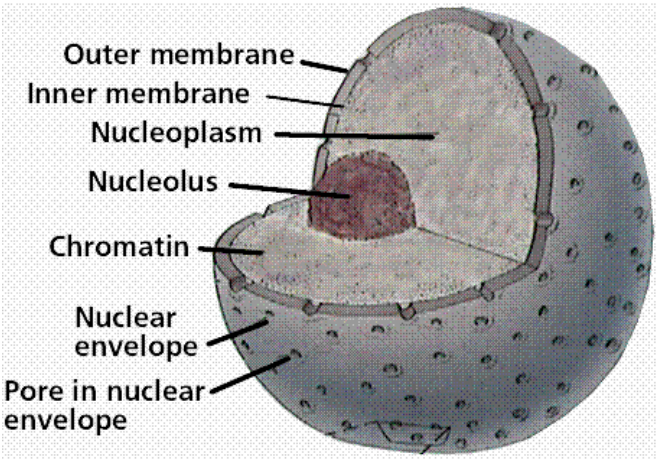
Nucleic Acids

- Control cellular activities, enable cells to copy themselves, enable cells to inherit traits from parents
- They do this by controlling the synthesis of proteins
- Enzymes are proteins that control chemical processes inside cells
- Two types of nucleic acid are DNA and RNA

Deoxyribonucleic Acid (DNA)

- Found in chromosomes of nucleus of every living cell- macromolecules





Cell Diagram Nucleus Diagram

Why is DNA important?

1. Carries **hereditary** characteristics- when it **replicates** it carries info from mother to daughter cells
2. Controls structure/ **function** of the cell (metabolism)- controls **protein synthesis** by the **sequence** of the **nucleotide** bases (genes)
3. It can **mutate**- accidental change in nucleotide sequence which alters genes- changes in gene pool and introduces **variation** that leads to genetic diversity

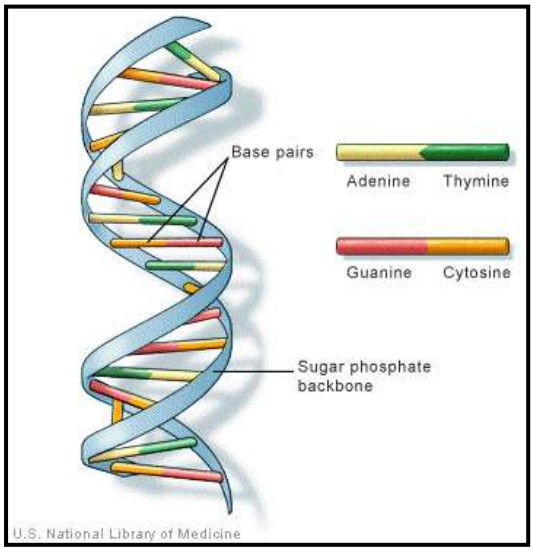
Chromosome Structure

- Coiled DNA forms X shape of chromosome
- 46 in human: artificially joined in karyotype to make 23, (23rd X female/Y male)

DNA Structure

- Chromatin Network: long, thin intertwined chromosomes
- Each chromosome is made up of DNA wound around histones (a protein)
- Histones wrap into nucleosomes- this allows DNA to be compact
- Nucleosomes wrap into chromosomes= **SUPERCOILING**
- DNA is a double helix shape

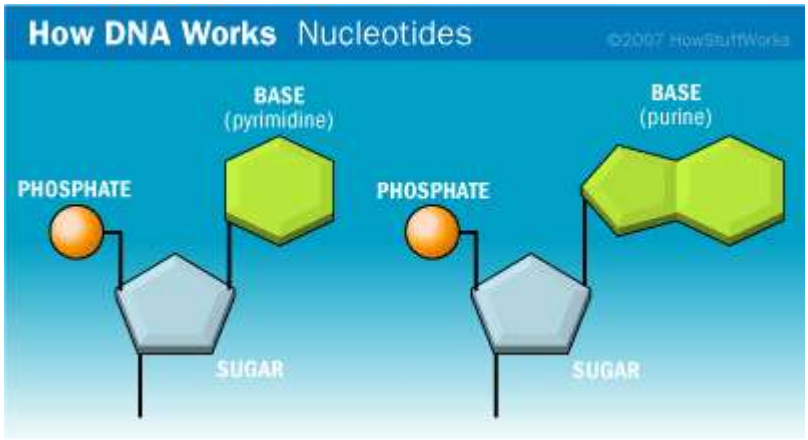
DNA and Protein Synthesis



Nucleotides

DNA is a polymer made up of long chains of small units (monomers) called nucleotides

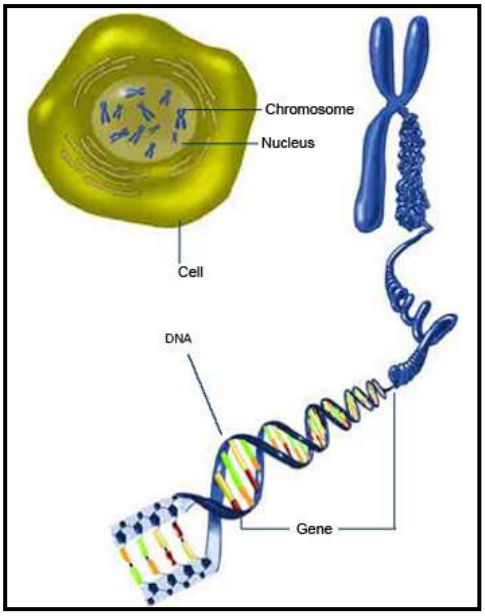
- Deoxyribose sugars (S)
- Phosphate molecule (P)
- Nitrogenous base
    - Adenine A- 2 bonding sites/ Purine
    - Thymine T- 2 bonding sites/ Pyrimidine
    - Guanine G- 3 bonding sites/ Purine
    - Cytosine C- 3 bonding sites/ Pyrimidine



DNA- Physical Structure

- Double helix: two strands parallel to each other in sugar/ phosphate chains: strong bonds
- Sugar/ phosphate chains linked by complimentary bases: weak hydrogen bond
- Adenine/ Guanine are large (purines)
- Thymine and Cytosine are small (Pyrimidine's)
- A+T and G+C

- The SEQUENCE of the nucleotides determines the gene and therefore the GENETIC CODE of the organism



Mitochondrial DNA

- Located in mitochondria which is an organelle that converts chemical energy to ATP
- Consists 37 genes
- Often inherited from mother because of **dilution** (much more mtDNA in egg cell than sperm cell) **degradation** of sperm mtDNA in fertilized egg or **failure** of **sperm mtDNA** to **enter egg**
- Single parent inheritance pattern found in most plants, fungi, animals
- Powerful tool for tracking ancestry through females (matrilineage)
- Identify human remains

What is a Gene?

- Portion DNA molecule
- Basic physical/ functional unit of heredity
- Each chromosome contains many genes
- Are the instructions to make proteins
- Every person has **two copies** of each gene from each parent
- Alleles- forms of the same gene with small differences in DNA base sequence= uniqueness
- Locus- a point on a chromosome where a pair of genes are

DNA technology- DNA Fingerprinting and Forensic Evidence

- Scientists can extract DNA from human body cells such as skin/ hair or semen
- DNA analysed in PCR (Polymerase Chain Reaction) process
- Once prepared, looks like bar code pattern- pattern of bars links to series of base pairs- each unique and known as DNA Fingerprints
- Prove paternity/ identify crime suspects/ find missing children

DNA and Protein Synthesis

DNA Gene Sequences

- Two people have small chance of having identical gene sequence
- The closer the relation, the greater chance their sequences will be similar- identical twins

Junk DNA

- Tests don't look at info inside genes, rather examine non- coding DNA that separates genes along chromosomes- junk DNA which is highly variable
- This variability ensures everyone has a unique DNA fingerprint

Should finger prints be taken from whole nation?

Negative:

- Could get framed
- Medical insurance (defective genes-deny insurance)
- People unemployed if sick
- Money better spent
- Jails overflowing already
- Inadequate court/justice system
- Lack of educated people deal technology

Advantages:

- Borders catch criminals
- Identify missing children
- Crime investigation more efficient
- Idea growing population

DNA Replication

- Process of making a new DNA molecule from existing DNA molecule- identical, hereditary
- Occurs during interphase of mitosis
- Catalysed by enzyme DNA polymerase

1. DNA double helix unwinds
2. Weak hydrogen bonds holding together base pairs break= 2 single chains of bases exposed
3. Free nucleotides in nucleoplasm attach to corresponding base partners and sugar/ phosphate bond forms
4. sequence of bases is exactly the same
5. Two identical double helices. Daughter DNA molecules wind around histones forming chromosome
6. Each daughter DNA strand is a chromatid and two identical chromatids are held together by a centromere (chromatid IS a DNA strand)

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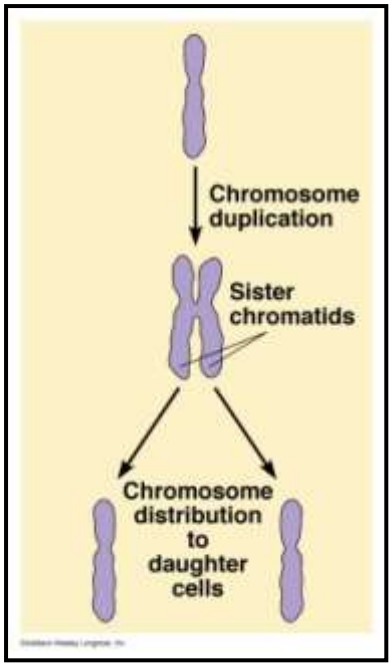


Mutations

- Wrong nucleotide with wrong base pair
- Watchdog enzymes splice out mistakes/ put correct nucleotide in place
- Sometimes can be beneficial mutation

Ribonucleic Acid- RNA

- Polymer made up of nucleotides in a single strand. Involved in protein synthesis
- Contains ribose sugar (DNA has Deoxyribose sugar) phosphate group and nitrogen base
- Adenine- Uracil
- Guanine- Cytosine

Differences between DNA and RNA

DNA	RNA
Functions only in nucleus- cannot go into cytoplasm as it needs to be protected	Goes into cytoplasm as a single strand copy of DNA to provide code to build proteins
Contains thymine	Thymine is replaced with Uracil
Double Helix	Single strand
Deoxyribose sugar that can bond with Thymine	Ribose sugar that can bond with Uracil

Different types of RNA

1. **mRNA- Messenger RNA**
    - built up in nucleoplasm with DNA as template
    - has a groups of 3 bases- codons
    - FUNCTION: bring code for synthesis of proteins from DNA in nucleus to ribosomes

2. **tRNA- Transfer RNA**
    - folds back into a loop with 3 exposed bases called anticodons on one end and an amino acid on the other
    - found in cytoplasm
    - FUNCTION: picks up amino acids in cytoplasm and brings to ribosome
3. **rRNA- ribosomal RNA**
    - made in nucleolis (dark areas of nucleus)
    - goes into cytoplasm when more ribosomes are needed/ combines with protein to make them
    - rRNA is a copy of DNA with ribosome code
    - FUNCTION: forms important structural component of ribosome

Protein

- Control chemical reactions(enzymes)
- Defend body against disease(antibodies)
- Transport substances around body(haemoglobin)
- Polymers- made up of smaller units called amino acids

Amino Acids

- 22 types, 11 essential cannot be made by our bodies
- The sequence of amino acids determines the protein
- 4 or more amino acids- polypeptide/ 3- tripeptide/ 2-dipeptide
- Protein contains atleast 50 amino acids

Transcription and Translation: an introduction

- Transcription: Process by which DNA makes RNA
- Translation: when mRNA carries code from DNA to ribosomes- the order of nucleotides in mRNA determines the sequence of amino acids= determines which protein is formed
- tRNA brings correct amino acid to the ribosome
- rRNA controls process at ribosome
- LOOK AT DIAGRAM OF PROTEIN SYNTHESIS

Stage one of Protein Synthesis: TRANSCRIPTION

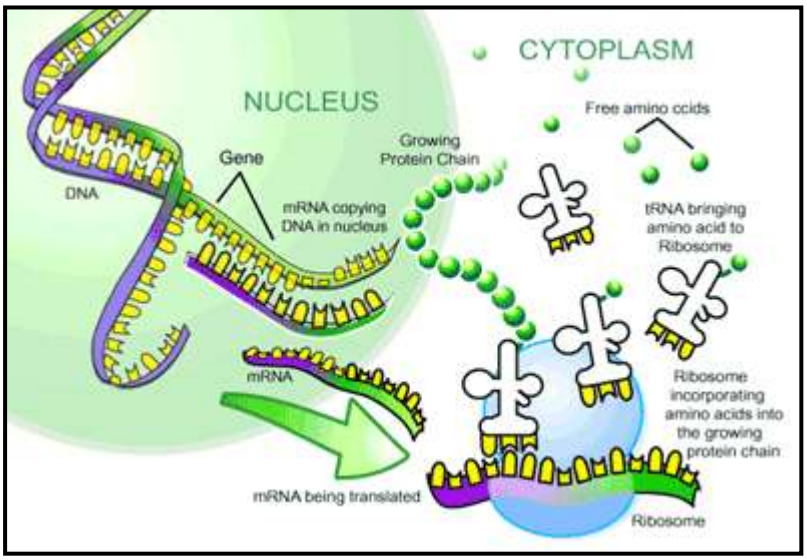
- Occurs in nucleus and controlled by thousands of enzymes
- One half of a DNA strand contains the code for the required protein by having the sequence in which the amino acids must combine
- GENE: a segment of a DNA strand which carries code needed to make a protein
- The DNA that codes for the gene forms a chromosomal puff- exposes nucleotides
- Free floating RNA nucleotides form a complimentary mRNA strand on one of the DNA strand
- Each group of 3 bases on the mRNA is a CODON
- mRNA moves out of nucleus through pores in nuclear membrane to carry code to ribosomes
- note: thymine replaced with uracil on mRNA

Stage Two of Protein Synthesis: TRANSLATION

- Occurs in cytoplasm on rough ER and controlled by 1000's of enzymes
- mRNA attached to ribosome on rough ER
- tRNA picks up amino acids according to their triplet bases: ANTICODON
- each tRNA has only one specific amino acid
- ribosome moves along mRNA from start to stop codon highlighting each codon as it moves
- as a codon is highlighted, it attracts the complimentary tRNA anticodon- bringing amino acid
- codons of mRNA determine which anticodons are brought and therefore the sequence of amino acids
- once amino acids are in correct sequence, they combine with peptide links= polypeptide chain
- tRNA leave mRNA , return to cytoplasm
- LOOK AT TRANSLATION DIAGRAM AND LEARN
- Note: methionine always starts sequence/ stop happens when no amino acid is brought with tRNA and peptide bonds stop

After Translation

- polypeptides move away from mRNA to Golgi Body- combines with fats/ mineral/ carbs/ vitamins to make complex protein
- mRNA is chopped by enzymes and goes back to nucleus as free floating enzymes



Take note of codon tables