Take notes while watching the following video tutorials to prepare for the "Nucleic Acids Activity".

Nucleic Acids Part 1: Introduction and Nucleotides (The Basic Building Blocks)

DNA:

RNA:

Function of

DNA

RNA

Supporting Cast:

Ribosomes

Red Blood Cells

RBCs are produced from stem cells in the bone marrow. When RBCs mature, they discard their DNA to make room for more hemoglobin. Thus, they have no nucleus, no DNA, and do not divide. They produce energy through glycolysis, so RBCs do not have mitochondira.

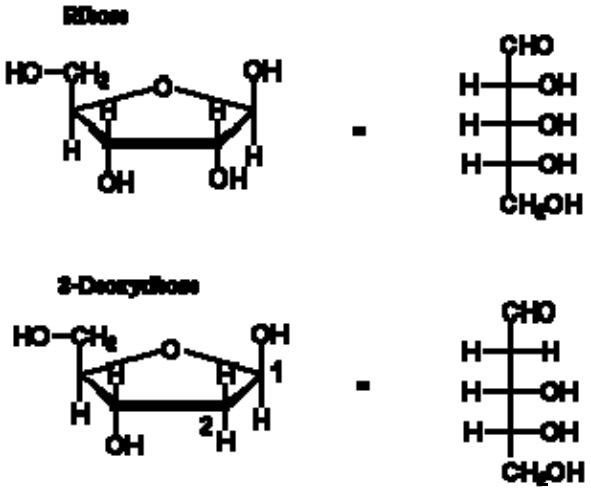
What is glycolysis?

What important biochemical reactions occur in mitochondria?

Nucleoside:

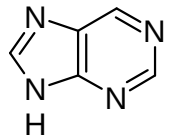
Nucleotide:

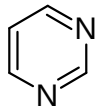
The Monosaccharide Component



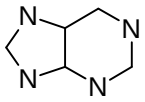
The Nitrogen Base

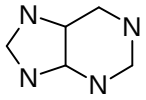
Derivatives of purine and pyrimidine

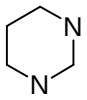


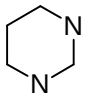


DNA Bases

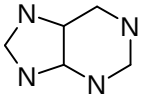


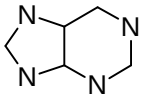


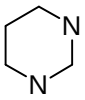




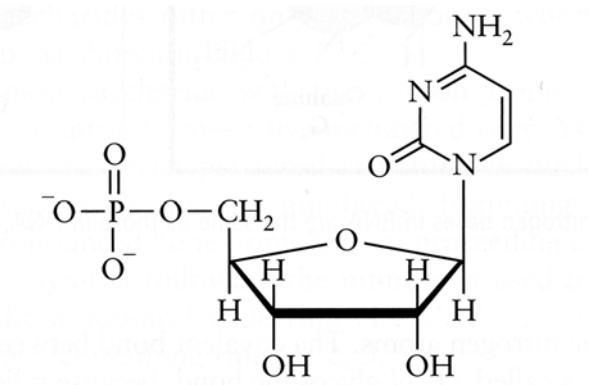
RNA Bases







The Phosphate Group



Point an arrow to the bond that links the ribose to the phosphate group.

What type of bond links the phosphate group to the sugar?

Other important nucleotides

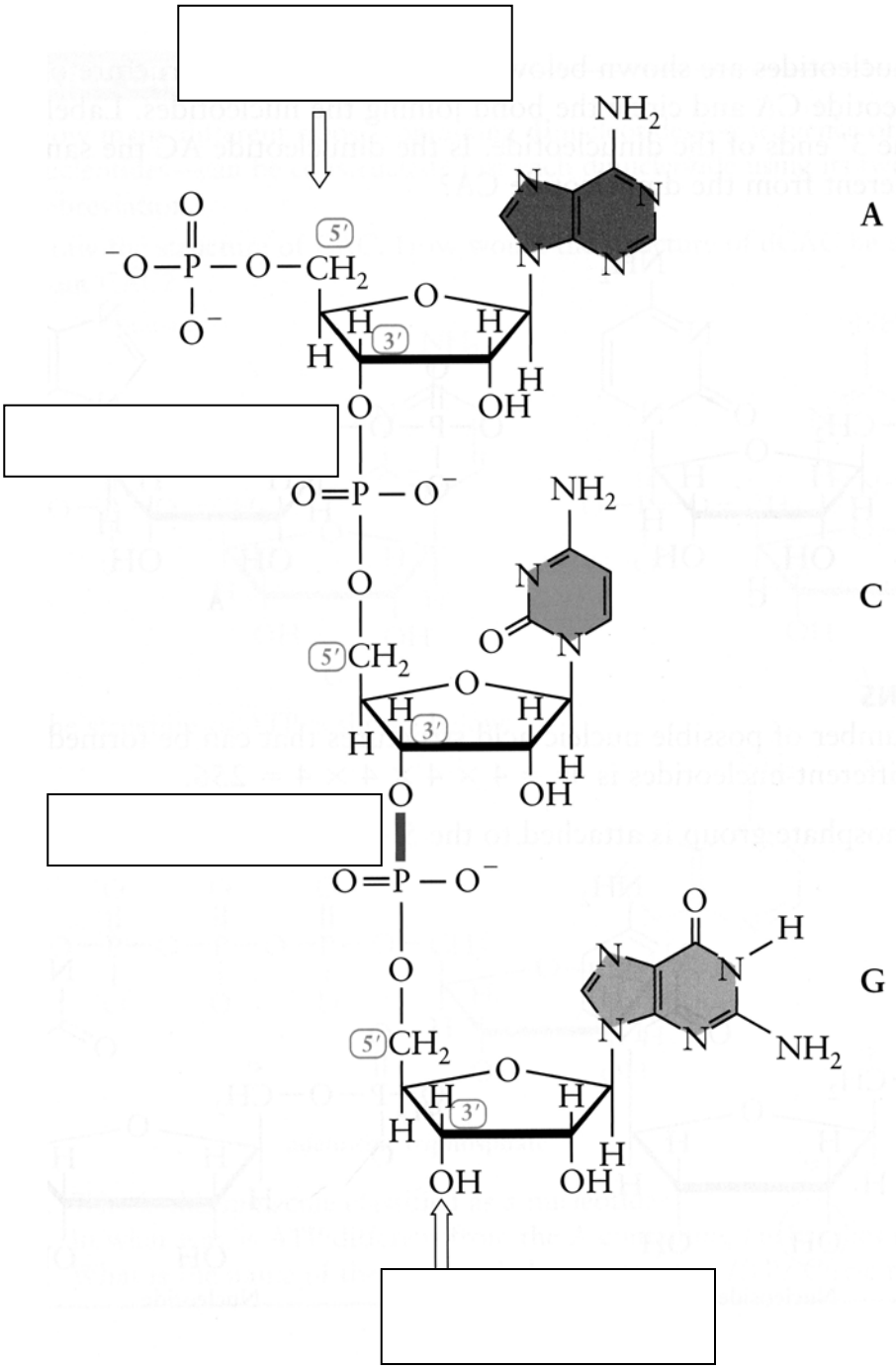
Construct AMP from its 3 basic parts: phosphate, adenine, & deoxyribose.

Nucleic Acids Part 2: DNA

Nucleic Acids

Nucleotides are joined when the phosphate of one nucleotide joins with the 3′ alcohol the other nucleotide to form a phosphate ester bond.

Example – the trinucleotide ACG



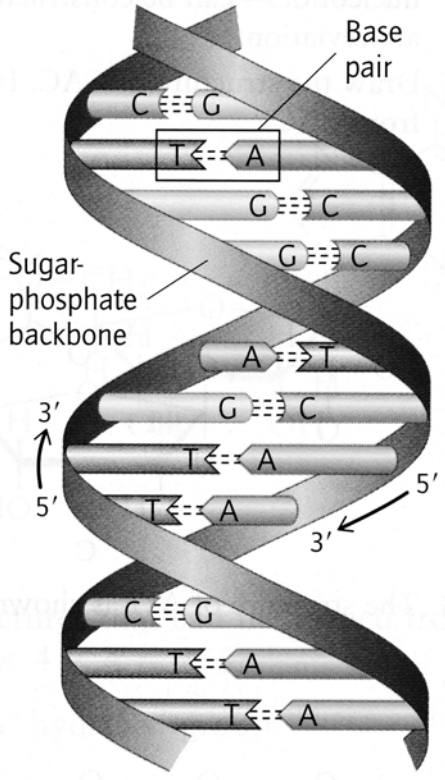
The number of nucleic acids that can be formed from 4 different nucleotides is 4^n. For example, only 3 nucleotides creates $4^3 = 64$ different possible nucleic acids.DNA is composed of millions of nucleotides creating astronomical possibilities.

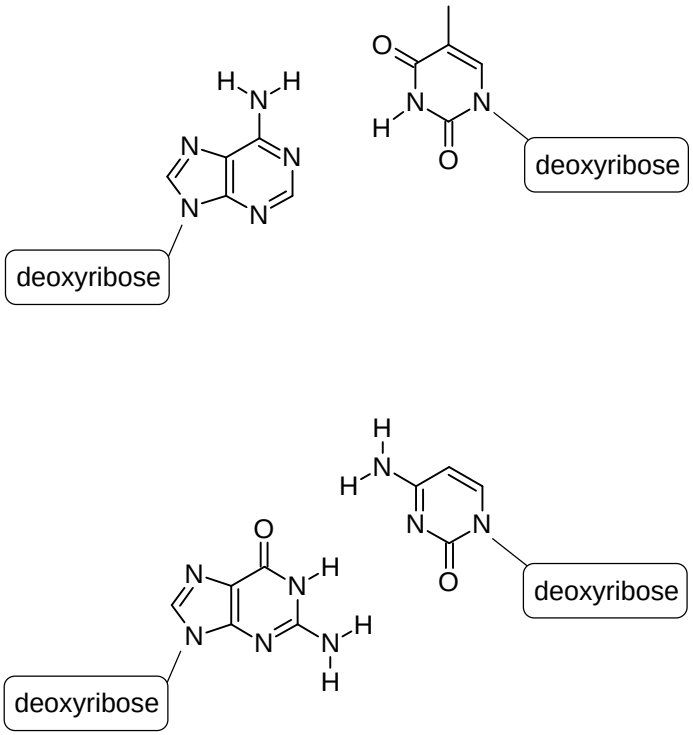
DNA

DNA consists of two nucleic acid molecules twisted around each other to form a double helix.

Hydrophilic Backbone:

Hydrophobic Base Pairs:





Chromosomes: Higher Order DNA Structure

DNA is packaged into chromosomes found in the nucleus of cells

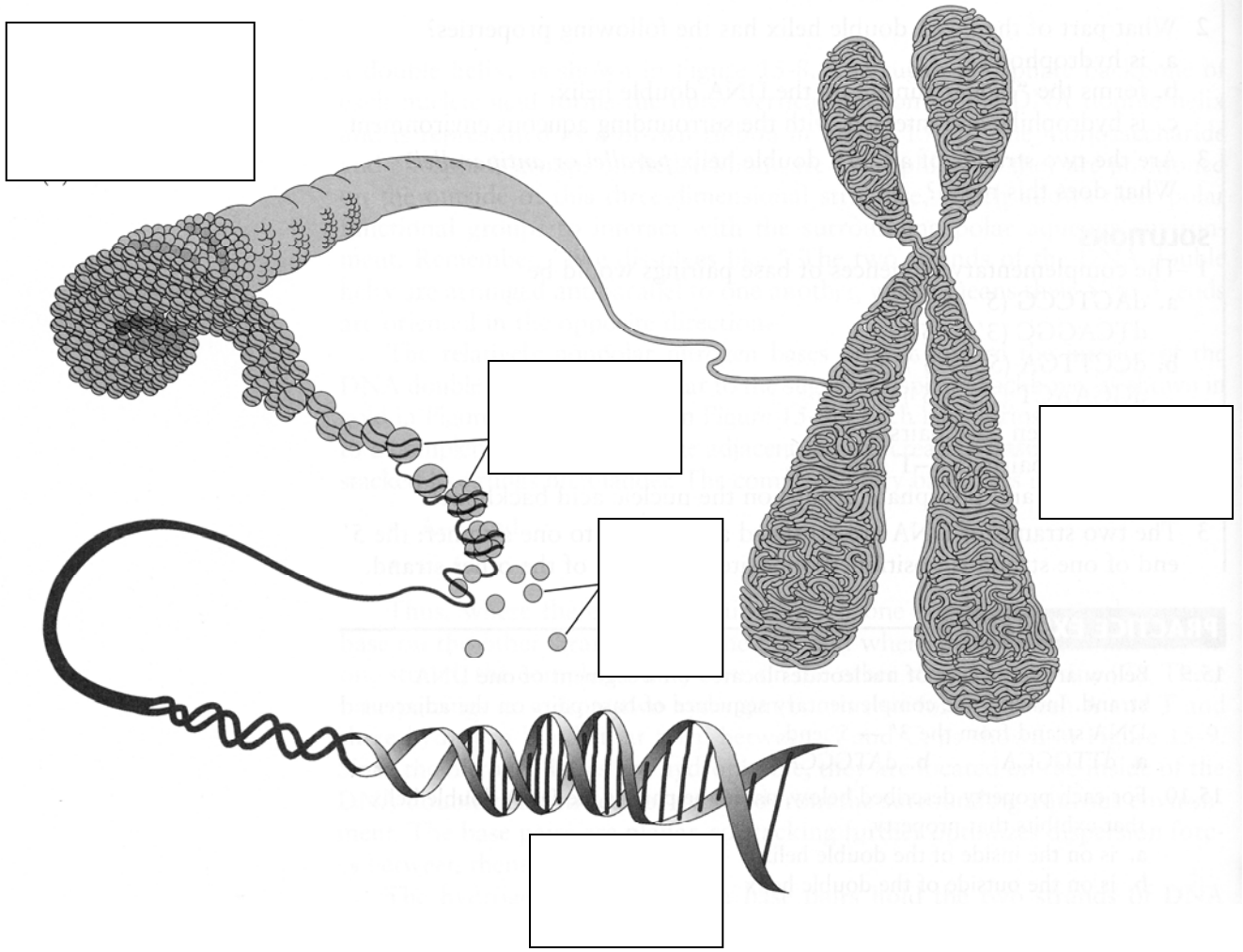
Chromosomes: highly compact structures containing DNA & proteins

Histones: proteins found in DNA

Nucleosomes: DNA wrapped around histones

Chromatin fiber: nucleosomes coiled upon themselves

Label the diagram below



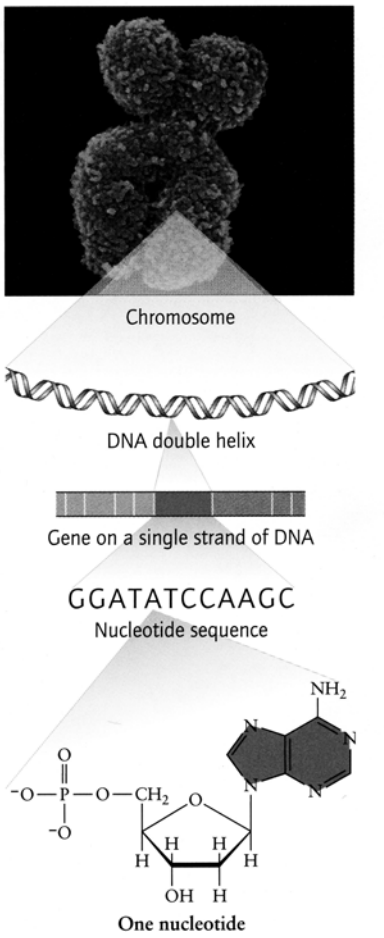
Genes and the Human Genome

Genome: the complete sequence of bases in DNA distributed over 46 chromosomes

Gene: a segment of DNA that contains the instructions for making a protein

Chromosome 6

Chromosome Structure



DNA Replication

Every person starts life as a fertilized egg (zygote) which contains the entire human genome. This single cell grows and divides to become a human being with one trillion cells – each with same genome as the zygote from which it originated.

DNA replication is an anabolic biochemical process.

1) Unravel super-coiled DNA to expose double helix

2) Each of the two strands is copied

Nucleic Acids Part 3: RNA and Protein Synthesis

The genes in DNA hold the instructions for how to synthesize proteins.

The actual synthesis of the proteins requires RNA and ribosomes.

RNA – 3 Major Forms for 3 different jobs

rRNA

mRNA

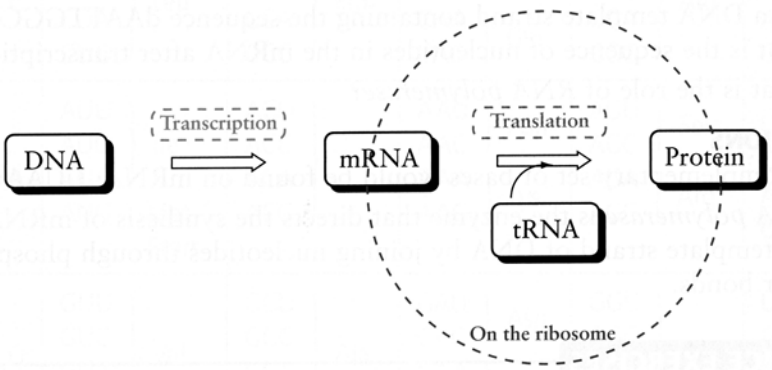
tRNA

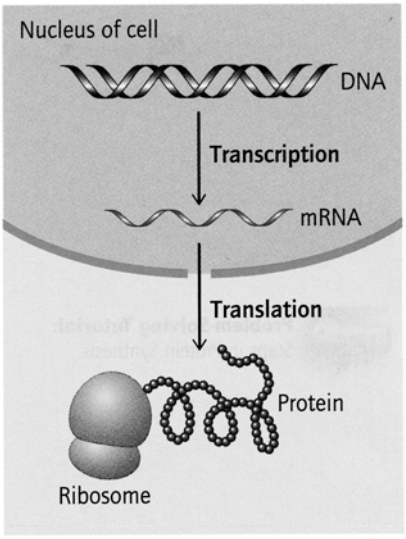
RNA is a single-stranded nucleic acid.

Ribosomes are the protein-making factories of the cell.

Transcription: Instructions from a section of DNA are copied to mRNA

Translation: tRNA delivers amino acids to the ribosome for protein synthesis





Transcription & mRNA

A segment of DNA unravels to expose the nucleotide sequence on the template strand of DNA so that RNA polymerase can build a complimentary nucleotide sequence of mRNA.
DNA returns to its double helix structure and mRNA is exported out of the nucleus and to the ribosomes in the cytoplasm.

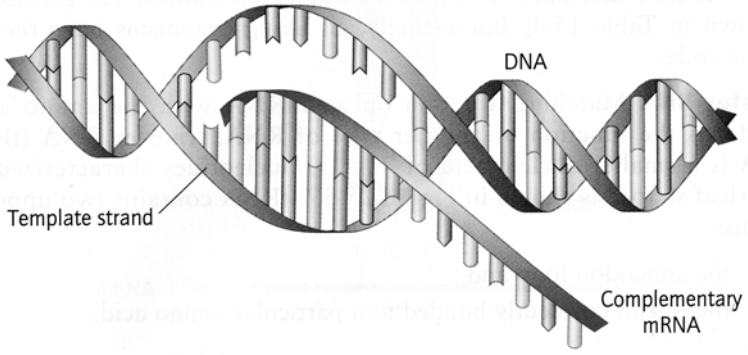
Gene expression: a gene's DNA is used as a template for synthesis of a specific protein

Gene expression begins with transcription.

1) DNA must be unraveled to expose the nucleotide sequence.

2) Copying begins at nucleotides called "start codons".

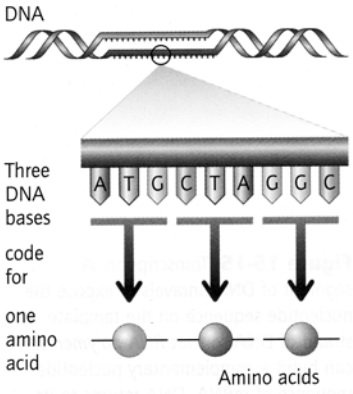
3) DNA refolds and mRNA is exported out of the nucleus and into the cytoplasm where the ribosomes are located



What is the complimentary mRNA sequence for a DNA sequence of GATCAT?

Ribosomes are the cellular structures were the nucleotide sequence of the mRNA is read and a polypeptide is built by linking amino acids.

Codon: every group of three nucleotides on an mRNA molecule is known as a codon because it codes for one of the 20 amino acids.



Since there are 64 possible codons and only 20 amino acids, each amino acid has more than one codon.

Genetic Code: the key for the codons and their amino acids

First letter	Second letter: U	Second letter: C	Second letter: A	Second letter: G	Third letter
U	UUU, UUC: Phe UUA, UUG: Leu	UCU, UCC, UCA, UCG: Ser	UAU, UAC: Tyr UAA, UAG: Stop	UGU, UGC: Cys UGA: Stop UGG: Trp	U C A G
C	CUU, CUC, CUA, CUG: Leu	CCU, CCC, CCA, CCG: Pro	CAU, CAC: His CAA, CAG: Gln	CGU, CGC, CGA, CGG: Arg	U C A G
A	AUU, AUC, AUA: Ile AUG: Met/Start	ACU, ACC, ACA, ACG: Thr	AAU, AAC: Asn AAA, AAG: Lys	AGU, AGC: Ser AGA, AGG: Arg	U C A G
G	GUU, GUC, GUA, GUG: Val	GCU, GCC, GCA, GCG: Ala	GAU, GAC: Asp GAA, GAG: Glu	GGU, GGC, GGA, GGG: Gly	U C A G

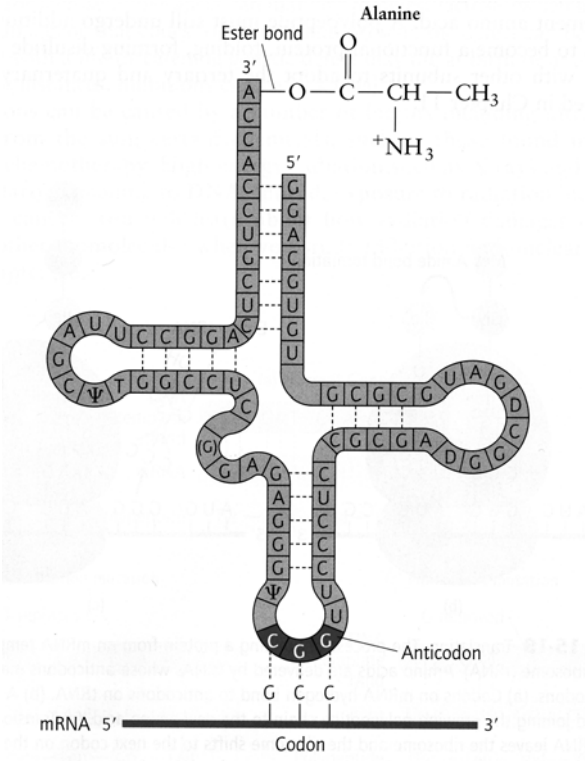
tRNA – a closer look

tRNA matches the codon on an mRNA with the corresponding amino acid

the cloverleaf shaped tRNA has two important regions

1) anticodon loop

2) 3′ end covalently bonded to the amino acid corresponding to the anticodon



Translation – Building a Protein

1) At the ribosome, an mRNA codon is read and a matching tRNA molecule arrives with the corresponding amino acid.

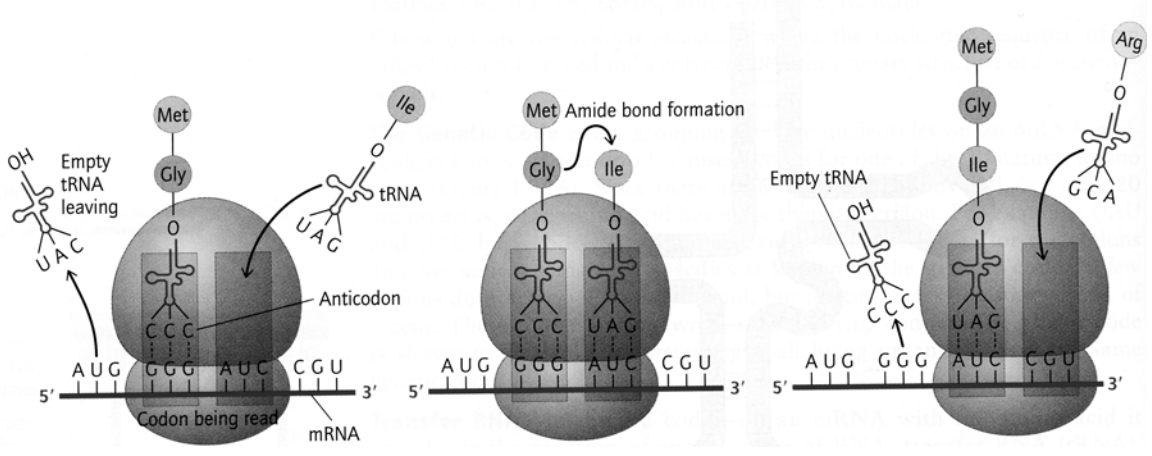
2) Base pairs H-bond temporarily between the anticodon on tRNA and the codon on mRNA.

3) The next tRNA arrives with its amino acid. The tRNA base pairs H-bond with the adjacent codon so that an amide bond can form between the two adjacent amino acids on the two adjacent tRNA molecules.

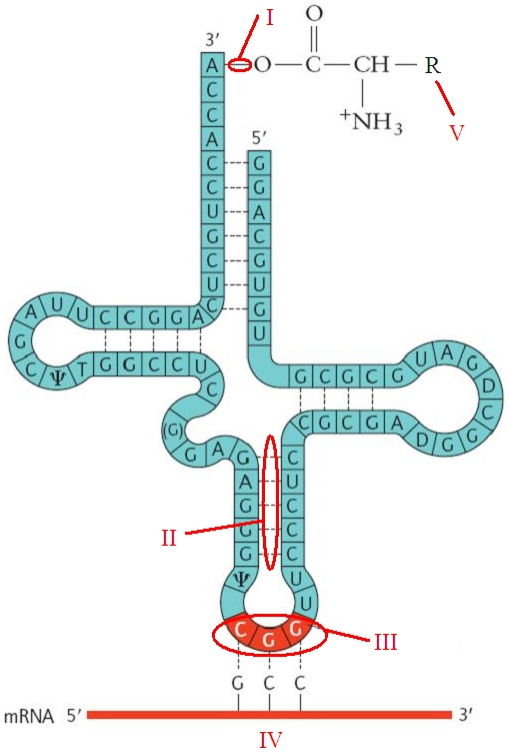
4) As the first tRNA is released the next codon on the mRNA is read and another tRNA molecule is recruited.

5) The process continues until a 'stop codon' is reached.

6) A polypeptide must undergo additional modifications to create the 2°, 3°, and possibly 4° structure to become a protein.



Use the genetic code table to identify the amino acid attached to this tRNA.



Second letter

First letter	U	C	A	G	Third letter
U	UUU, UUC: Phe; UUA, UUG: Leu	UCU, UCC, UCA, UCG: Ser	UAU, UAC: Tyr; UAA: Stop; UAG: Stop	UGU, UGC: Cys; UGA: Stop; UGG: Trp	U C A G
C	CUU, CUC, CUA, CUG: Leu	CCU, CCC, CCA, CCG: Pro	CAU, CAC: His; CAA, CAG: Gln	CGU, CGC, CGA, CGG: Arg	U C A G
A	AUU, AUC, AUA: Ile; AUG: Met/Start	ACU, ACC, ACA, ACG: Thr	AAU, AAC: Asn; AAA, AAG: Lys	AGU, AGC: Ser; AGA, AGG: Arg	U C A G
G	GUU, GUC, GUA, GUG: Val	GCU, GCC, GCA, GCG: Ala	GAU, GAC: Asp; GAA, GAG: Glu	GGU, GGC, GGA, GGG: Gly	U C A G

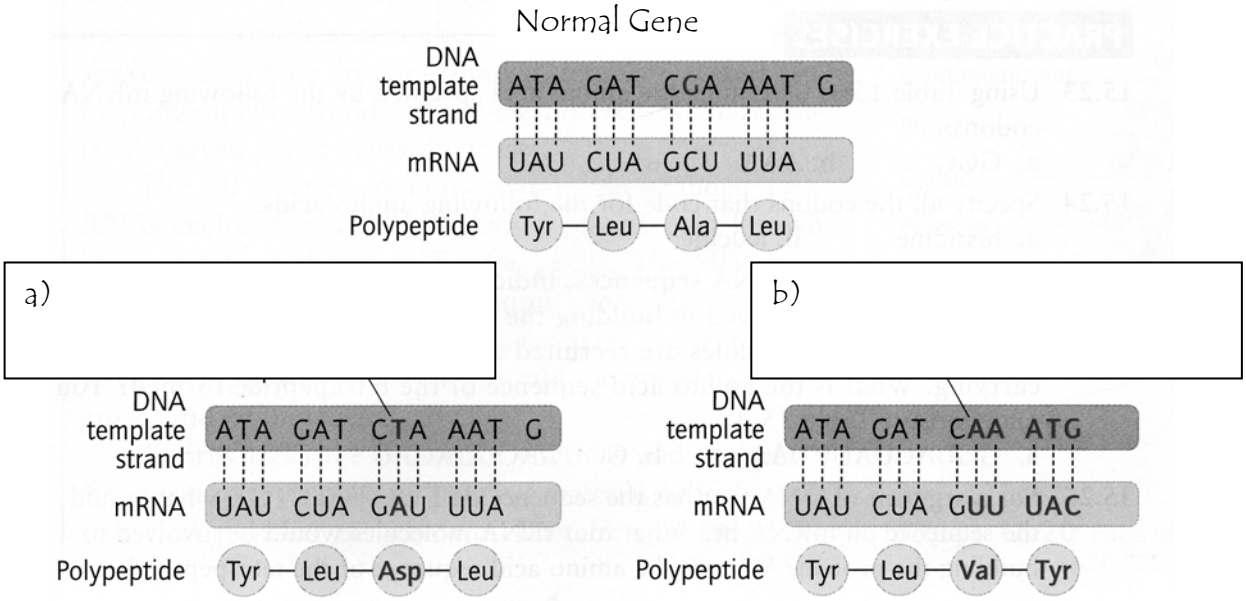
Nucleic Acids Part 4: Genetic Mutations

Any permanent chemical change at one or more nucleotides in the DNA sequence that affects the primary structure of a protein

Substitution: a mutation caused by the substitution of a nucleotide

Frameshift: a mutation caused by the deletion of a nucleotide

Compare the altered genetic codes to the Normal Gene below and classify them as Substitution or Frame Shift.



Effects of DNA mutations are minimized by the fact that there is more than one codon for most amino acids.

DNA mutations can create defective enzymes.

Some we can live with.

Some we can not.

Mutations are caused by a variety of factors: genetics, certain chemicals, high energy light (UV, X rays & gamma rays)

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