Genetics Quick Reference

Version 0.5

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http://Firmitas.org

Nitrogen Bases:

Purines
(2 rings)
Adenine
Guanine

Pyramidines
(1 ring)
Thymine
Cytosine
Uracil

mRNA = messenger RNA
tRNA = transcription RNA
rRNA = ribosomal RNA

Codon ≡ 3 RNA bases, therefore ∃ 64 possible codons. ∃ 20 amino acids. Codon redundancy adds protection against translation errors.

Start codon is AUG Methionine
Stop codons are UAA UGA UAG.

Wild type = most common alleles i.e. not mutated.

XX= female
XY= male,
XXY=hermaphrodite

In just a few hours, all of a human's six billion base pairs in 46 chromosomes are copied.

DNA≡deoxyribose 5C sugar, phosphate, N base
Deoxyribose lacks on oxygen at 2nd carbon (2').
Phosphate is between sugar 3' (OH) or 5' CH_2.
Condensation reaction → phosphodiester bonds.
DNA & RNA have *Sugar-Phosphate Backbone*.
Each end of a DNA strand is has 3' or 5' free.
DNA strands are antiparallel: 3'→5' & 5'→3'.
A single strand is referred to as an ssDNA.
Bases (A T C G U) attach to the sugar at 1'.
Between A & T ∃ 2 H bonds; betw. C & G ∃ 3.
Chargaff's Rules: %A,T=30 each, %C,G=20.
DNA→ RNA → protein = "*Central Dogma*".
Genes are always are certain loci (sing. locus).

DNA Replication ← handled by enzymes
This is Watson/Crick's *Semiconservative Model*
1. *Helicase* divides strands into *replication fork,* kept apart by single-stranded binding proteins.
2. *Topoisomerase* nicks DNA to remove tension
3. *RNA Primase* provides starting points on both *leading* and *lagging* strands.
4. *DNA Polymerase III* works linearly *5'→3'* on *leading strand* and another creates lagging's Okazaki fragments, each up to an RNA primer.
5. *RNA Primase* continues to add RNA primer every ~50 bases on the lagging strand.
6. *Ligase* is said to *seal* gaps between phosphates of Okazaki fragments.
7. *DNA Polymerase I* removes the RNA primer.
Bacteria have *girase* instead of topoisomerase.
Helicase is hexagonal in shape & rotates.

Mutations (always refers to DNA damage)
Mutagen ≡ something that causes mutation
Examples are heavy metals, carcinogens.
DNA Polymerases I and II proofread+fix errors
Example of a mutation is thymine dimer.
UV photons cause adjacent thymines to bond.
Other base pairs do not form these dimers.
Proof-reading enzymes ensure copy reliability.
Nucleases excise damaged DNA area.
DNA Polymerase fills in excised section.
Plants are better than animals at DNA repair.
Plants have more nuclease than animals.
Bacteria have even more, can be zapped w/UV.
Point mutations affect only one base.
- Silent = final amino acid is the same
- Missense = amino acid is different
- Nonsense = protein cut short by stop codon.
- Frameshift = deleted or inserted codon.

Example of missense is mutation for Sickle cell, which is CAT in lagging strand.

Karyotype = display of all chromosomes with homologous ones side by side.
HIV has enzyme that converts RNA to DNA.
Puberty is earlier now due to bovine hormones.
Down's = triple #21 chromosome.
The greater percentage of introns that an organism has, the longer it probably lives.

Transcription = DNA → mRNA
One gene gets converted to one mRNA.
Ribosome A=attach site, P=protein site, E=exit.
Initiation
- *RNA polymerase II* assembled at promoter site on minus strand. Eukaryotic promoter is TATA box (TATAAAA). Prokyarotic promoter is Pribnow box (TATAAT).
- Then it opens the DNA.

Elongation
- *RNA polymerase II* creates & checks mRNA from the *minus* DNA strand using complementary rules.

Termination
- Terminator sequence reached.
- 5' cap and poly-A tail added to mRNA.
- *Spliceosomes* then splice out *introns*, leaving exons' useful data in mRNA.
- RNA Polymerase is disassembled.

Note, prokaryotes do not have introns.
Introns possibly come from virii attacks.
Poly-A tail protects against degradation.

Translation = mRNA → protein
Initiation
- Smaller module attaches to 5' cap.
- Large subunit attaches forming TIC, i.e. translation initiation complex.
- Ribosome advances to AUG codon.

Elongation
- For each codon, tRNA (clover shape) joins its anti-codon on center leaf to matching mRNA codon, and contributes the amino acid from the tRNA stem.
- Ribosome attaches amino acid to growing protein & tRNA shifts over.

Termination
- Stop codon is reached, protein released.
- Ribosome disassembles.

Meiosis (=Meiosis I & Meiosis II) → *gametes*
Occurs only in ovaries (eggs) & testes (sperm).
Gametes are haploid, later fuse to make zygote.
Polar bodies are eggs that are discarded (2 or 3).
78% of miscarriages are caused by DNA damage.
Meiosis I = *1 diploid→2 (doubled) haploid cells*
Prophase I: synapsis results in tetrads being formed, then crossover happens via chiasmata.
Metaphase I: tetrads migrate to metaphase plate.
Anaphase I: sister chromatids don't pull apart, but rather homologous chromosomes do.
Telophase I: nuclear envelope not reformed, chromosomes don't become chromatin.
Meiosis II = *2 (dbld.) haploid cells→4 gametes*
There is no Interphase.
Prophase II: -
Metaphase II: chromosomes line up at plate.
Anaphase II: sister chromatids separate.
Telophase II: cell division results in 4 gametes.