

Science Olympiad Designer Genes Cheat Sheet (Division C – Regionals/States)

1. DNA & RNA Structure

- DNA: double helix of nucleotides (A–T, G–C), antiparallel strands (5'→3', 3'→5'). Sugar: deoxyribose. Bases: adenine, thymine, cytosine, guanine.
- RNA: single-stranded, uracil replaces thymine, sugar is ribose. Types: mRNA (messenger), tRNA (transfer), rRNA (ribosomal). • Purines (A,G) – double ring; Pyrimidines (C,T,U) – single ring.

2. DNA Replication

- Semi-conservative; occurs in S phase. Key enzymes:
Helicase: unwinds DNA. Primase: adds RNA primers. DNA Pol III: elongates. DNA Pol I: replaces primers. Ligase: joins Okazaki fragments.
Leading strand: continuous (5'→3'). Lagging strand: discontinuous (Okazaki fragments).

3. Transcription & Translation

- Transcription (nucleus/prokaryotic cytoplasm): promoter → RNA polymerase binds → elongation → termination. mRNA processed in eukaryotes (5' cap, poly-A tail, intron splicing).
- Translation: ribosome reads mRNA codons → tRNA anticodon binds → peptide bond formation → stop codon terminates.
Start codon = AUG (Methionine). Stop codons = UAA, UAG, UGA.

4. Codon Table (RNA → Amino Acid)

AUG – Met (Start); UUUUUC – Phe; UUAUUG – Leu; UCUUCU/UCAUUG – Ser; UAUUAC – Tyr; UAAUAG/UGA – Stop; UGUUUC – Cys; UGG – Trp;
GUU/GUC/GUA/GUG – Leu; CUU/CCU/CCA/CCG – Pro; CAU/CAC – His; CAA/CAG – Gln; CGU/CGC/CGA/CGG – Arg; AUU/AUA/AUA – Ile; GUU/GUC/GUA/GUG – Val;
GCU/GCC/GCA/GCG – Ala; GAU/GAC – Asp; GAA/GAG – Glu; GGU/GGC/GGA/GGG – Gly.

5. Mendelian Genetics

- Law of Segregation: alleles separate during gamete formation.
- Law of Independent Assortment: genes assort independently (unless linked).
- Monohybrid: 3:1 ratio; Dihybrid: 9:3:3:1.
- Probability: multiply for 'and', add for 'or'.
- Pedigree symbols: square (male), circle (female), shaded = affected.
- Sex-linked traits: mostly on X chromosome; males affected more often.

6. Hardy-Weinberg Equilibrium

$$p + q = 1 \quad ; \quad p^2 + 2pq + q^2 = 1$$

Assumes: large pop, random mating, no mutation, migration, or selection.

Use p^2 for homozygous dominant, q^2 for homozygous recessive, $2pq$ for heterozygous.

7. Molecular Biology & Biotechnology

- Restriction enzymes: cut DNA at specific sites (EcoRI: GAATTC). Sticky/blunt ends.
- Plasmid cloning: vector + insert + ligase → recombinant plasmid → transformation → selection.

Designer Genes Two For One

Liyong Dong



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