SUBJECT
Biology

MODULE
Botany & Zoology High-Yield Units & Active Recall Mindmaps

WEIGHTAGE
360 Marks Complete Compendium

CURRICULUM
NCERT Rationalized

NEET 2027 Biology NCERT Line-by-Line High-Yield Mindmaps

Prepared by NEETnova Academic Council & Kota Senior Faculty Panel * 100% Aligned with Official NTA & NMC Guidelines

1. EXECUTIVE OVERVIEW & STRATEGIC FOUNDATION

This master booklet serves as the definitive NCERT Line-by-Line blueprint for securing a perfect 360/360 in NEET Biology. It condenses complex genetics crosses, physiological feedback loops, diagram hotspots, cycle stoichiometry, and ecological models into clear, high-retention frameworks to eliminate negative marking in the 90 biology questions.

2. NCERT LINE-BY-LINE COMPREHENSIVE STUDY MODULE

4.1 Genetics & Molecular Basis of Inheritance (24-30 Qs)

Genetics is the highest-weightage unit in NEET. Mendel Laws: Monohybrid phenotypic ratio 3:1, genotypic 1:2:1. Dihybrid phenotypic ratio 9:3:3:1. Incomplete dominance (Mirabilis jalapa) and Codominance (ABO blood groups) both show 1:2:1 phenotypic and genotypic ratios. Molecular genetics: DNA replication is semiconservative (proven by Meselson & Stahl using ^{15}N and CsCl density gradient). Transcription: RNA Polymerase reads template strand (3 to 5) and synthesizes mRNA (5 to 3). Lac Operon: lactose acts as an inducer by binding the repressor protein produced by i-gene.

- Mendelian Laws: Dominance, Segregation (Universal law with no exceptions), Independent Assortment
- Deviations: Incomplete dominance (Pink Snapdragon 1:2:1), Codominance (AB blood group I^A I^B 1:2:1)
- Genetic Proofs: Griffith (Transformation in Streptococcus), Hershey-Chase (^{35}S vs ^{32}P in T2 Bacteriophage)
- Replication & Transcription: Helicase unwinds, DNA Pol III synthesizes 5 to 3; RNA Pol II transcribes mRNA
- Lac Operon: Inducer is Lactose / Allolactose; Structural genes z (β-galactosidase), y (permease), a (transacetylase)

NCERT LINE HIGHLIGHT: Hershey and Chase (1952) used radioactive ^{35}S (protein coat) and ^{32}P (DNA core) in T2 bacteriophage to definitively prove DNA is the genetic material.

4.2 Human Physiology: Organ Systems & Mechanisms (12-15 Qs)

Circulatory System: Cardiac cycle duration = 0.8 seconds (Joint diastole: 0.4s, Atrial systole: 0.1s, Ventricular systole: 0.3s). Stroke volume = 70 mL; Cardiac output = 70 mL × 72 bpm ≈ 5.04 L/min. Excretory System: Counter-current mechanism in Henle loop and vasa recta creates osmotic gradient (300 mOsmol/L in cortex to 1200 mOsmol/L in inner medulla). Glomerular Filtration Rate (GFR) = 125 mL/min = 180

Litres/day (99% reabsorbed). Neural System: Resting membrane potential is -70 mV maintained by Na^+/K^+ ATPase pump (pumps 3 Na^+ OUT for every 2 K^+ IN).

- Cardiac Cycle: 0.8s duration; Lub (closure of AV tricuspid/bicuspid valves); Dub (closure of semilunar valves)
- Excretion: GFR = 125 mL/min; Counter-current multiplier in Henle loop concentrates urine 4 times (1200 mOsmol/L)
- RAAS Pathway: Low GFR triggers Renin release from JGA → Angiotensin II → Aldosterone → Na^+/water reabsorption
- Action Potential: Depolarization via rapid influx of Na^+; Repolarization via efflux of K^+

NCERT LINE HIGHLIGHT: Juxtaglomerular apparatus (JGA) secretes renin when GFR falls, activating the Renin-Angiotensin-Aldosterone System (RAAS) to restore GFR.

4.3 Plant Physiology: Bioenergetics & Growth Regulators (8-10 Qs)

Photosynthesis: Light reaction generates ATP and NADPH via non-cyclic photophosphorylation (Z-scheme involves PS II [P680] and PS I [P700]; photolysis of water occurs at PS II). Dark reaction (Calvin Cycle): RuBisCO fixes CO_2 into 3-PGA. To synthesize 1 glucose molecule (6 CO_2), Calvin cycle requires 18 ATP and 12 NADPH. C4 plants (Kranz anatomy in maize, sugarcane) avoid photorespiration using PEPcase in mesophyll cells, consuming 30 ATP per glucose. Plant Hormones: Auxin promotes apical dominance; Cytokinin promotes cell division and delays senescence; Gibberellins cause stem elongation; Abscisic acid (ABA) acts as stress hormone; Ethylene triggers fruit ripening.

- Z-Scheme: Non-cyclic photophosphorylation produces ATP + NADPH; Cyclic produces ONLY ATP (PS I only)
- Calvin Cycle: RuBisCO is most abundant protein in biosphere; Fixation, Reduction, Regeneration (18 ATP + 12 NADPH)
- C4 Pathway: Kranz anatomy; PEPcase fixes CO_2 into OAA (4C); RuBisCO localized only in bundle sheath cells
- PGR Roles: Auxin (Apical dominance, 2,4-D weedicide), Gibberellin (Bolting in rosette plants), Ethylene (Fruit ripening)

NCERT LINE HIGHLIGHT: C3 plants require 18 ATP and 12 NADPH per glucose, whereas C4 plants require 30 ATP and 12 NADPH per glucose.

4.4 Reproduction in Flowering Plants & Humans (12-14 Qs)

Angiosperm Embryology: Pollen grain (male gametophyte) is 2-celled (vegetative + generative) in 60% angiosperms, 3-celled in 40%. Female gametophyte (embryo sac) is monosporic, 7-celled and 8-nucleate. Double fertilization: Syngamy (egg + sperm -> diploid zygote) + Triple fusion (polar nuclei + sperm -> triploid Primary Endosperm Nucleus PEN). Human Reproduction: Menstrual cycle hormonal surges: LH surge on day 14 triggers ovulation. Corpus luteum secretes progesterone to maintain endometrium. Spermatogenesis yields 4 functional sperms from 1 primary spermatocyte; Oogenesis yields only 1 ovum + polar bodies.

- Embryo Sac: 7-celled, 8-nucleate structure; 3 antipodals, 2 synergids with filiform apparatus, 1 egg, 1 central cell
- Double Fertilization: Unique to angiosperms; Syngamy (2n zygote) + Triple Fusion (3n endosperm)
- Menstrual Cycle: Follicular phase (FSH & Estrogen rise); LH Surge triggers Ovulation at Day 14; Luteal (Progesterone)
- Embryonic Development: Morula (8-16 cells) → Blastocyst with Inner Cell Mass & Trophoblast (implants on day 7)

NCERT LINE HIGHLIGHT: Cleavage divisions in zygote are mitotic; morula (8-16 blastomeres) transforms into blastocyst which implants in the uterine endometrium.

4.5 Cell Biology, Cell Cycle, Mitosis & Meiosis (10-12 Qs)

Cell Theory: Schleiden & Schwann; Rudolf Virchow proposed "Omnis cellula-e cellula". Endomembrane system includes Endoplasmic Reticulum, Golgi apparatus, Lysosomes, and Vacuoles (Mitochondria and Chloroplasts are NOT part of endomembrane). Cell Cycle: Interphase constitutes 95% of duration (G_1: growth, S: DNA replication from 2C to 4C with constant chromosome number 2n, G_2: protein synthesis). Meiosis I is reductional: Prophase I has 5 sub-stages (Leptotene, Zygotene [synapsis, synaptonemal complex], Pachytene [crossing over via recombinase], Diplotene [chiasmata, dissolution of synaptonemal complex], Diakinesis [terminalization]).

- S-Phase: DNA content doubles (2C → 4C), but chromosome number remains CONSTANT (2n → 2n)
- Prophase I Sub-phases: Pachytene is the stage of crossing over mediated by enzyme Recombinase
- Anaphase vs Anaphase I: Centromeres split in Anaphase of Mitosis and Anaphase II; Centromeres DO NOT split in Anaphase I
- Biomolecules: Peptide bond (-CONH-), Glycosidic bond (-O-), Phosphodiester bond in nucleic acids

NCERT LINE HIGHLIGHT: During S-phase, amount of DNA per cell doubles from 2C to 4C, but the chromosome number remains unchanged at 2n.

4.6 Ecology, Biodiversity & Environmental Models (10-12 Qs)

Organisms & Populations: Population growth models: Exponential $dN/dt = rN$ (J-shaped), Logistic $dN/dt = rN((K - N)/K)$ (S-shaped sigmoid, where K is carrying capacity). Ecosystem: 10% energy transfer law (Lindeman); pyramid of energy is ALWAYS upright. Pyramids of biomass can be inverted (e.g., aquatic ecosystem: phytoplankton < zooplankton < fish). Biodiversity: Alexander von Humboldt species-area relationship $\log S = \log C + Z \log A$ (Z = 0.1 to 0.2 for local areas; Z = 0.6 to 1.2 for entire continents).

- Population Models: Logistic growth is realistic in nature; dN/dt = rN (1 - N/K) where K is carrying capacity
- Ecological Pyramids: Pyramid of Energy is NEVER inverted; Biomass pyramid inverted in aquatic ocean ecosystem
- Species-Area Curve: log S = log C + Z log A; Humboldt observed species richness increases with area up to a limit
- Conservation Hotspots: Western Ghats-Sri Lanka, Indo-Burma, Himalayas cover <2% Earth but harbor 50%+ endemic species

NCERT LINE HIGHLIGHT: Robert May estimates global species diversity at approximately 7 million species, of which only 22% have been scientifically documented.

TABLE 4.1: C3 VS C4 PHOTOSYNTHETIC PATHWAY COMPARATIVE MATRIX

Physiological Feature	C3 Plants (e.g. Rice, Wheat)	C4 Plants (e.g. Maize, Sugarcane)
Leaf Internal Anatomy	Normal mesophyll, no Kranz anatomy	Kranz anatomy with distinct bundle sheath cells
Primary CO_2 Acceptor	RuBP (5-Carbon keto-sugar)	PEP (Phosphoenolpyruvate, 3-Carbon)
First Stable Carbon Product	3-PGA (3-Phosphoglyceric acid, 3C)	OAA (Oxaloacetic acid, 4C)
Primary Carboxylating Enzyme	RuBisCO (in mesophyll cells)	PEPcase (in mesophyll); RuBisCO in bundle sheath
Photorespiration (C2 Cycle)	High (25% photosynthetic loss at high temp)	Negligible / Absent (High CO_2 at RuBisCO site)
ATP & NADPH Cost per Glucose	18 ATP + 12 NADPH	30 ATP + 12 NADPH (12 extra for PEP regeneration)
Optimum Temperature Range	20°C - 25°C	30°C - 45°C (Adapted to tropical high light/temp)

TABLE 4.2: POPULATION INTERACTIONS & ECOLOGICAL RELATIONSHIPS

Interaction Type	Species A Effect	Species B Effect	NCERT Textbook Classic Example
Mutualism	+ (Benefited)	+ (Benefited)	Lichens (Alga + Fungus), Mycorrhizae, Fig tree & Fig wasp mutual obligate pollinator
Competition	- (Inhibited)	- (Inhibited)	Abingdon tortoise & goats in Galapagos; Flamingos & resident fishes for zooplankton
Predation	+ (Benefited)	- (Harm / Killed)	Tiger & Deer; Prickly pear cactus controlled by Cactoblastis moth in Australia
Parasitism	+ (Benefited)	- (Harm / Host)	Cuscuta on hedge plants; Liver fluke (two intermediate hosts: snail and fish)
Commensalism	+ (Benefited)	0 (Unaffected)	Orchid growing on mango branch; Barnacles on whale back; Cattle egret & grazing cattle
Amensalism	- (Harm / Inhibited)	0 (Unaffected)	Penicillium notatum inhibiting bacteria; Walnut tree juglone chemical secretion

TABLE 4.3: KEY HUMAN ENDOCRINE HORMONES & CLINICAL DISORDERS

Endocrine Gland	Secreted Hormone	Target Organs / Functions	Hypo / Hyper Secretion Disorder
Anterior Pituitary	Growth Hormone (GH)	Body bones & muscular growth	Dwarfism (Hypo); Gigantism & Acromegaly (Hyper)
Posterior Pituitary	Antidiuretic Hormone (ADH)	Distal tubules / Water reabsorption	Diabetes Insipidus (Hypo, excessive dilute urine)
Thyroid Gland	Thyroxine (T_4) & T_3	Basal Metabolic Rate (BMR) regulation	Cretinism (infant), Myxedema (adult), Graves disease (Hyper)

Adrenal Cortex	Aldosterone & Cortisol	Na^+ reabsorption & Glucocorticoid stress	Addison Disease (Hypo); Cushing Syndrome (Hyper)
Pancreas (Islets)	Insulin (β-cells) & Glucagon	Glucose homeostasis in blood	Diabetes Mellitus (Hypo insulin, hyperglycemia & glycosuria)
Parathyroid Gland	Parathyroid Hormone (PTH)	Hypercalcemic (increases blood Ca^{2+})	Tetany (Hypocalcemic muscle spasms); Osteoporosis (Hyper)

TABLE 4.4: MENDELIAN GENETICS CROSSES & RATIO SUMMARY

Type of Genetic Cross	Phenotypic Ratio	Genotypic Ratio	Classical NCERT Example
Monohybrid Cross	3 : 1	1 : 2 : 1	Pisum sativum Tall (TT) × Dwarf (tt)
Dihybrid Cross	9 : 3 : 3 : 1	1:2:1:2:4:2:1:2:1	Round Yellow (RRYY) × Wrinkled Green (rryy)
Incomplete Dominance	1 : 2 : 1	1 : 2 : 1	Snapdragon (Antirrhinum) Red × White → Pink
Codominance	1 : 2 : 1	1 : 2 : 1	ABO Blood Groups (I^A I^B genotype)
Monohybrid Test Cross	1 : 1	1 : 1	Unknown Dominant (Tt) × Homozygous Recessive (tt)
Dihybrid Test Cross	1 : 1 : 1 : 1	1 : 1 : 1 : 1	Heterozygous Dihybrid (RrYy) × Recessive (rryy)

4. FORMULA VAULT, KEY EQUATIONS & SHORTCUTS

Hardy-Weinberg Equilibrium

$$p + q = 1, p^2 + 2pq + q^2 = 1$$

p: dominant allele freq, q: recessive allele freq

Species-Area Relationship

$$\log_{10}(S) = \log_{10}(C) + Z * \log_{10}(A)$$

S: richness, A: area, Z: slope (0.1-0.2 local, 0.6-1.2 continental)

Cardiac Output Equation

$$\text{Cardiac Output} = \text{Stroke Volume (70 mL)} * \text{Heart Rate (72 bpm)}$$

Standard resting adult output ≈ 5.04 Litres/minute

Glomerular Filtration Rate (GFR)

$$\text{GFR} = 125 \text{ mL/min} = 180 \text{ Litres/day}$$

Urine volume = 1.5 L/day; 99% of filtrate is reabsorbed

Calvin Cycle ATP & NADPH Cost

$$1 \text{ Glucose } (6\ CO_2) \text{ requires } 18 \text{ ATP} + 12 \text{ NADPH}$$

3 ATP + 2 NADPH per CO_2 fixed in C3 plants

C4 Photosynthesis Energy Cost

$$1 \text{ Glucose in C4 requires } 30 \text{ ATP} + 12 \text{ NADPH}$$

Additional 12 ATP consumed in PEP regeneration

Respiratory Quotient (RQ)

$$\text{RQ} = \text{Volume of } CO_2 \text{ evolved / Volume of } O_2 \text{ consumed}$$

Carbohydrates = 1.0, Fats = 0.7, Proteins = 0.9, Organic acids > 1

Mendelian Dihybrid Cross Ratio

$$\text{Phenotypic: 9:3:3:1 | Genotypic: 1:2:1:2:4:2:1:2:1}$$

Independent assortment of two non-linked gene pairs

5. STEP-BY-STEP SOLVED NUMERICALS & ILLUSTRATIONS

Illustration 01: Hardy-Weinberg Population Allele Frequency

Problem: In a randomly mating population at Hardy-Weinberg equilibrium, the frequency of homozygous recessive individuals (aa) is 0.16 (16%). Calculate: (a) frequency of recessive allele q, (b) frequency of dominant allele p, and (c) frequency of heterozygous individuals (Aa).

Strategic Framework: Use the fundamental Hardy-Weinberg equations: $p + q = 1$ and $p^2 + 2pq + q^2 = 1$. Recessive genotype frequency corresponds to q^2.

1. Step 1: Given $q^2 = 0.16$. Take square root: $q = \sqrt{0.16} = 0.40$.
2. Step 2: Dominant allele frequency: $p = 1 - q = 1 - 0.40 = 0.60$.

3. Step 3: Heterozygote frequency: $2pq = 2 \times 0.60 \times 0.40 = 0.48$ (48%).
4. Step 4: Homozygous dominant frequency: $p^2 = 0.60^2 = 0.36$ (36%).
5. Step 5: Verify total: $p^2 + 2pq + q^2 = 0.36 + 0.48 + 0.16 = 1.00$ (100%).

FINAL ANSWER: p = 0.60 | q = 0.40 | Heterozygotes (2pq) = 0.48 (48%)

Illustration 02: Stoichiometric ATP Yield in Cellular Respiration

Problem: Calculate the total net ATP molecules produced from complete aerobic respiration of 1 molecule of glucose, accounting for Glycolysis, Link Reaction, and Krebs Cycle.

Strategic Framework: Sum ATP generated from substrate-level phosphorylation and oxidative phosphorylation via NADH (2.5 to 3 ATP) and $FADH_2$ (1.5 to 2 ATP).

1. Step 1: Glycolysis: 2 net ATP (substrate level) + 2 NADH (yielding 2 × 3 = 6 ATP or 4 ATP via glycerol phosphate shuttle) = 6-8 ATP.
2. Step 2: Link Reaction (Pyruvate to Acetyl-CoA): 2 NADH × 3 = 6 ATP.
3. Step 3: Krebs Cycle (2 turns): 2 GTP/ATP (substrate level) + 6 NADH (6 × 3 = 18 ATP) + 2 $FADH_2$ (2 × 2 = 4 ATP) = 24 ATP.
4. Step 4: Grand total net ATP produced = (8 + 6 + 24) = 38 ATP (or 36 ATP depending on shuttle mechanism).

FINAL ANSWER: Net Yield = 36 to 38 ATP per Glucose molecule

6. HIGH-YIELD NCERT POINTERS & RAPID FIRE CHECKLIST

- [ ] In human eye, fovea centralis contains ONLY densely packed cones and offers the highest visual visual acuity and resolution.
- [ ] During cardiac cycle, First heart sound (LUB) is produced by closure of AV valves (tricuspid & bicuspid); Second sound (DUB) is produced by closure of semilunar valves.
- [ ] DNA replication is bidirectional and semidiscontinuous: leading strand synthesizes continuously (5 to 3), lagging strand synthesizes discontinuously as Okazaki fragments.
- [ ] Schenk and Haberlandt pioneer plant tissue culture; Totipotency is the inherent capacity of a plant cell to regenerate into a whole complete plant.
- [ ] Ecology: Pyramid of energy is NEVER inverted under any circumstance because energy is continuously lost as metabolic heat (Second Law of Thermodynamics).
- [ ] Placenta secretes human chorionic gonadotropin (hCG), human placental lactogen (hPL), estrogens, and progesterone to sustain pregnancy.

7. NTA EXAM TRAPS & NEGATIVE MARKING ALERTS

Trap: Confusing "Mitosis in Gamete Formation". In haploid organisms (e.g. Bryophytes, Algae) and male honeybees (drones), gametes are produced by MITOSIS, not meiosis.

Trap: Direction of DNA synthesis. DNA Polymerase III can ONLY add nucleotides in the 5 to 3 direction on the new strand, reading the template 3 to 5.

Trap: Assertion-Reason causal trap. In questions starting with "Both A and R are true", verify if R is the TRUE biological explanation of A or just another independent correct statement.

Trap: Ecological graph axis labels. In population growth graphs, time is always on the X-axis and population density N is on the Y-axis.

8. MEMORY HACKS & MNEMONICS FOR RAPID RETENTION

Mitosis Phases Sequence: "PMAT" -> Prophase, Metaphase, Anaphase, Telophase.

Adrenal Cortex Hormones (Outer to Inner): "GFR - Salt, Sugar, Sex" -> Zona Glomerulosa (Mineralocorticoids/Salt), Zona Fasciculata (Glucocorticoids/Sugar), Zona Reticularis (Androgens/Sex).