FREE NOTES · NCERT + NEET LEVEL

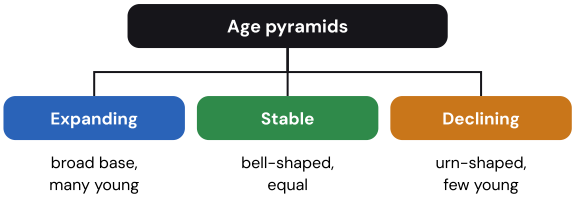
Organisms & Populations

Populations: attributes, growth (exponential and logistic), life history variation, and population interactions (predation, competition, parasitism, commensalism, mutualism).

01 Population attributes
02 Population growth
03 Life history variation
04 Population interactions
05 Predation and competition in detail
06 Parasitism and mutualism in detail
07 Extra: organism and its environment (NEET)
08 Important Q&A
09 Common mistakes
10 Practice (NEET style)
11 Quick revision

01 Population attributes

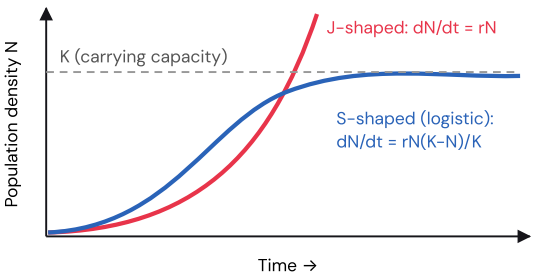
- Population = individuals of a species in a defined area sharing resources and interbreeding. Attributes not shown by individuals: **birth rate**, **death rate**, **sex ratio**, **age distribution**.
- Birth and death rates are per capita: e.g. 20 lotus plants last year, 8 new ⇒ birth rate = 8/20 = 0.4 per lotus per year.
- Age pyramids (pre-reproductive, reproductive, post-reproductive) show if a population is growing, stable or declining.
- Population density measured by numbers, percent cover (plants), biomass, indirect (pug marks, faecal pellets of tigers), relative densities (fish caught per trap).



Shapes of age pyramids

02 Population growth

- Density changes by **natality** (B), **immigration** (I) (+) and **mortality** (D), **emigration** (E) (−): $N_{t+1} = N_t + [(B + I) - (D + E)]$.
- **Exponential** (unlimited resources): $dN/dt = rN$; $N_t = N_0e^{rt}$; **J-shaped** curve. r = intrinsic rate of natural increase (Norway rat 0.015, flour beetle 0.12; India 1981 r = 0.0205).
- **Logistic** (limited resources): $dN/dt = rN(K - N)/K$; **sigmoid** curve; K = carrying capacity. Phases: lag, acceleration, deceleration, asymptote. More realistic (Verhulst–Pearl).



Exponential vs logistic growth

03 Life history variation

- Populations evolve to maximise **reproductive fitness** (Darwinian fitness, high r) in their habitat.
- Some breed only once in lifetime (Pacific salmon, bamboo); others many times (most birds, mammals). Some produce many small offspring (oysters, pelagic fishes); others few large offspring (birds, mammals).
- Life history traits evolve in relation to abiotic and biotic constraints of the habitat.

04 Population interactions

Interaction	Species A	Species B	Example
Mutualism	+	+	Lichen (fungus + alga), mycorrhiza, fig–wasp, orchid *Ophrys*–bee (sexual deceit)
Competition	-	-	Flamingoes and fishes for zooplankton; Abingdon tortoise and goats (Galapagos)
Predation	+	-	Tiger–deer; prickly pear cactus controlled in Australia by a moth
Parasitism	+	-	Cuscuta on hedge plants; liver fluke; lice on humans; cuckoo eggs in crow nest (brood parasitism)
Commensalism	+	0	Orchid on mango branch; barnacles on whale; cattle egret and cattle; sea anemone–clown fish
Amensalism	-	0	Penicillium inhibiting bacteria

05 Predation and competition in detail

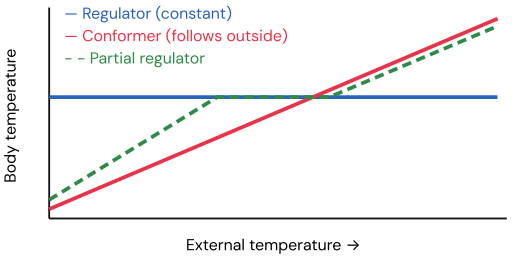
- Predators transfer energy across trophic levels, keep prey populations in check, maintain species diversity (removal of starfish *Pisaster* led to extinction of 10+ invertebrate species: Paine's experiment).
- Prey defences: camouflage (frogs), poison (Monarch butterfly distasteful due to chemical from weed eaten as caterpillar), thorns (*Acacia*, cactus), chemicals (*Calotropis* cardiac glycosides; nicotine, caffeine, quinine, strychnine, opium as defence).
- **Gause's competitive exclusion principle**: two closely related species competing for same resources cannot coexist indefinitely; the inferior is eliminated.
- **Resource partitioning**: MacArthur: 5 warbler species coexist by foraging on different parts of the same tree.
- Interference competition: one species reduces feeding efficiency of other even when resources are plenty.

06 Parasitism and mutualism in detail

- Parasites are host-specific, co-evolve with hosts; adaptations: loss of unnecessary sense organs, adhesive organs/suckers, loss of digestive system, high reproductive capacity. Many have complex life cycles with intermediate hosts (human liver fluke: snail and fish).
- **Ectoparasites** (lice, ticks, copepods on fish, *Cuscuta* without chlorophyll) vs **endoparasites** (live inside host). Brood parasitism: cuckoo eggs resemble crow eggs.
- Mutualism: plant–animal interactions in pollination and seed dispersal; fig species pollinated by only its partner wasp species (wasp lays eggs in fruit, larvae use seeds). Mediterranean orchid *Ophrys*: petal resembles female bee; male bee pseudocopulates and carries pollen.

07 Extra: organism and its environment (NEET)

- Major abiotic factors: **temperature** (eurythermal = wide range; stenothermal = narrow), **water** (euryhaline / stenohaline salt tolerance), **light**, **soil**.
- Responses: **regulate** (birds, mammals: homeostasis), **conform** (most animals, all plants), partial regulators, **migrate** (Siberian cranes to Keoladeo, Bharatpur), **suspend** (hibernation of bears, aestivation of snails/fish, diapause of zooplankton, seed dormancy).
- Small animals rarely found in polar regions: high surface area : volume ratio loses heat fast.



Regulators vs conformers

- Adaptations: **kangaroo rat** (meets water need by internal fat oxidation, concentrated urine); desert plants: thick cuticle, sunken stomata, CAM, leaves → spines (*Opuntia*); **Allen's rule**: mammals of cold climates have shorter ears and limbs; seals have blubber.
- High altitude sickness (nausea, fatigue, palpitation): low O_2; body adapts by making more RBCs, lowering Hb's O_2 binding, faster breathing.
- Archaebacteria in hot springs above 100 °C; fish in Antarctic waters below 0 °C.

08 Important Q&A

Q1. In a pond there were 20 Hydrilla plants; through reproduction 8 new plants were added in a year. Calculate birth rate.

8/20 = 0.4 offspring per plant per year.

Q2. Why is logistic growth more realistic?

Resources are always limited; growth slows as N approaches carrying capacity K.

Q3. State Gause's competitive exclusion principle.

Two closely related species competing for the same limited resources cannot coexist indefinitely; the competitively inferior one is eliminated.

09 Common mistakes

- Calling orchid on mango tree parasitism (commensalism).
- Writing logistic as J-shaped (it is S-shaped).
- Saying immigration decreases population.
- Confusing amensalism (−,0) with commensalism (+,0).

10 Practice (NEET style)

1. Equation of exponential growth?
2. Fish living with sea anemone?
3. Brood parasite bird?
4. Upper limit of population size?
5. Orchid showing sexual deceit?

ANSWERS

1) dN/dt = rN · 2) Clown fish (commensalism) · 3) Cuckoo (koel) · 4) Carrying capacity K · 5) *Ophrys*

11 Quick revision: 5 minutes before the exam

POPULATION

- Birth, death, sex ratio, age
- Age pyramids: expanding/stable/declining

GROWTH

- J: dN/dt = rN
- S: rN(K–N)/K
- K = carrying capacity

INTERACTIONS

- Mutualism ++, competition −−
- Predation, parasitism +−
- Commensalism +0, amensalism −0

KEY NAMES

- Gause exclusion
- MacArthur warblers
- Paine Pisaster

Have a doubt? Ask the AI Doubt Solver at padhaiadda.netlify.app, or take the mock test on this chapter.