

Unit 4: Energy, Environment, Microbiology and Immunity

WBI14 · Issue 2 · Topics 5-6 · photosynthesis, ecosystems, climate, evolution,
microbes, immunity · sheets 4.1-4.10

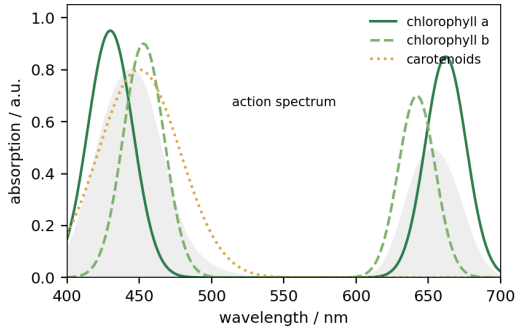
Energy in, energy through, energy lost

Follow the energy: photosynthesis fixes it, food chains lose it, microbes recycle it, and immunity spends it.

Two stages, two places

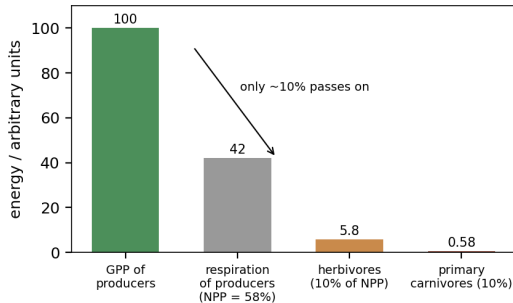
Stage	Where	Made
Light-dependent 光反应	thylakoid membranes	ATP, reduced NADP, O ₂
Light-independent 暗反应	stroma	GALP, then glucose or RuBP

Spectra and limiting factors



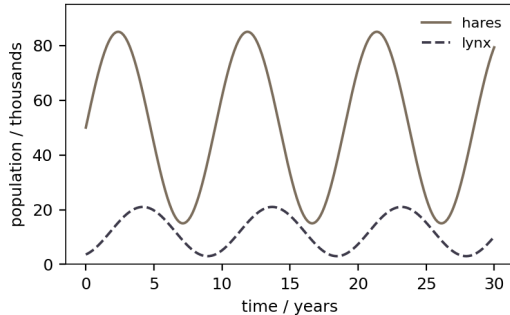
Where the pigments absorb best, photosynthesis runs fastest: the match of the two spectra is the evidence.

Ten per cent, four losses



- 1 Fix 固定** grassland fixes 45 000 kJ per square metre per year
- 2 Subtract 扣除** respiration spends 19 000, so $NPP = 26\ 000$
- 3 Transfer 传递** cattle keep about 2 600; humans eating cattle keep 260

Populations cycle, communities succeed



Each stage of succession changes the soil and microclimate, and so admits the next stage.

Evidence, gases, extrapolation

Methane 甲烷

About 28 times CO₂ per kilogram - but gone in about 12 years. A one-tonne leak matters most this decade.

Carbon dioxide

Weaker per kilogram but effectively permanent on human timescales. Cumulative load is what matters.

Selection filters, isolation splits

Directional 定向选择: one extreme favoured,
the mean shifts - resistance alleles spread

Stabilising 稳定选择: the average favoured, both extremes trimmed

Isolation 隔离: barrier (allopatric) or behaviour (sympatric) stops gene flow

Speciation 物种形成: diverged populations can no longer interbreed

Aseptic technique and the growth constant

- 1 **Difference 对数差** $\log$ of 1.6×10^7 minus $\log$ of $2 \times 10^4 = 2.903$
- 2 **Divide 相除** $k = 2.903 / (0.301 \times 5) = 1.93$ per hour
- 3 **Double 翻倍** doubling time $= 1/k =$ about 31 minutes

Barriers first, then the specific response

Barriers meet every pathogen; specific immunity meets the ones that pass - and HIV dismantles the coordination itself.

Humoral and cellular, memory for life

Primary response 初次应答

Days to rise, modest peak, mostly IgM - then memory B cells settle in for life.

Secondary response 再次应答

Memory cells divide at once: antibody in days, ten times the titre, IgG - the basis of vaccination.

Resistance is selection; HAls are systems

Your turn

A zone of inhibition equals the antibiotic disc's own 6 mm diameter. What does it show?

- ☐ A. no inhibition at all - the bacterium is resistant at that concentration
- ☐ B. the antibiotic is weak but still working
- ☐ C. the agar was too deep
- ☐ D. the disc was placed too late

Four clocks of time of death

- 1 **PCR** 95 C denature, 50-60 C primers anneal, 72 C extend: 2^n copies
- 2 **Electrophoresis** 电泳 short fragments travel furthest toward the anode
- 3 **Profile** 图谱 band positions identify individuals; shared bands show relatedness
- 4 **Death time** 死亡时间 37 minus 31 = 6 degrees fall: about 6 hours - state the assumptions

Check yourself

Your turn

Grassland NPP is 40 000 kJ per square metre per year. At 10% per transfer, what reaches second-order consumers?

- A. 400 kJ - two transfers of 10%
- B. 4 000 kJ - one transfer
- C. 40 kJ - three transfers
- D. 400 000 kJ - the food chain multiplies energy