BIOM10002 Exploring Biomedicine

THE UNIVERSITY OF MELBOURNE · UNDERGRADUATE · SEMESTER 2, 2026

Full guide + ask Sia about BIOM10002

SIDE 1/2 MECHANISMS · PATHWAYS · CLASSIFICATIONS · CAUSE → EFFECT

A4 NOTE SHEET · TWO PAGES ALLOWED

v2 · 2026-10-25

0 · Exam map

COURSE.JSON · BRIEF

10 | 5 | 10 | 5 | 25 | 45

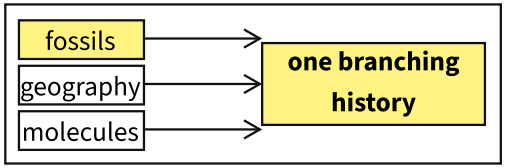
ASSESSMENT	WEIGHT
4 x Quizzes	10%
1A Abstract · 1B ePoster & video	5% · 10%
2A Annotated Bibliography · 2B Literature Review + Reflections	5% · 25%
Final Exam	45%

Permitted materials: "2 x double sided A4 pages of notes" *(BIOM10002 2026 SM2 Canvas Assessment page; MD_Assessment_Exploring_Biomedicine_BIOM10002_2026_SM2.md).*

★ **Exam move:** identify level → name entities → draw directional mechanism → predict a changed condition → state the observation that discriminates a rival explanation.

1 · Common ancestry

C1 · EVIDENCE



Independent records converge; each has different preservation and measurement biases.

RECORD	WHAT IT CONTRIBUTES	BOUNDARY
Fossils	Ordered snapshots	Burial, mineralisation, discovery are selective
Biogeography	Isolation and movement	Present distribution is not a full history
Homology	Inherited organisation	Convergence can resemble shared descent
Molecules	Fine-scale comparison	Clock, fossil date and distribution answer different questions

A gap is not contrary evidence. Missing intermediates weaken precision; conflict requires a robust observation incompatible with the proposed tree and not explained by sampling or method.

CONVERGENCE TEST

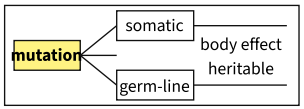
Separate record from inference: fossils supply ordered snapshots; present distribution records isolation and movement; homology and sequences test relatedness. A fossil date, molecular clock and present range answer different questions, so state scale and uncertainty.

OBSERVATION	WARRANTED USE
Independent records agree	One branching account gains support
Intermediate is missing	Precision weakens; descent is not erased
Robust relationship is incompatible	Conflict only after sampling and method are checked
Fossil record	Burial, mineralisation and discovery are uncommon; absence weakens precision rather than erasing descent.
Cross-record synthesis	State scale and uncertainty; show convergence, constraints and the added sample that separates rival histories.

Next sample: choose an observation that makes rival histories predict different outcomes.

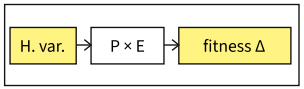
2 · Variation → population change

C1 · MECHANISMS



Medical consequence and evolutionary consequence can occupy different levels.

Mutation changes DNA sequence and generates alleles without anticipating need. Only heritable change can enter population history. Always name **cell lineage, inheritance route, phenotype and environment**; then ask which process changes frequency.



Selection filters phenotypes in context; populations evolve as frequencies change.

PROCESS	SIGNATURE	DO NOT INFER
Selection	Heritable variant consistently differs in reproductive success	"Common/useful" automatically means adaptive
Drift	Random finite sampling; strongest in small populations	Required adaptive direction
Gene flow	Migration + reproduction move alleles; often reduces connected-population differences	Migrant allele is advantageous

Fitness is relative: survival may rise while mating success falls. Measure the component that contributes alleles to future generations, in the defined population and environment.

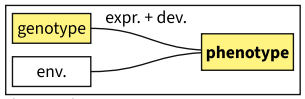
EXAM TIP *Write phenotype → performance → reproductive output, then test drift, migration and non-random mating as alternatives.*

CHANGED-CONDITION DRILL

Selection: a colour variant avoids one predator but attracts fewer mates; count viable offspring, not survival alone. **Drift:** after a storm leaves few breeders, a frequency shift need not be adaptive. **Gene flow:** later migrants may restore an allele and reduce differences between fragments. Use repeated populations or time points across generations: one endpoint cannot reveal the path.

3 · Inheritance & the null

C2 · GENOTYPE



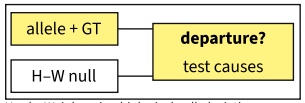
Phenotype does not map one-to-one to genotype; dominance is not abundance or fitness.

Genotype = allelic composition; *phenotype* = observed outcome through expression, development and environment. Dominance describes contribution to a heterozygous phenotype—not which allele is common, strong or favoured.

BEFORE ANY CROSS

```
parental genotypes → allele notation → dominance relation → independence assumptions → offspring genotype probabilities → phenotype probabilities only if mapping is justified
```

Punnett squares organise possible genotypes. They do **not** predict exact family counts, explain polygenic traits or include every environmental influence.



Hardy–Weinberg is a biological null: deviation diagnoses a question, not a cause.

NULL CONDITIONS	FOLLOW-UP IF DEPARTURE
Random mating; evolutionary forces absent; very large population	Selection, drift, migration, mutation, non-random mating or measurement problems
One sampled population and generation; aligned allele/genotype counts and sampling units	Check subdivision, geography, relatedness, fitness and genotyping error

4 · Reproductive isolation

C2 · SPECIATION

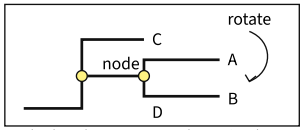
Prezygotic barriers prevent mating or fertilisation; postzygotic barriers reduce hybrid viability or fertility. Ask where gene flow falls and whether the barrier is complete, asymmetric or environment-dependent. Fertile introgression can blur a simple split.

DEPARTURE CHECK

Before naming a cause, verify one population and generation, aligned allele/genotype counts, sampling units, geography and relatedness. Pooled subpopulations can create excess homozygotes; reanalyse regions separately.

5 · Read the tree

C3 · PHYLOGENY

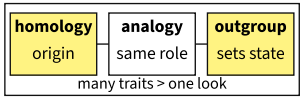


A and B share the most recent node; rotation changes page position, not relationship.

FEATURE	READ IT AS	TRAP
Tip	Sampled lineage	Not necessarily an ancestor
Internal node	Common ancestor	Compare nodes, not horizontal spacing
Clade	Ancestor + all descendants	Omitting any descendant breaks the clade
Branch length	Only quantitative with scale/legend	Long unscaled line has no time/change meaning

PAIRWISE METHOD

```
trace candidate lineages backwards → locate their meeting node → choose the pair whose shared node is most recent
```



Bird and insect wings are analogous; vertebrate bone organisation is stronger homologous evidence.

Code character states consistently; flag missing/ambiguous data. A distant or inappropriate outgroup can destabilise coding. Allow reversal, convergence and uncertainty rather than forcing one conspicuous similarity.

6 · Evidence audit

C3 · LITERATURE

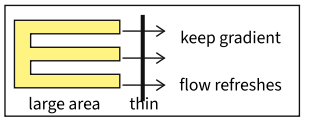
SOURCE	WORK	LIMIT
Primary study	Methods + observations in detail	May answer only a narrow link
Review	Integrates agreement/dispute	Not a substitute for recoverable evidence for a specific claim

```
question · organism/population · comparison · measurement · result · limitation → exact mechanism link supported
```

Peer review is a filter, not a guarantee. Cross-sectional association may motivate a mechanism but cannot establish temporal direction or causation.

7 · Exchange surfaces

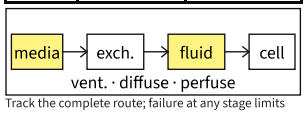
C4 · GEOMETRY



High demand favours area, short distance and a maintained concentration gradient.

Diffusion works over short distances. Ventilation and circulation renew media so local diffusion can serve cells far from the environment. A structure earns explanatory value only when linked to **substance, direction, barrier, gradient and bulk transport**.

CHANGE	PREDICTION	TRADE-OFF
Thicker barrier	Slower exchange	Thinness may increase damage/water loss
Less area	Lower exchange capacity	Folding needs support + transport
Slower medium flow	Gradient weakens	Flow has energetic cost
Higher demand	Downstream step may limit delivery	Measure more than breathing rate



Track the complete route; failure at any stage limits delivery.

Gas moves down partial-pressure gradients; pigments and fluid flow help maintain them. Temperature, oxygen availability and activity alter demand, so state comparison conditions.

LOCATE THE BOTTLENECK

OBSERVATION	TEST NEXT
Fresh medium fails to reach the surface	Ventilation
Surface is intact but crossing slows	Barrier thickness, area and gradient
Gas crosses but tissue delivery lags	Carrying capacity or perfusion
Breathing rises during activity	Compare circulation with demand

Prediction rule: thickening the barrier, reducing area or slowing medium flow lowers flux. Folding adds area but needs support and transport; thinness improves diffusion but can increase damage or water loss. Name the exchanged substance and direction at every arrow.

8 · Acquire → assimilate

C4 · NUTRITION

AUTOTROPH

energy + inorganic inputs → organic matter

HETEROTROPHS

animal: ingest | fungus: secrete | then absorb

Plants also acquire minerals through roots and partnerships while producing carbon compounds.

MATERIAL-TRACING ANSWER

```
environmental source → capture → mechanical/chemical breakdown → membrane crossing → distribution → cellular use → waste
```

Acquisition ≠ assimilation. Capturing food does not make molecules available to cells. Symbiotic microorganisms can expand usable substrates, so the functional system may exceed one organism.

STRATEGY	KEY MECHANISM	QUESTION TO ANSWER
Animal	Ingests; digests internally	Where are polymers broken and products absorbed?
Fungus	Secretes enzymes; absorbs products	Where is the external substrate processed?
Plant	Roots/partnerships supply minerals; photosynthesis supplies carbon compounds	How do inputs reach tissues?

9 · Detect → respond

C5 · SIGNALLING

The same input can produce different responses with different receptor distribution, internal state or prior learning. High sensitivity detects weak signals but may respond to noise; a strict threshold may miss early information. Replace "affects" with actor + interaction + direction + consequence.

10 · Dynamic stability

C5 · HOMEOSTASIS

Set points or defended ranges can shift with time, development and context. Identify the regulated endpoint, sensor and effector evidence; decide whether the response reduces or amplifies the deviation; state the energetic or environmental limit.

Thermoregulation: temperature changes reaction rates, while heat production, insulation, circulation, behaviour and body-size surface relationships contribute. Treat it as coordinated allocation, not one reflex.

Semester 2 examination period, 2–20 November 2026.
Your exam allows two double-sided A4 pages of notes; this sheet is one of them. Check on the LMS whether printed notes are accepted; if they must be handwritten, copy it.

BIOM10002 Exploring Biomedicine · Drills & traps

WHICH IS TRUE? · WORKED APPLICATIONS · SHORT-ANSWER FRAMES · FAST RECALL

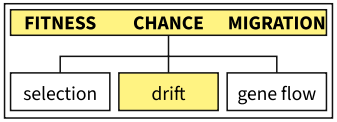
Full guide + ask Sia about BIOM10002

SIDE 2/2 DRILLS · TRUE/FALSE CONTRASTS · WORKED APPLICATIONS · SHORT ANSWERS FINAL EXAM · 45% v2 · 2026-10-25

11 · Which is true? Evolution

C1 · MC TRAPS

TEMPTING CLAIM	CORRECT CONTRAST
Exposure caused an adaptive mutation because it was needed.	False. Mutation does not anticipate need; phenotype and environment affect what follows.
A somatic mutation causing disease changes descendant allele frequencies.	False. It matters medically but needs a reproductive route to enter population history.
Selection changes individuals so populations can adapt.	False. Individuals are selected; population frequencies change across generations.
A trait that improves survival always raises fitness.	False. Mating success or viable offspring can offset survival benefit.
A rare allele lost after a bottleneck must be harmful.	False. Drift has no required adaptive direction.
Gene flow may restore local variation and reduce population differences.	True, when migrants reproduce and source frequencies differ.
A fossil gap disproves descent.	False. Selective preservation weakens precision; contrary evidence predicts incompatible relationships.



One endpoint is insufficient: compare direction, population size, connectivity and time points.

FAST DISCRIMINATOR

```
selection needs variation + heritability + consistent reproductive difference; drift needs finite sampling; gene flow needs migration + reproduction
```

SHORT ANSWER *State observation separately from mechanism. Then name the prediction and a control or rival process.*

11b · Permission check

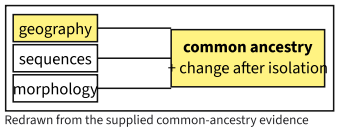
BRIEF · OFFICIAL SOURCE

Official wording: "2 x double sided A4 pages of notes" *(BIOM10002 2026 SM2 Canvas Assessment page)*. This document is arranged as one double-sided A4; the rule allows two. The Final Exam is an end-of-semester examination worth **45%**.

Separate pass condition: at least **75% workshop attendance (9 of 12)**, unless an approved Special Consideration outcome applies.

12 · Application: island lineage

C1 · WORKED



Redrawn from the supplied common-ancestry evidence figure for the island application.

1. **Endpoint/level:** relationship of island and mainland lineages; molecular, organismal and geographic evidence.
2. **Pattern:** DNA similarity and geographic proximity agree; morphology differs.
3. **Mechanism:** common ancestry followed by isolation and selection could produce the combination.
4. **Rival/control:** independent origin or convergence predicts a different coherent pattern across independent homologous evidence; seek an additional discriminating sample.
5. **Boundary:** fossils, present distribution and molecular comparison operate at different scales and have distinct biases.

Do not collapse convergence and common ancestry. Similar current function may be analogous; inherited organisation and multiple independent records carry the relationship claim.

13 · Application: two plants

C2 · WORKED

Answer: define genotype and measured height; hold genotype constant while changing light/nutrients; attribute the observed difference through expression and development only to the extent tested. A credible alternative is measurement or another uncontrolled environmental input.

Cross trap: first state parental genotypes, allele notation, dominance and independence. Translate genotype probability to phenotype probability only when the mapping is justified; family counts are not guaranteed.

ISLAND EVIDENCE BOUNDARY

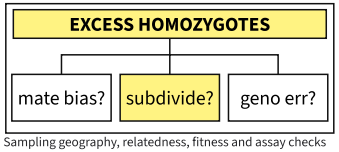
RECORD	USE WITHOUT OVERCLAIMING
DNA similarity	Supports sampled-locus relatedness
Geographic proximity	Supports an isolation/movement history
Distinct morphology	May reflect post-isolation selection; not separate origin

Discriminator: add an independent homologous character or sequence. Ask whether the rival history predicts a different coherent pattern; attach preservation, sampling and measurement bias to the affected record.

14 · Population-genetics traps

C2 · WHICH IS TRUE

CLAIM	VERDICT + REPAIR
Dominant means common and evolutionarily favoured.	False: dominance concerns heterozygous phenotype only.
A Punnett square predicts exact offspring counts.	False: it organises probabilities under stated assumptions.
Hardy–Weinberg describes a perfect real population.	False: it is a null expectation used to detect questions.
Excess homozygotes proves selection.	False: assortative mating, subdivision or genotyping error can produce it.
Geographic separation is speciation.	False: speciation requires evolved reproductive isolation.
All post-divergence gene exchange erases lineage history.	False: limited reticulation or fertile introgression can occur.



Sampling geography, relatedness, fitness and assay checks discriminate alternatives.

POOLED-REGION APPLICATION

Two partially isolated regions pooled together show excess homozygotes. The pooled sample may manufacture departure by treating distinct mating populations as one. Reanalyse regions separately before invoking selection. State population and generation; align allele counts, genotype counts and sampling units.

BARRIER CLASSIFIER

STAGE REDUCED	BARRIER	EVIDENCE
Encounter/courtship	Prezygotic	Individuals do not meet or mate
Fertilisation	Prezygotic	Gametes do not unite
Development	Postzygotic	Hybrid viability falls
Reproduction	Postzygotic	Hybrid fertility falls

Report whether isolation is complete, asymmetric or environmentally contingent. Morphological difference alone does not establish speciation.

MORE WHICH-IS-TRUE CHECKS

CLAIM	REPAIR
Selection always removes variation.	Trade-offs and changing environments can preserve it.
A migrant allele must be advantageous.	Gene flow requires migration and reproduction, not advantage.
One endpoint separates drift from selection.	Use population size, direction, connectivity and repeated time points.

15 · Application: rotate the tree

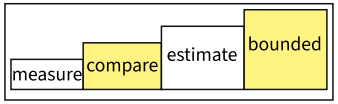
C3 · WORKED

1. Define relatedness as recency of common ancestry.
2. Ignore page distance; trace A and B backwards to their meeting node.
3. Compare that node with the node each shares with C or D.
4. Rotation about a node is a drawing change, not an evolutionary event.
5. Only interpret branch length as time/change when the diagram supplies a scale or legend.

WHICH IS TRUE?	ANSWER
Nearby tips are closest relatives.	Only if they share the most recent node.
A named clade may omit an awkward descendant.	No: ancestor + **all** descendants.
Insect and bird flight proves close relationship.	No: analogous function can evolve independently.
One character settles a tree.	No: prefer coherent patterns across independent homologous traits.

16 · Evidence-to-claim drill

C3 · APPRAISAL



A paper supports only the link its population, design and measurement can test.

Record question, organism/population, comparison, measurement, result and limitation. If the study answers a neighbouring question, narrow the claim. Distinguish direct observation from interpretation; specify actor, interaction, direction and consequence.

20 · Short-answer frame

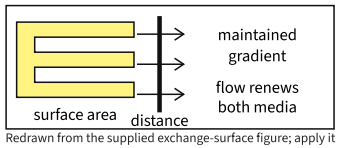
C1–C5 · RESPONSE METHOD

1. **Define** endpoint, comparison and level.
2. **Describe** the measured pattern without causal overreach.
3. **Explain:** actor → interaction → direction → consequence.
4. **Predict:** change one condition and state the outcome.
5. **Control/rival:** remove an alternative without changing the focal process.
6. **Bound:** uncertainty, trade-off, scale and what the evidence cannot establish.

FINAL SCAN *Circle every mechanism verb; underline its evidence. Label every arrow with a physical or biological process.*

17 · Application: fish gills

C4 · WORKED



Redrawn from the supplied exchange-surface figure; apply it to gill lamellae.

1. **Endpoint:** gas delivery across gill lamellae.
2. **Observation:** extensive thin surfaces; blood flow renews the internal medium.
3. **Mechanism:** large area + short distance + maintained gradient support diffusion; circulation distributes gases.
4. **Changed condition:** outside water, lamellae collapse; area and structural support fall.
5. **Rival/control:** if breathing rate rises but tissue delivery fails, measure circulation/transport rather than locating the bottleneck at ventilation.
6. **Limit:** folding needs support; thinness risks damage/water loss; performance depends on medium and demand.

OBSERVED FAILURE	LIKELY STAGE TO TEST
Fresh medium does not reach surface	Ventilation
Surface intact but crossing slows	Barrier thickness/area/gradient
Crossing occurs but tissue delivery lags	Carrying capacity or perfusion

18 · Nutrient drill

C4 · MATERIAL ROUTE

A herbivore eats cellulose-rich tissue but microbial partners release usable compounds. Teeth, gut retention and microbes form one acquisition system; attributing digestion to teeth alone misses the biochemical step.

```
capture ≠ cellular availability
name breakdown site → membrane crossing → distribution → use → waste; compare benefit with processing cost
```

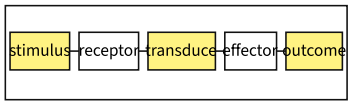
21 · Fast recall

C1–C5 · LAST PASS

PROMPT	MUST NAME	BLOCK THIS TRAP
Evolution	Level, heritability, process, environment	Purposeful mutation
Phylogeny	Most recent node, full descendant set, scale	Tip spacing
Exchange	Substance, barrier, gradient, bulk flow, demand	Organ name only
Signal	Stimulus, receptor, transduction, effector, outcome	Environment → behaviour jump

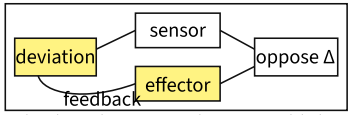
19 · Application: plant bends to light

C5 · WORKED



For directional light: receptor placement and transduction lead to differential cell expansion.

1. **Endpoint:** directional growth at organismal level.
2. **Pattern:** bending follows directional light.
3. **Mechanism:** photoreceptor detection → intracellular change → hormone redistribution → differential expansion.
4. **Control:** alter direction while controlling other conditions; disrupting receptor/transduction predicts loss or change of response.
5. **Boundary:** a plant needs no nervous system for information processing; sensitivity trades early detection against noise.



Apply to the ectotherm: movement between sun and shade keeps performance within a workable range.

HOMEOSTASIS ANSWER

Define the defended endpoint and its range; show deviation → detection → response that opposes it. Explain how time, development or context can shift the range. Then state a cost/limit and test a rival such as direct temperature effects without coordinated regulation.

WHICH IS TRUE?	ANSWER
Homeostasis fixes a value exactly.	False: it maintains tolerable ranges.
Any fluctuation is failure.	False: range and endpoint matter.
Positive feedback defines homeostasis.	False here: negative feedback opposes deviation.
Temperature response is one reflex.	False: behaviour, circulation, insulation, heat production and size can contribute.

SIGNAL PREDICTIONS

CHANGE	PREDICTION
Receptor placement differs	Same light, different response
Transduction is disrupted	Detection need not reach growth
Sensitivity rises	Weak input detected; noise response may rise
Threshold is stricter	Noise falls; early information may be missed

A complete claim names stimulus, receptor, intracellular change, effector and outcome; do not jump directly from environment to behaviour.