



Full guide + ask Sia
about HUBS1404

SIDE 1 · PLAN YOUR OWN A4

MEMORY AID PLANNER · mechanisms → rules → prediction

OWN WORK ONLY

1 · Exam Map

COURSE OUTLINE · S2
2026

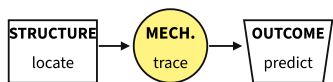
Tests 30% Mid 30% Final 40%

Final: formal multiple choice examination on **all** course material; 40%; must be attempted.

PERMITTED MATERIALS · VERBATIM

“This is a RESTRICTED OPEN BOOK examination covering ALL course material. A memory aid can be brought into the exam; this will be collected by Examinations / does not leave the exam venue. Format: 1 x A4 sheet; both sides; drawings permitted, own work; any size font.” (HUBS1404 course outline, Semester 2 2026)

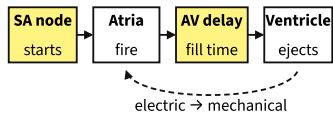
Use this as a plan: remake the high-risk arrows, ratios and contrasts in **your own notes/work**. Prioritise relationships you reverse under pressure.



Default MCQ route: identify the compartment, trace the first effect, then predict downstream change. *Front figure.*

2 · Cardiac Order

CH 01 · MAP + FAQ



Conduction and pumping are ordered; an ECG records electrical activity, not valve motion or contraction strength. *CH 01 fig. 1.*

CLAIM	CORRECT DISCRIMINATOR
Valves	Open/close with pressure differences; preserve direction, do not create pressure.
Wall thickness	Ventricles eject; left ventricle serves higher-resistance systemic circuit.
Autonomic input	Modulates nodal rate/conduction; does not create intrinsic rhythmic capacity.

Keep routes separate: body → right atrium → right AV valve → right ventricle → pulmonary valve → lungs → left atrium → left AV valve → left ventricle → aortic valve → body. Autorhythmic cells initiate/conduct; contractile cells turn excitation into force.

EXAM MOVE *If a site is delayed, keep upstream events intact and shift downstream activation; do not erase the already initiated atrial event.*

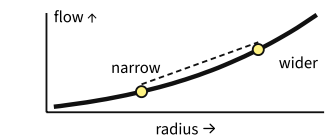
3 · Flow & Resistance

CH 02 · WORKED

Flow = pressure difference ÷ resistance

Cardiac output = heart rate × stroke volume

Two-point rule: one pressure is insufficient. Flow requires an upstream-to-downstream **difference**. If both pressure difference and resistance change, calculate the quotient.



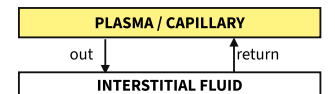
At fixed pressure difference, a modest radius increase can greatly increase flow because resistance falls steeply. *CH 02 fig. 1.*

VESSEL	EXAM-VALUE FUNCTION
Elastic artery	Accepts pulsatile ejection; supports movement between beats.
Arteriole	Adjustable radius → powerful local and systemic resistance control.
Capillary	Thin exchange interface; huge total area → low average velocity.
Vein	Large compliant volume; valves + muscle/respiratory effects aid return.

SCALE CHECK Write **vessel / organ bed / systemic**. A local resistance rise does not alone determine mean arterial pressure.

4 · Exchange Forces

CH 02 · OVERVIEW



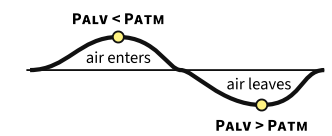
Name the direction before the force: hydrostatic and retained-solute osmotic effects act across plasma-
interstitium boundaries.

Trap: venous-return aids move existing blood volume; they do not generate new blood. Pressure, velocity, resistance and cross-sectional area are related but **not interchangeable**.

Local versus systemic: one tissue can dilate to meet metabolic demand while another constricts. Whole-body arterial pressure depends on cardiac output and the combined resistance of parallel beds; slower fluid-volume control changes the amount available to circulate. High systemic pressure therefore does not guarantee good perfusion through a narrowed downstream bed.

5 · Ventilation Mechanics

CH 03 · MAP + WORKED



Quiet inspiration: diaphragm contracts → thorax/lung volume rises → alveolar pressure falls → air enters; quiet expiration reverses by elastic recoil. *CH 03 fig. 1.*

FIRST ALTERED RELATION	CONSEQUENCE
Low compliance	More distending-pressure change needed for the same volume.
Narrow airway	Higher airway resistance limits flow.
Low surfactant effect	Greater surface-tension problem; reduced alveolar stability.
Air in pleural space	Disrupted lung-chest wall coupling despite open airways.

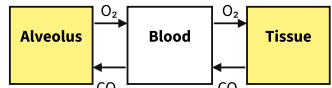
Minute ventilation = tidal volume × rate

Alveolar ventilation = (tidal volume - dead space) × rate

Compartment rule: atmospheric, alveolar and intrapleural pressures are not synonyms. Compare only the pressures that drive the event.

6 · Gas Exchange

CH 04 · MAP + FAQ



Each gas follows its own partial-pressure gradient; opposite directions across one membrane are compatible. *CH 04 fig. 1.*

V/Q = alveolar ventilation ÷ pulmonary perfusion

PATTERN	READ IT AS
Ventilation ↓ relative to perfusion	Low V/Q; stream oxygenation impaired.
Ventilation with almost no perfusion	Dead-space-like behaviour.
Perfusion without effective ventilation	Shunt-like behaviour.

Do not collapse levels: diffusion across a thin, large-area barrier ≠ carriage by haemoglobin ≠ delivery by blood flow. Exercise raises tissue O₂ use and CO₂ production, then ventilation and cardiac output respond together.

Failure site: thick barrier alters diffusion; reduced haemoglobin alters carriage; low flow alters delivery. Identical V/Q ratios need not mean identical absolute transfer when both V and Q differ.

7 · Digestion → ATP

CH 05 · MAP + FAQ



Digestion supplies absorbable molecules; catabolic redox pathways transfer energy into gradients; ATP couples it to work. *CH 05 fig. 1.*

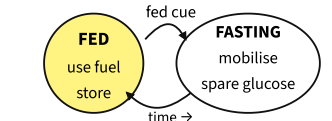
BOUNDARY / ROUTE	QUESTION TO ASK
Lumen → epithelium	Was the nutrient digested and absorbed?
Epithelium → blood/lymph	Which transport route carries it?
Circulation → cell	Can target tissue take it up?
Inside cell	Oxidise, convert or store?

Shared network, different entry: glucose can be oxidised, stored as glycogen or synthesised onward; fatty acids enter central pathways after beta oxidation; amino acids need nitrogen handling before carbon skeleton use.

TRAP *Digestion is not cellular respiration. Successful absorption does not prove uptake or oxidation.*

8 · Fed ↔ Fasting

CH 06 · MAP + WORKED



State changes fuel traffic rather than flipping every pathway fully on or off. *CH 06 fig. 1.*

FED	POSTABSORPTIVE / FASTING
Intestinal delivery; insulin pattern; immediate oxidation; glycogen and reserve synthesis.	Glycogen support → gluconeogenesis; fatty-acid mobilisation; ketone availability rises over time.

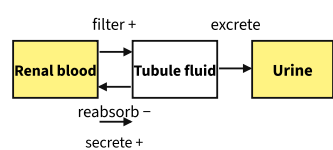
Route discriminator: pancreatic exocrine products travel by ducts to intestine; endocrine hormones enter blood. Portal blood delivers absorbed nutrient to liver; **bile** uses a ductal route.

Totals before shares: an internal contribution can rise while total supply falls if absorbed delivery falls by more.

Fasting order: declining intestinal delivery → shorter-interval glycogen support → gluconeogenesis → greater fatty-acid reliance → rising ketone availability. Hormonal signals act through different receptors and time courses.

9 · Renal Mass Balance

CH 07 · MAP + WORKED



Assign the compartment and direction before the sign. Filtration enters nephron fluid; reabsorption returns to blood; secretion adds to tubule. *CH 07 fig. 1.*

PUT THIS HIGH ON YOUR OWN SHEET

Excretion = filtered - reabsorbed + secreted

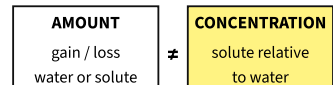
Clearance = urine concentration × urine flow ÷ plasma concentration

IF ONLY THIS CHANGES	DIRECT EFFECT
Reabsorption inhibited	More stays in tubule → excretion rises.
Secretion rises	Excretion rises; can exceed filtered load.
GFR high	More volume enters nephrons; not equal to urine flow because later transport intervenes.

Sequence: renal corpuscle → proximal region → loop → distal region → collecting system. Early changes alter the load delivered downstream; distal/hormonal regulation can modify the final urine response.

10 · Water Logic

CH 08 · FAQ



Draw compartments first: concentration cannot automatically be converted into total amount or volume.

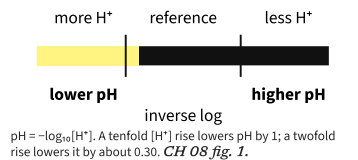
The medullary gradient provides the osmotic setting for water conservation when collecting segments are sufficiently permeable. Low conserving signal can leave more water in tubular fluid and produce more dilute urine.

TRAP *Small urine volume does not by itself prove concentrated urine; compare solute with water.*

Filtration barrier: water and suitable small solutes enter Bowman's space; cells and most large proteins are retained normally. GFR is volume entering nephrons per time, not final urine flow. Interpret clearance only after asking whether the substance is freely filtered, reabsorbed or secreted.

11 · Acid-Base Clocks

CH 08 · WORKED + FAQ



pH = -log₁₀[H⁺]. A tenfold [H⁺] rise lowers pH by 1; a twofold rise lowers it by about 0.30. *CH 08 fig. 1.*

INITIATOR	PRIMARY DIRECTION
Ventilation ↓	CO ₂ retained → respiratory acidic shift.
Ventilation ↑	CO ₂ removed → respiratory alkaline shift.
Non-respiratory primary change	Classify as metabolic; compensation does not rename origin.

Immediate: protein/phosphate buffers

Short interval: ventilation changes CO₂ removal

Slower: kidneys secrete H⁺, recover/generate buffer

DECISION RULE *Primary variable → direction → time available → compensation. Never name the disorder from its compensation.*

12 · Reproduction Loop

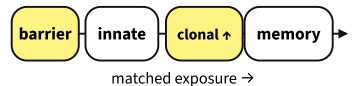
CH 09 · EVIDENCE BOUNDARY

LAYER	WHAT TO LABEL
Central	Neural-endocrine signal to pituitary level.
Pituitary	Blood-borne output to responsive gonadal tissue.
Gonad	Local function + steroid/peptide products at distant targets.
Feedback	Usually stabilising; reinforcing only in its specified state/phase.

Sequence: production → maturation → release → transport → fertilisation → division/movement → implantation. Attach location and time; later structures cannot cause earlier events.

13 · Defence Layers

CH 10 · MAP + FAQ



Barriers and innate recognition precede antigen handling, matched lymphocyte expansion, effectors, resolution and memory. *CH 10 fig. 1.*

INNATE	ADAPTIVE
Rapid; encoded recognition of recurring microbial/damage patterns; barriers, cells and mediators.	Diverse receptors; context-dependent activation; clonal expansion; antigen-specific effectors and memory.

Re-exposure: memory speeds matched adaptive response; it does not replace barriers or innate response. Not all lymphocytes secrete antibody.

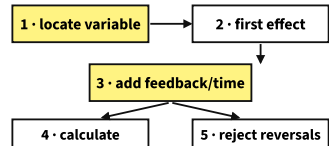


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SIDE 2 · DRILL BEFORE THE EXAM

14 · MCQ Decoder

ALL CHAPTERS · FAQ



Answer at the earliest broken link. Real terms can still form a false option when compartment, direction, scale or timing is wrong.

WHICH IS TRUE?	REJECT BECAUSE...
ECG directly measures ventricular force.	False: surface electrical change precedes mechanics.
Higher upstream pressure guarantees higher flow.	False: use pressure <i>difference</i> and resistance.
Low V/Q identifies the cause.	False: ratio shows mismatch, not which term changed.
Small urine volume proves high concentration.	False: concentration needs solute relative to water.
Memory replaces innate defence later.	False: re-exposure layers matched memory onto early defence.

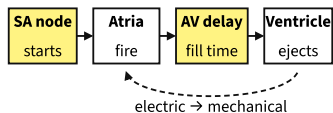
Option audit: circle the noun naming the compartment, underline the changed variable, and mark $\uparrow/\downarrow$ beside the earliest link. If two choices share the same endpoint, prefer the one that preserves the correct route and timing. A downstream true fact cannot rescue an option whose first causal link is false.

EXPLAIN-ALoud FRAME
“The changed variable is in . The first direct effect is because . Over time, compensation can ; therefore option is true.”

ERROR LOG Label every miss: *vocabulary · direction · compartment · scale · calculation · timing.*

15 · Cardiac Timing Drill

CH 01 · WORKED



Use the conduction order order while calculating: $60 \div 75 = 0.80$ s; $60 \div 100 = 0.60$ s; the cycle is 25% shorter. *CH 01 fig. 1 + worked example.*

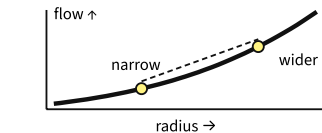
RATE TRAP Convert beats/min to seconds per cycle before interpreting the mechanism. From 75→100 bpm: $0.80 \rightarrow 0.60$ s; reduction = $0.20/0.80 = 25\%$. A shorter cycle limits filling time.

16 · Flow Application

CH 02 · WORKED

Stem: pressure difference 20 → 24 mmHg; resistance 4 → 6 relative units.

Initial flow = $20 \div 4 = 5$ units
Final flow = $24 \div 6 = 4$ units
Change = $4 - 5 = -1$; relative = $-1 \div 5 = -20\%$



Which is true? Flow falls from 5 to 4 despite ΔP rising; resistance dominates the quotient. Radius is a powerful resistance control. *CH 02 fig. 1 + worked example.*

STEM CHANGE	FIRST LINE TO WRITE
Valve failure	Altered direction/pressure loading before symptom.
Arteriole constriction	Radius $\downarrow$ → resistance $\uparrow$ → local perfusion tends $\downarrow$ if gradient fixed.
Many capillaries in parallel	Total cross-sectional area $\uparrow$ → average velocity $\downarrow$.

Sanity: equal upstream/downstream pressures give no directed bulk flow. Dilution lowers resistance, but realised flow still depends on the gradient. Velocity is not total organ flow.

SHORT-ANSWER FRAME “Although ΔP rose by , R rose from to ; because flow is their quotient, flow .”

17 · Ventilation Application

CH 03 · WORKED

A: 500 mL × 12/min. **B:** 300 mL × 20/min. Dead space = 150 mL.

	MINUTE	ALVEOLAR
A	$500 \times 12 = 6000$ mL/min	$(500 - 150) \times 12 = \mathbf{4200}$
B	$300 \times 20 = 6000$ mL/min	$(300 - 150) \times 20 = \mathbf{3000}$

A fresh 4200	dead 1800
B fresh 3000	dead 3000

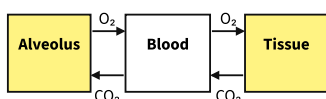
minute = 6000
Pattern A delivers 1200 mL/min more fresh gas beyond dead space. Subtract dead space before multiplying.

Mechanics check: shallow breathing uses more of each breath in dead space. If compliance, airway radius or pleural coupling changes, identify that relation before predicting ventilation.

Capacity trap: a capacity containing residual volume cannot be measured simply by collecting only gas entering and leaving the mouth.

18 · V/Q & Gas Traps

CH 04 · WORKED + FAQ



Region A $V/Q = 4/5 = 0.80$; B = $2/4 = 0.50$, so B has poorer ventilation relative to blood flow. The ratio alone does not identify the cause. *CH 04 fig. 1 + worked example.*

WHICH IS TRUE?	RESOLUTION
O ₂ and CO ₂ cannot cross one membrane in opposite directions.	False: each follows its own partial-pressure gradient.
A diffusion defect and low haemoglobin capacity are the same failure.	False: barrier transfer versus blood carriage.
Exercise response begins with lung activity.	False: working tissue O ₂ use $\uparrow$ and CO ₂ production $\uparrow$; integrated supply responds.
Reduced alveolar ventilation causes a renal disorder.	False: CO ₂ retention initiates respiratory acidity; kidney response is slower compensation.

Exercise: tissue O₂ use $\uparrow$ and CO₂ production $\uparrow$ → gradients/unloading change → local flow, cardiac output and ventilation rise. Ventilation without adequate circulation cannot deliver O₂.

EXPLAIN-ALoud FRAME
“At the boundary, gas moves from to because its own partial pressure is higher at . Blood then carries it by .”

19 · ATP Accounting

CH 05 · WORKED

Supplied model: 6 substrate units; 2 ATP early + 8 ATP later per unit.

Early = $6 \times 2 = 12$ ATP
Later = $6 \times 8 = 48$ ATP
Total = **60 ATP**
Shares: $12/60 = 20\%$; $48/60 = 80\%$



Use values supplied in the question and add each contribution once: 12 early + 48 later = 60 ATP. *CH 05 fig. 1 + worked example.*

Pathways: catabolism breaks substrates; anabolism builds and needs energy; oxidation is electron loss. Cytosolic glycolysis and later oxidative phosphorylation are distinct steps.

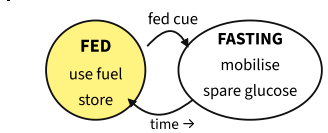
COMPARTMENT CHECK Lumen digestion → epithelial absorption → transport → cellular pathway → oxidation/conversion/storage.

20 · Fuel-Source Accounting

CH 06 · WORKED

Fed: 70 absorbed + 20 internal. **Later:** 10 absorbed + 65 internal.

Fed total = 90; internal = $20/90 = 22.2\%$
Later total = 75; internal = $65/75 = 86.7\%$
Total falls 15; internal amount rises 45.



State controls fuel traffic. The later internal share is 86.7% while total supply is lower: totals before fractions. *CH 06 fig. 1 + worked example.*

WHICH IS TRUE?	WHY
A blocked pancreatic duct directly blocks endocrine hormone transport.	False: exocrine uses ducts; endocrine enters blood.
Fed means catabolism stops.	False: oxidation, storage and synthesis coexist.
Fasting is one instantaneous switch.	False: glycogen support, gluconeogenesis, fat mobilisation and ketone availability develop over time.

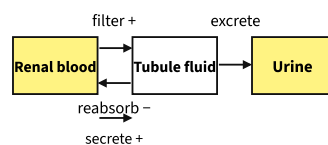
PERCENTAGE LINE “Internal amount changed by , its share changed from to , while the whole changed from to .”

21 · Renal Calculation

CH 07 · WORKED

Given: filtered 120 mg/min; reabsorbed 95 mg/min; secreted 15 mg/min.

Excretion = $120 - 95 + 15 = \mathbf{40}$ mg/min
Fraction of filtered load = $40/120 = 33.3\%$



Direction fixes the arithmetic: 120 filtered – 95 reabsorbed + 15 secreted = 40 mg/min excreted. *CH 07 fig. 1 + worked example.*

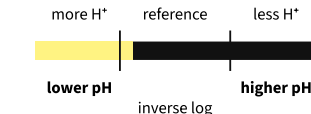
Which is true? Inhibiting reabsorption raises excretion if other terms are fixed. Secretion can make excretion exceed filtered load. Urine flow does not equal GFR because downstream transport acts.

22 · pH Application

CH 08 · WORKED

Given: [H⁺] rises from 40 to 80 nmol/L.

Ratio = $80 \div 40 = 2$
 $\Delta pH = -\log_{10}(2) \approx \mathbf{-0.301}$
Therefore pH falls by about 0.30; it is not halved.



Doubling [H⁺] from 40 to 80 nmol/L lowers pH by $\log_{10}(2) \approx 0.30$. *CH 08 fig. 1 + worked example.*

TIME / CAUSE	WHICH IS TRUE?
Immediate	Protein and phosphate buffers can act first.
Short regulatory interval	Ventilation can alter CO ₂ removal.
Slower	Renal H ⁺ secretion and buffer recovery/generation contribute.
After compensation	Name remains based on initiating respiratory/metabolic change.

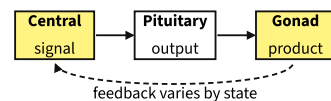
Cause/compensation: ventilation $\downarrow$ retains CO₂ → respiratory acidic shift; ventilation $\uparrow$ removes CO₂ → respiratory alkaline shift. A non-respiratory primary change is metabolic. Compensation does not rename it.

23 · Development Sequence

CH 09 · WORKED

Invested stage model: 120 → 90 → 54 → 45 cells.

TRANSITION	RETENTION
120 → 90	$90/120 = 75\%$
90 → 54	$54/90 = \mathbf{60\%}$ (lowest)
54 → 45	$45/54 = 83.3\%$
Overall	$45/120 = 37.5\%$



Keep source, target, feedback and sequence visible while comparing transition percentages with overall retention. *CH 09 fig. 1 + worked example.*

Hormone audit: source → blood route → receptor-bearing target → feedback. Negative feedback commonly stabilises; reinforcing feedback is state-specific.

EXPLAIN-ALoud FRAME
“Stage occurs in after . Its transition retention is / = %, while overall retention uses the original denominator: / = %.”

24 · Immune Expansion

CH 10 · WORKED

Primary: 200 matched cells → 3000 effectors. **Later:** 800 matched memory-derived cells → 20,000.

Primary fold = $3000/200 = 15$ -fold
Later fold = $20,000/800 = 25$ -fold
Final-total ratio = $20,000/3000 = \mathbf{6.67\times}$



Place the calculation on the response timeline: primary 15-fold; later matched response 25-fold and $6.67\times$ the final total. *CH 10 fig. 1 + worked example.*

WHICH IS TRUE?	RESOLUTION
Innate means random.	False: encoded recognition of recurring microbial/damage patterns.
Antigen contact activates every adaptive pathway.	False: matching, context and supporting signals matter.
Every lymphocyte secretes antibody.	False: B-cell descendants may; other lymphocytes coordinate, kill or persist as memory.
Bigger inflammation is always better.	False: judge threat control and collateral tissue damage.

Timeline: barrier → local recognition/mediators → recruited cells → antigen handling → matched expansion → effectors → resolution → memory. Re-exposure keeps early innate stages but changes matched adaptive history.

25 · Final Fast-Recall Grid

CH 01–10

PROMPT	WRITE / SAY FIRST
Cardiac	Electrical site → pressure/mechanics → flow.
Haemodynamics	Two pressures; $\Delta P/R$; local or systemic?
Ventilation	Muscle → volume → P_{ALV} vs P_{ATM} → flow.
Gas exchange	Gas-specific gradient; V/Q; diffusion vs carriage.
Metabolism	Compartment; carbon/electron route; state; total.
Renal	Filter – reabsorb + secrete = excrete.
Acid–base	Primary variable; direction; time; compensation.
Reproduction	Source → target → feedback; location + sequence.
Immunity	Barrier → innate → matched expansion → memory.

Own-page priority: signed relationships → denominators/balances → compartments → time chains → one worked number per calculation → error traps. Remove prose clear from arrows.