SI-04

SI-04: Q5
Model Completion Patterns

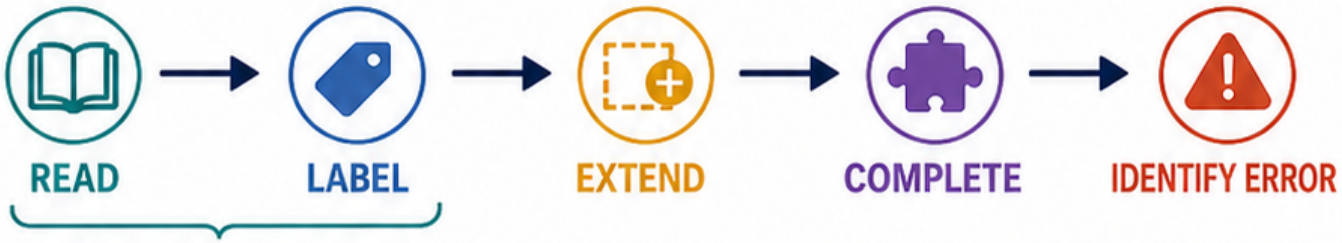
From Reading to Drawing — Before & After Patterns for Five High-Yield Visual Models

Sprint Review · Free at Sophriva

just interpreting — you're putting your pen to the page. The difference between 2/4 and 4/4 on Q5 is usually whether you used the correct visual conventions and showed the cascade explicitly.

Q5 | 4 pts | Skill 2 (Visual Models) | Construction & Completion

1. The Q5 Task Spectrum



S8 mainly covered reading.

Task	What you do	Typical phrasing
1 Read / Interpret	Describe what's already in the model	"What does component X represent?"
2 Label	Add names to indicated structures	"Label the indicated structures."
3 Extend	Add new components or relationships	"Add an arrow showing the effect of Z."
4 Complete	Fill in missing parts of a partial model	"Complete the diagram to show what happens when..."
5 Identify error	Spot and correct an incorrect element	"The diagram contains an error. Identify and correct it."

This module focuses on the three task types that involve drawing: extend, complete, identify error.

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2. Drawing Conventions: The Universal Symbol Key

Use standard visual symbols so the grader can follow your logic immediately.

Symbol	Meaning	When to use
→	Activation, positive regulation, energy flow, transformation, prey-to-predator energy transfer	Default arrow for almost any flow or activation
⊥ (T-bar)	Inhibition, repression, blockage	When one component decreases or stops another
↻	Feedback loop pointing back to upstream	Negative feedback (T-bar end) or positive feedback (arrow end)
⊕ P	Phosphorylation by a kinase	Signal transduction cascades
✕ / X	Knockout, mutation, blocked, disrupted	When marking what was disrupted
- - - → (dashed arrow)	Reduced, weakened, or potential interaction	When showing partial loss
⇒ (double arrow)	Strongly increased flow	When emphasizing amplified effect
○ → ●	Inactive → active	Conformational change, activation state

Rule: Don't invent symbols.
Use these conventions and the grader can immediately follow your logic.

Visual clarity = easier scoring.

Page focus: memorize the symbol key before completing models.

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3. Pattern 1: Signal Transduction Cascade – Receptor Loss

Show the disruption point and trace the entire downstream cascade visually.

A The Setup

Ligand → Receptor → G-protein → Adenylyl Cyclase → cAMP → PKA → Gene X expression

B BEFORE (Intact Pathway)

Ligand	Ligand binds receptor.
Receptor	Receptor undergoes conformational change.
G-protein	G-protein is activated.
Adenylyl Cyclase	Adenylyl cyclase is activated.
cAMP	cAMP levels increase.
PKA	PKA is activated.
Gene X expression	**Gene X is expressed.**

AFTER (Receptor Mutation Prevents Ligand Binding)

Ligand	Ligand still arrives.
Receptor ✗	Ligand cannot trigger conformational change in the mutated receptor.
G-protein	Activation does not occur.
Adenylyl Cyclase	Not activated.
cAMP	Levels do not increase.
PKA	Not activated.
~~Gene X expression~~	Gene X expression is **ABSENT.**

C What a Strong Q5 Answer Shows

- ✗ on the correct component
- Downstream cascade clearly disrupted in visual form
- Final outcome explicitly indicated
- Mechanism written in 1 sentence

Actual scoring points may vary by year and prompt, but graders consistently reward **visual** + **verbal** answers that show all four elements.

Page focus: mark the disruption, then show the full downstream consequence.

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4. Pattern 2: Negative vs. Positive Feedback — Loop Drawing

Choose the correct loop symbol:
T-bar for stabilizing, arrow for amplifying.

1. The Setup

2a. Negative Feedback (most common)

Result: oscillation around a setpoint. System self-corrects.

Examples:
- body temperature
- blood glucose (insulin/glucagon)
- blood pressure baroreceptor reflex

2b. Positive Feedback (amplifying)

Result: rapid escalation to a defined endpoint, not homeostasis.

Examples:
- childbirth contractions (oxytocin)
- blood clotting cascade
- action potential depolarization (Na^+ influx)

3. When the model asks you to ADD a feedback loop

- Read the question to identify whether the system stabilizes (negative) or amplifies to completion (positive).
- Draw the loop from the final response back to the earliest step it influences.
- Choose the correct symbol: T-bar for stabilizing, arrow for amplifying.
- Write a one-sentence label: 'Negative feedback maintains homeostasis' or 'Positive feedback amplifies the response to completion.'

4. When the model asks: WHAT IF FEEDBACK IS LOST?

- Mark ✕ on the feedback loop.
- For lost negative feedback: response continues to rise — add upward arrow on the response box + label 'loss of homeostasis.'

- For lost positive feedback: response fails to reach completion — add ↓ on response + label 'process cannot complete.'

Page focus: feedback questions are mostly symbol-choice questions.

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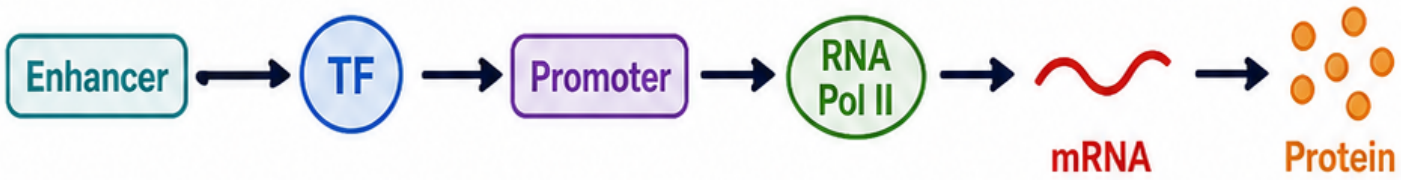
5. Pattern 3:
Gene Regulation Model — TF Mutation

Watch direction carefully: lost activator ↓, lost repressor ↑.

A) The Setup: a eukaryotic transcription regulation diagram with enhancer, transcription factor (TF), promoter, RNA Pol II, mRNA, protein.



B1 Variant A — TF DNA-Binding Domain Mutation

- X at the TF-DNA contact (between TF and enhancer)
- Arrow from enhancer to promoter: removed or dashed
- mRNA arrow: dashed or absent
- Protein output: greatly reduced to basal levels (basal transcription may persist; if the prompt states the TF is absolutely required, output is essentially zero)

Note:
TF cannot bind enhancer;
RNA polymerase II is not recruited.

B2 Variant B — Repressor Knockout (Loss-of-Function)

- X on the repressor protein at the silencer
- Inhibition (T-bar) from silencer is removed
- Transcription proceeds without repression → mRNA arrow becomes bold or doubled
- Protein output: increased

Note:
Repressor cannot bind silencer;
transcription is no longer suppressed → expression increases.

C) The Counterintuitive Trap

If the question asks "what happens when a repressor is mutated?" students often predict a decrease in expression by reflex. The correct logic: removing a repressor increases expression because repression is lifted. Mark this with bold/doubled arrows downstream — the visual cue makes the answer obvious to the grader.

Page focus: always ask whether the mutation removes activation or removes repression.

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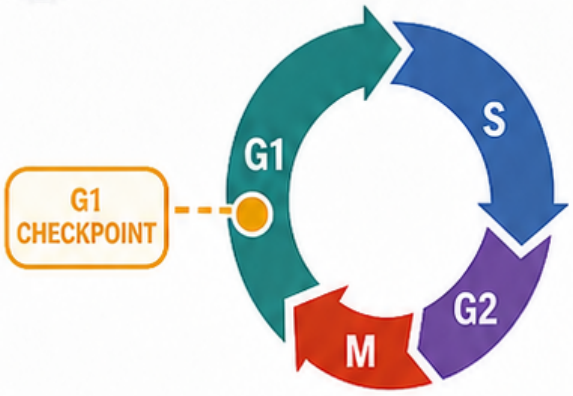
6. Pattern 4: Cell Cycle Checkpoint – p53 Disruption

Show the checkpoint bypass visually: damage goes into S phase instead of arrest.

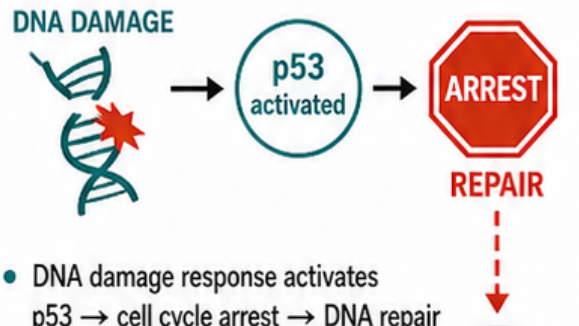
A Cell Cycle & Checkpoint Logic



G1 → [G1 Checkpoint: DNA damage response activates p53]

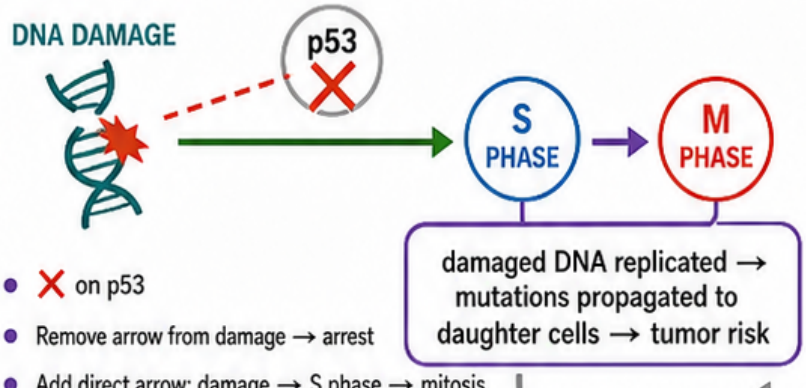
- damage detected → ARREST / REPAIR or APOPTOSIS
- no damage → Continue to S phase

B BEFORE (p53 intact)



- DNA damage response activates p53 → cell cycle arrest → DNA repair
- Cells with severe damage: p53 → apoptosis
- Result: damaged DNA does NOT propagate.

C AFTER (p53 loss-of-function)



- ✕ on p53
- Remove arrow from damage → arrest
- Add direct arrow: damage → S phase → mitosis (despite damage)
- Add label below S/M: "damaged DNA replicated → mutations propagated to daughter cells → tumor risk"
- Optional: add second arrow showing "no apoptosis triggered"

D) Why this Q5 pattern is high-frequency

The cell cycle is testable in both Unit 4 (cell cycle) and Unit 6 (gene expression / cancer). p53 specifically appears in CED descriptions of how mutations in tumor suppressor genes lead to uncontrolled cell division.

Page focus: the key visual cue is the bypass arrow around arrest.

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7. Pattern 5: Food Web — Apex Predator Removal

Read chain length carefully: cascade direction alternates down the food web.

Food web Q5 questions can use either a 3-level or a 4-level chain. The cascade direction alternates with chain length, so you must read the chain carefully and apply the right logic.

Pattern 5A — 3-Level Chain (Wolf → Elk → Plants)

Wolf
(apex predator)

Elk
(primary consumer / herbivore)

Plants — willows, aspens
(producers)

BEFORE (intact food web): All three trophic levels stable. Wolves regulate elk numbers; elk graze plants but plant biomass remains healthy.

AFTER (wolves removed):

- ✕ on wolves
- ---→ Arrow from elk to wolves: removed
- ↑ Elk population: ↑ (no top-down predation pressure)
- ↓ Plant biomass: ↓ (overgrazed by expanded elk population)

Cascade direction: 2 changes (one ↑, one ↓). Removing the apex flips the level immediately below it (↑), which then flips the level below that (↓).

Mechanism: Without wolves, elk populations expand and overgraze the dominant producers — a classic top-down trophic cascade (Yellowstone model).

Pattern 5B — 4-Level Chain (Orca → Sea Otter → Sea Urchin → Kelp)

Orca
(apex predator)

Sea Otter
(mesopredator)

Sea Urchin
(primary consumer / herbivore)

Kelp
(producer)

BEFORE (intact food web): All four trophic levels stable. Orcas regulate otter numbers; otters control urchin populations; urchins graze kelp but kelp forests stay healthy.

AFTER (orcas removed):

- ✕ on orcas
- ---→ Arrow from sea otters to orcas: removed
- ↑ Sea otter population: ↑ (no top-down predation)
- ↓ Sea urchin population: ↓ (more otters consume more urchins)
- ↑ Kelp biomass: ↑ (less urchin grazing)

Cascade direction: 3 alternating changes (↑, ↓, ↑). Removing the apex flips each subsequent level in turn.

Mechanism: Without orcas, sea otter populations expand, urchin populations are suppressed by increased otter predation, and kelp forests recover — alternating top-down trophic cascade (kelp forest model).

A) The Alternating Rule (Memorize This)

Chain length	Level 1 (apex)	Level 2	Level 3	Level 4
3-level	✕ removed	↑	↓	—
4-level	✕ removed	↑	↓	↑
5-level	✕ removed	↑	↓	↑ ↓

Rule: Each level alternates down the chain. The level immediately below the disruption goes opposite to the disrupted level; each subsequent level flips again.

B) Common student trap:

Assuming "removing the apex hurts everyone below it."

This is wrong — only the level directly below increases unchecked. Lower levels alternate.

C) Q5 Visual Cue Convention

- ↑ / ↓ arrows next to each box
- ✕ on the disrupted level
- ---→ Removed or dashed arrows for blocked energy flow
- → Bold or thickened arrows for amplified flow

This visual shorthand earns the represented relationships point even before the grader reads your written answer.

Page focus: in trophic cascades, never guess — count the levels and alternate.

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8. Q5 Completion Method + Mistakes + Practice + Cheat Card

Finish with the method, the common traps, and the one-page review summary.

1. The 3-Step Q5 Completion Method

1 Read the entire model FIRST (20 seconds)

- Identify the model type (signaling, gene reg, cell cycle, food web, etc.).
- Read all labels, arrows, and symbols.
- DO NOT pick up your pen yet.

2 Identify exactly what change is requested

- Knockout? Mutation? New component? Lost feedback?
- Highlight the affected component in your mind (or with a tiny annotation).

3 Trace the cascade and mark with conventional symbols

- Start at the disruption.
- Follow each arrow downstream.
- Mark every affected element with the appropriate symbol (✕, dashed, ↑/↓, bold).
- Add a 1-sentence biological note explaining the change.

Total time on Q5: 6–8 minutes of the 90-minute Section II window.

2. Top 5 Q5 Drawing Mistakes

#	Mistake	Fix
1	Drawing a brand-new diagram from scratch instead of modifying the given one	Modify the existing model — graders look for changes relative to the original
2	Using arrows everywhere, including for inhibition	T-bar (⊣) for inhibition; arrow (→) for activation. Mixing them confuses the grader
3	Forgetting to mark the disruption point with ✕	The ✕ is the visual anchor — without it, your answer requires the grader to guess where you started
4	Writing a long paragraph instead of using the visual conventions	Q5 is a visual question — use the diagram. Short labels (1 sentence) only
5	Inverting "T-bar = inhibition" when adding a positive feedback arrow	Arrow heads = activation, T-bars = inhibition. Always check this match before final answer

3. Practice Question — Q5-Style FRQ (4 pts)

Model:

[Enhancer]—TF-A⟶[Promoter]—RNA Pol II⟶mRNA⟶Protein P

[Silencer]—TF-B⊣

TF-A is an activator; TF-B is a repressor.

(a) Predict the effect of a loss-of-function mutation in TF-B on Protein P levels. Explain. [2 pts]

(b) On the diagram, indicate how the cascade changes when TF-A is also nonfunctional in addition to TF-B being nonfunctional. [2 pts]

Model Answer (what a full-credit response includes)

(a) With TF-B nonfunctional, the silencer cannot recruit a repressor and the inhibition of transcription is lost. RNA Pol II transcribes the gene without repression, so mRNA and Protein P levels increase above the normal baseline.

[1 pt: identifies that loss of repressor lifts inhibition; 1 pt: predicts increase in Protein P]

(b) Modified diagram (description):

- ✕ on TF-A and ✕ on TF-B
- Arrow from enhancer to promoter: dashed or removed (TF-A cannot recruit Pol II)
- T-bar from silencer: removed (TF-B not bound)
- mRNA arrow: dashed or absent
- Protein P: at basal/leak level, not strongly upregulated despite loss of repression

Mechanism note: Without TF-A, the activating recruitment of RNA Pol II is lost; the loss of TF-B alone is insufficient to drive transcription without an activator. Protein P remains low.

[1 pt: ✕ on both TFs and downstream arrows modified appropriately; 1 pt: explains that activator is required for transcription even when repressor is also lost]

4. One-Page Cheat Card

Symbol key: ⟶ activate · ⊣ inhibit · ⟳ feedback · ✕ knockout · —— dashed = weakened · ↑↓ direction

5 patterns (memorize the disruption + visual change)

	Pattern / Model Type	Common Disruption	Key Visual Change / Tip
1	Signal cascade	Receptor mutation	✕ on receptor, dashed downstream, no gene expression
2	Feedback loop	Add or remove the loop	T-bar for negative, arrow for positive
3	Gene regulation	TF or repressor mutation	Watch direction: lost activator ↓, lost repressor ↑
4	Cell cycle	p53 loss	✕ on p53, direct arrow bypassing arrest
5	Food web	Apex removal	3-level: ✕ apex, ↑ herbivore, ↓ producer · 4-level: ✕ apex, ↑ meso, ↓ herbivore, ↑ producer (alternating)

Time on Q5: 6–8 min · 4 pts · Use symbols, not paragraphs.

End of SI-04 content — review complete.

Page focus: complete the given model, use standard symbols, and show the cascade