

Name: \_\_\_\_\_ Period: \_\_\_\_\_ Date: \_\_\_\_\_

Open [peebedu.com](http://peebedu.com) and navigate to **Operail**. Click the **Introduction** button and read the popup, which explains how an operon functions using a train analogy: the promoter is a station, RNA polymerase is a locomotive, the operator is a signal switch, and the repressor is a crossing gate. Then explore the simulation by toggling components and clicking **All Aboard!** to run transcription.

## Free Response Questions

### Question 1 – Conceptual Analysis

**Simulation Task:** Toggle all genes (A, B, C) and the promoter ON, and toggle the repressor OFF. Click "All Aboard!" and observe the Event Log as RNA polymerase transcribes the genes and mRNA is delivered to the ribosome. Then click "Reset," toggle the repressor ON, and click "All Aboard!" again. Compare the two outcomes.

**(A)** (1 pt) **Describe** the role of negative regulatory molecules in controlling whether structural genes in a prokaryotic operon are transcribed.

---

---

---

**(B)** (1 pt) **Explain** why the structural genes of an operon are transcribed when the repressor protein is absent but are not transcribed when the repressor protein is present, even though RNA polymerase and the promoter are functional in both cases.

---

---

---

**(C)** (1 pt) **Predict** how the growth rate of a bacterial population in a nutrient-rich environment would be affected if a mutation in the operator sequence caused the enzymes encoded by a catabolic operon to be produced continuously, regardless of whether the substrate is present.

---

---

---

**(D)** (1 pt) **Justify** your prediction.

---

---

---

## Question 2 — Analyze Model / Visual Representation

**Simulation Task:** Toggle all genes (A, B, C), the promoter, and the transcription factor ON. Toggle the repressor OFF. Click "All Aboard!" and observe how the transcription factor affects the rate of transcription in the Event Log. Then click "Reset," toggle the transcription factor OFF (keeping everything else the same), click "All Aboard!" again, and compare.

**(A)** (1 pt) **Describe** the relationship between the promoter sequence and the ability of RNA polymerase to begin transcription of the structural genes in an operon.

---

---

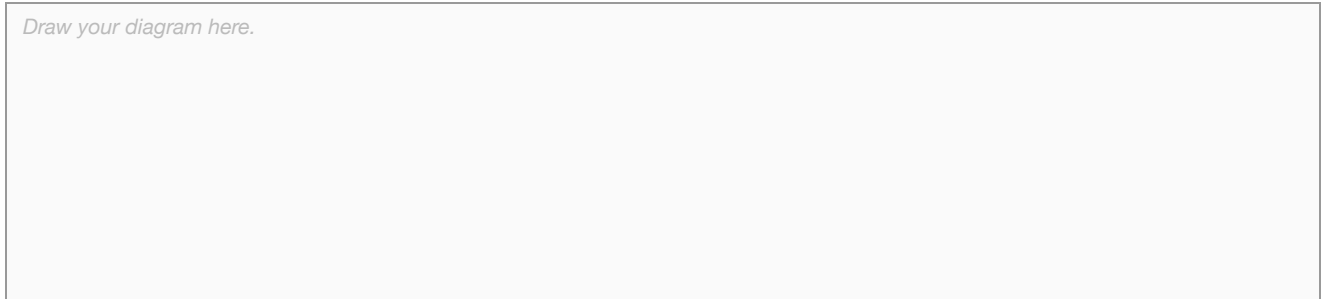
**(B)** (1 pt) **Explain** why all three structural genes in an operon are transcribed together as a single unit rather than being regulated independently.

---

---

**(C)** (1 pt) **Represent** In the box below, draw a labeled diagram of a prokaryotic operon showing the promoter, operator, at least three structural genes, RNA polymerase, and repressor protein in their correct relative positions, with arrows indicating the direction of transcription.

*Draw your diagram here.*



**(D)** (1 pt) **Explain** how a bacterial population in which some individuals carry a promoter mutation that eliminates transcription of a nutrient-metabolism operon would be affected by competition for that nutrient in the environment.

---

---