Formative Assessment Plan: “Glow It Up! Exploring Bioluminescence, Fluorescence, and the Genetics of GloFish”

Overall Goal: To continuously monitor student understanding of biofluorescence, its mechanisms, genetic basis, and differentiation from other light production methods, allowing for timely feedback and instructional adjustments.

ENGAGE Phase Formative Assessment (Lesson 1: Illuminating the Unknown)

- **Assessment Method: Think-Pair-Share and Question Board Analysis**
- **Description:**
    - During the Think-Pair-Share activity, students initially record their observations and questions individually. As they share in pairs and then with the whole class, the teacher circulates, listening to their initial ideas and misconceptions.
    - The "Question Board" (or shared digital document) serves as a living formative assessment tool.
- **What it Assesses:**
    - Prior knowledge and pre-conceptions about light production and glowing phenomena.
    - Ability to make observations and formulate relevant scientific questions.
    - Engagement with the topic.
- **Feedback/Instructional Adjustment:**
    - **Immediate:** Clarify initial misunderstandings during whole-class sharing. Highlight and group similar questions on the board to show common interests.
    - **Later:** Review the collected questions at the end of the lesson to gauge the class's baseline understanding and identify specific areas that need more emphasis in the Explore phase.
    - **Teacher Action:** Note down recurring misconceptions or particularly insightful questions to address directly in subsequent lessons.

EXPLORE Phase Formative Assessment (Lesson 2: Fluorescent Funhouse + Station Labs)

- **Assessment Method 1: Observation Charts and Group Discussions (During Lab Stations)**
- **Description:**
    - Students complete lab handouts with observation charts at each station (Fluorescent Funhouse, UV-Vis, GloFish tank, Glow stick experiment).
    - The teacher actively circulates among groups, listening to their discussions, asking probing questions, and reviewing their in-progress charts.
- **What it Assesses:**
    - Ability to make accurate observations of fluorescence.
    - Understanding of basic concepts like excitation, emission, and wavelength in context.
    - Ability to differentiate between various glowing phenomena observed.
    - Collaboration and communication skills within groups.
- **Feedback/Instructional Adjustment:**
    - **Immediate:** Provide real-time feedback and ask clarifying questions ("What do you notice about the color of the light going *in* versus the light coming *out*?", "How is this glow different from the glow stick?"). Guide groups to correct misconceptions or deepen their analysis.
    - **Later:** Collect the partially or fully completed observation charts (if time permits for a quick check). Look for patterns in common errors or missing details across groups.
- **Assessment Method 2: Exit Ticket: "3-2-1 Summary"**
- **Description:**
    - At the end of one of the Explore lab periods, ask students to complete an exit ticket:
        - 3 things they observed about glowing materials.
        - 2 new science terms they learned or applied (e.g., excitation, emission, wavelength, fluorescence).
        - 1 question they still have about glowing.
- **What it Assesses:**
    - Recall of key observations.
    - Acquisition of new vocabulary and basic conceptual understanding.
    - Identification of lingering confusion.
- **Feedback/Instructional Adjustment:**
    - **Immediate (for teacher):** Quickly review the exit tickets to identify areas where the class struggled or excelled. This informs the starting point for the Explain phase.
    - **Later (for students):** Begin the next class by addressing the most common questions from the exit tickets or clarifying widely misunderstood terms.

EXPLAIN Phase Formative Assessment (Lesson 3: The Genetic Basis of Natural Biofluorescence)

- **Assessment Method: "Natural Fluorescence Explained" Worksheet (Targeted Questions)**
- **Description:**
    - As students work on the "Natural Fluorescence Explained" worksheet, particularly after the teacher-led instruction on GFP and the Central Dogma, include targeted questions that require them to:
        - Draw a simplified diagram showing light absorption and re-emission by a fluorescent protein.
        - Fill in a blank flow chart: DNA → _____ → Fluorescent Protein.
        - Explain in their own words how a fish's ability to glow biofluorescently is "inherited."
- **What it Assesses:**
    - Understanding of the molecular mechanism of fluorescence (absorption/emission).
    - Comprehension of the Central Dogma in the context of fluorescent protein production.
    - Initial grasp of the inheritable nature of biofluorescence.
- **Feedback/Instructional Adjustment:**
    - **Immediate:** Circulate and monitor student progress on the worksheet. Address individual struggles with diagrams or conceptual explanations. Provide mini-feedback loops ("Check your arrow direction here," "Think about what comes between DNA and protein").
    - **Later:** Collect the worksheets. Focus feedback on the conceptual questions (diagrams, inheritance explanation). Mark these for completeness and conceptual accuracy rather than a formal grade. Use common errors to plan for re-teaching or further explanation in the Elaborate phase.
    - **Peer Assessment Option:** Have students swap worksheets and provide constructive feedback on specific questions using a simple rubric provided by the teacher (e.g., "Is the diagram clear? Is the explanation accurate?").

ELABORATE Phase Formative Assessment (Lesson 4: Natural vs. Artificial Fluorescence & GFP in E. coli Extension)

- **Assessment Method 1: Glow Comparison Carousel: Compare/Contrast Charts (Spot Check)**
- **Description:**
    - During the carousel activity, students complete compare/contrast charts for Natural Biofluorescent Fish, GloFish, and DNA vs. Dye.

    - The teacher periodically checks these charts as groups rotate or at the end of the activity.
- **What it Assesses:**
    - Ability to differentiate between various types of "glowing" based on mechanism, source, and heritability.
    - Understanding of the key distinctions between natural biofluorescence and artificial genetic modification (GloFish) or dyeing.
- **Feedback/Instructional Adjustment:**
    - **Immediate:** Point out missing distinctions or inaccuracies directly to groups as they are working. "Make sure you include whether the glow is passed on to offspring for each type."
    - **Later:** Use a quick whole-class discussion to synthesize findings. Address any prevalent misconceptions observed in the charts. The Venn diagram activity serves as a strong in-class synthesis that also reveals understanding.
- **Assessment Method 2 (for GFP in E. coli Extension): Venn Diagram Comparison (Plasmid in bacteria vs. genome integration in GloFish)**
- **Description:**
    - Students create a Venn Diagram comparing GFP expression in bacteria (from a plasmid) and in GloFish (from integrated genome). Key comparison points include: temporary vs. permanent, not inherited vs. inherited.
- **What it Assesses:**
    - Deep understanding of the implications of gene location (plasmid vs. chromosome) and its effect on expression and inheritance.
    - Ability to synthesize complex genetic concepts.
- **Feedback/Instructional Adjustment:**
    - **Immediate:** Circulate and provide feedback on the completeness and accuracy of their Venn diagrams. Ask students to justify their placement of characteristics.
    - **Later:** Collect and review. Use common errors or omissions to guide a brief reteach or targeted discussion before the final evaluation. This is a higher-order thinking assessment, so identifying patterns of struggle is key.

EVALUATE Phase Formative Assessment (Leading into the Summative Evaluation)

- **Assessment Method: "Mini-Scenario Application" or "Concept Check Questions"**
- **Description:** Before assigning the full summative assessment, create 2-3 short, scenario-based questions similar in style to the "Deep-Sea Dragonfish" or "Sparkle Fish" scenarios, but simpler and perhaps with multiple-choice or short-answer options.
- **Example Formative Scenario Question:**
    - "A scientist discovers a new species of deep-sea fish that glows red. When the scientist brings it into the lab and shines a blue light on it, the fish glows even

brighter. Which type of light production is this most likely, and why? (Choose one: Bioluminescence, Biofluorescence, or Artificial Dye)"

- **What it Assesses:**
  - Ability to apply learned concepts to new situations.
  - Identification of key characteristics distinguishing the glowing types.
  - Readiness for the more complex summative assessment.
- **Feedback/Instructional Adjustment:**
  - **Immediate (for teacher):** Quickly review student responses to these mini-scenarios.
  - **Later (for students):** Review the answers as a class, discussing the reasoning behind the correct choices and clarifying any remaining confusion. This provides a final opportunity for students to self-correct before the summative test. If a large number of students struggle, consider a brief review session or re-explaining the most challenging concepts.

Formative Assessment Considerations for "EXTENSION: Breeding GloFish"

- **Assessment Method: Punnett Square Practice Problems (with self-correction or peer-check)**
- **Description:**
  - Provide a worksheet with various GloFish crosses (e.g., heterozygous x homozygous recessive, two heterozygotes).
  - Students complete the Punnett squares and answer questions about expected phenotypic ratios.
- **What it Assesses:**
  - Application of Mendelian genetics principles (Punnett squares).
  - Understanding of dominant/recessive traits in the context of GloFish inheritance.
- **Feedback/Instructional Adjustment:**
  - **Immediate:** Circulate and check calculations and interpretations.
  - **Later:** Provide an answer key for self-correction, or have students swap and peer-check. Address common errors on the board. This ensures students understand the mechanics of inheritance before the final reflection.