

The P(hoto)-B(lue)-B(ottle)-Experiment

Analysis A

A1



Using the tutorial 'Photosynthese – ein Fall für Zwei: Teil 1', explain the colour changes of the PBB solution. Then describe the accompanying energy transformation during one reaction cycle (Yellow → Blue → Yellow).

A2 Give reasons why the PBB-experiment serves as a suitable model experiment for the natural cycle of photosynthesis and cellular respiration.

A3 Assess the extent to which the PBB-model experiment serves as a simulation of the natural cycle of photosynthesis and cellular respiration. Doing so, develop a set of criteria that help you create an overview of its *benefits* and *limits*.

Additional assignment for biology classes:

A4 Imagine you are a biology teacher for lower secondary classes and you want to use the PBB-model experiment. Reduce the complex cycles in the tutorial for your purpose (see also the diagrams in B1). Use the following terminology: *low-energy substance*, *high-energy substance*, *light*, *photosynthesis*, *cellular respiration*, *oxygen*, *yellow/ blue solution*.

E1 Using the provided material (hot plate, torch with different light colours, UV torch), explore how to drive a chemical reaction in the vial. This becomes evident when a blue substance generated in the reaction becomes visible *within the yellow solution*.



Contents:
3 chemicals
(EV^{2+} , PF^+ ,
 EDTA^*)
+ water
+ air

Hint: colours within the visible light spectrum

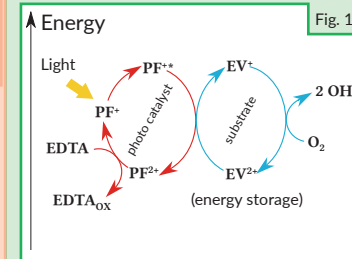


E2 Is the statement **T** rue or **F** alse? Test your decision by either conducting or suggesting an appropriate experiment.

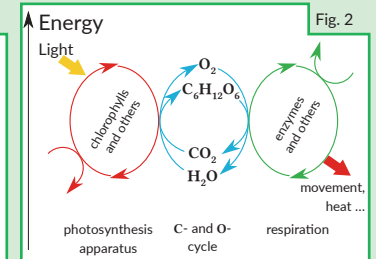
- ☐ In order to take place, the reaction Yellow (Solution) → Blue (Solution) requires supplying energy.
- ☐ The reaction Yellow → Blue does **not** work with any given light from the visible spectrum.
- ☐ The reaction Blue → Yellow requires **only** kinetic energy.
- ☐ The reaction cycle Yellow → Blue → Yellow runs only two times.
- ☐ The reaction Blue → Yellow requires oxygen.
- ☐ The PBB-reaction cycles correspond to the natural reaction cycles of photosynthesis and cellular respiration.
- ☐ The reaction Yellow → Blue only takes place if the temperature is above 5 °C.

Analysis B

B1 in the model experiment



in nature



Name the substances and cycles within the two figures (fig. 1: model experiment; fig. 2: photosynthesis/cellular respiration).

B2 Name all forms of energy involved within the natural cycle of photosynthesis and cellular respiration. Then describe the conversion of energy during said processes.

B3 Explain the reasons why the PBB experiment constitutes a suitable model experiment for the natural cycle of photosynthesis and cellular respiration. Then point out its limits.

Additional assignment for biology classes:

B4 There are different ways to model the natural cycle of photosynthesis and cellular respiration. One possible way is depicted in fig. 2. Based on your previous knowledge and the findings in B3, develop fig. 2 further.