

Electron Transport Chain (ETC) Theatre

Summary

This activity uses role plays to demonstrate the principles of electron transport chains and energy production in oxidative phosphorylation.

Pre activity: a video on oxidative phosphorylation (not required)

Class size: 10-60 students

Materials needed:

- Coins or poker chips: as electrons

Duration: 30-60 min

Type: Instructor guided role play; TBL format questions

Key concepts: oxidation and reduction, electron transport chain, free energy, electrons, endergonic and exergonic, electron carriers, ATP synthetase, chemiosmosis, selective permeable membrane, mitochondrion, proton motive force

Act 1: Redox reaction and energy release/capture

1. In a group, each student represents a molecule. Pass coins to each group. While students pass the coins to each other, they describe whether they are oxidized or reduced. See [classroom 1 clip 1a](#) and [classroom 2 clip 1a](#) (linked to *sadana* video raw footage 4 time 31:27-31:48; *visbal* video part II time 09:02-09:15).
2. Pick four to eight students to form an electron transport chain (ETC). Each student's height represents their free energy level. Ask the students to form a line in the order that allows the electrons to pass from the first to the last without any investment of energy. Students will form a line of tall to short in height. If two students are of equal height, you should switch one with someone else from the audience. See [classroom 2 clip 1b](#) (linked to *visbal* video part II time 10:39-11:59).
3. The instructor will act as NADH who carries electrons from glycolysis and citric acid cycle. Pass coins to the first student as the beginning of the electron transport chain. Now the student will pass the electron down the chain until it reaches the oxygen gas. See [classroom 2 clip 1c](#) (linked to *visbal* video part II time 12:07-12:46).

TBL based formative assessment: The audience answers three questions based on Act 1 in the TBL format. See sample questions [set 1](#).

Act 2: The structure of mitochondrion and oxidative phosphorylation

1. Divide the classroom into two compartments representing the intermembrane space and the mitochondria matrix.

2. All students who remain on their seats are hydrogen ions.
3. Ask the role play students to form a line in the same order as in act 1 at the border (as the inner membrane of mitochondrion) between the two spaces.

(Recommended) You may draw a mitochondrion on the board to explain the structure and the position of the participants. Label each component on the board map to help students visualize the role play.

4. Pass coins to the first student. While the electron is passed down the cytochrome complexes, instruct each complex to transport a hydrogen ion (a student in the audience) from the mitochondrion matrix to the intermembrane space. Keep doing this until one side of the classroom is filled up with students. Explain what happens to the class, especially the concept of selectively permeable membrane, potential energy and the proton motive force. See [classroom 1 clip 2a](#) and [classroom 2 clip 2a](#) (linked to *sadana* raw footage 5 time 30:20-33:50; *visbal* part 2 time 13:15-15:08).

(Recommended) You want to accumulate enough students at one side so that they feel very uncomfortable and really want to go back to their seats.

5. The instructor or a student will be the ATP synthetase. You can rotate or act like a tumbler that allows the hydrogen ions to pass by pushing your arms around to generate ATP. See [classroom 1 clip 2b](#) and [classroom 2 clip 2b](#) (linked to *sadana* raw footage 5 time 33:30-33:52; *visbal* part 2 time 16:00-16:33).
6. Once all hydrogen ions pass and reach equal concentrations on both sides, ask students to reflect on what changes have occurred.

TBL based formative assessment: All students answer three questions based on Act 2 in the TBL format. See sample questions [set 2](#).

Act 3: Oxidative phosphorylation at multiple sites (optional)

Student participates in Act 1 and 2 will be the directors of Act 3 to replay Act 2 in their respective group using props including a set of double sided cards and a table size board of a mitochondrion drawing. Download sample cards [3a](#).

TBL based formative assessment: All groups will answer a series of application questions on oxidative phosphorylation. See sample questions [set 3](#).