The Cytochrome c Oxidase Assay Kit

Cat. #: CB008
Size: 100 Tests

Description

The Cytochrome c Oxidase Assay Kit is designed for the determination of cytochrome c oxidase activity in soluble and membrane bound mitochondrial samples. Cytochrome c oxidase is the last enzyme in the respiratory electron transport chain of mitochondria. Its main function is to convert molecular oxygen to water and aid in establishing mitochondrial membrane potential. Cytochrome c oxidase locates to the inner membrane which separates the mitochondrial matrix from the intermembrane space. This colorimetric assay is based on observation of the decrease in absorbance at 550 nm of ferrocytochrome c caused by its oxidation to ferricytochrome c by cytochrome c oxidase. This kit is suitable for detection of mitochondrial outer membrane integrity and for detection of mitochondria in subcellular fractions.

Components

This kit is sufficient for 100 tests.
Assay Buffer: 25 ml, 50 mM Tris-HCl, pH 7.0, containing 600 mM KCl.
Enzyme Dilution Buffer: 20 ml, 20 mM Tris-HCl, pH 7.0, containing 500 mM sucrose
Cytochrome c: 50 mg
1 M Dithiothreitol (DTT): Solution 0.4 ml, 1 M DTT in deionized water
Cytochrome c Oxidase(positive control): 1 vial
n-Dodecyl b-D-maltoside: 10 mg

1X Assay Buffer: 10 mM Tris-HCl, pH 7.0, containing 120 mM KCl – Dilute an aliquot of Assay Buffer 5-fold with water. Keep at room temperature (~25 °C).
1X Enzyme Dilution Buffer: 10 mM Tris-HCl, pH 7.0, containing 250 mM sucrose – Dilute an aliquot of Enzyme Dilution Buffer 2´ (E2903) 2-fold with water. Keep at 2–8 °C.
Enzyme Dilution Buffer with 1 mM n-Dodecyl β-D-maltoside (for measurement of mitochondrial integrity): 10 mM Tris-HCl, pH 7.0, containing 250 mM sucrose and 1 mM n-dodecyl-b-D-maltoside – Dissolve 1.02 mg of n-Dodecyl-b-D-maltoside (D4641; MW 510.6 Da) in 2 ml of 1´ Enzyme Dilution Buffer.
0.1 M Dithiothreitol (DTT) Solution: Dilute an aliquot of the 1 M DTT Solution (D7059) 10-fold with ultrapure water to a concentration of 0.1 M.
Ferrocytochrome c Substrate Solution (0.22 mM): Dissolve 2.7 mg of cytochrome c (MW 12,384 Da) in 1 ml of water. In order to reduce the protein, add 5 ml of the 0.1 M DTT Solution to a final concentration of 0.5 mM, mix gently, and wait for 15 minutes. The color of the solution should go from dark orange-red to pale purple-red. Measure the A550/A565 ratio of an aliquot diluted 20-fold with 1´ Assay Buffer (50 ml in 950 ml of 1X Assay Buffer). Use the 1X Assay Buffer to zero the spectrophotometer. The A550/A565 ratio should be between 10 and 20.
Note: If the A550/A565 ratio remains less than 10, the substrate has not been sufficiently reduced and the enzyme activity will not be valid. In this case refer to the Troubleshooting Guide (see Appendix).
Cytochrome c Oxidase Positive Control: Dissolve the vial in the volume of water specified in the instructions on the label/CofA. For the enzyme assay, further dilute the sample 10-fold with 1´ Enzyme Dilution Buffer and use 20–40 ml for each control reaction mixture. The sample may be stored at 2–8 °C for at least 3 weeks or frozen in aliquots at –20 °C.
Enzyme Sample: The best results are achieved when the enzyme activity is between 0.4–4.0 milliunits of cytochrome c oxidase per reaction. For unknown samples, it is suggested to test several sample dilutions to ensure the readings are within the linear range of the assay.

Reagents and Equipment Required but Not Provided.

- Spectrophotometer
- 1 ml Cuvettes
- Analytical balance

- Ultrapure water (³18 MW´cm resistivity at 25 °C)

Procedure

A. Measurement of cytochrome c oxidase activity

The absorption of cytochrome c at 550 nm changes with its oxidation state. This property is the basis for the assay.3 Cytochrome c is reduced with dithiothreitol and then reoxidized by the cytochrome c oxidase. The difference in extinction coefficients ($\Delta\varepsilon^{mM}$) between reduced and oxidized cytochrome c is 21.84 at 550 nm. The oxidation of cytochrome c by cytochrome c oxidase is a biphasic reaction with a fast initial burst of activity followed by a slower reaction rate.10,11 In this assay the initial reaction rate is measured during the first 45 seconds of the reaction.

Total volume of the reaction is 1.1 ml (see Table 1).

Spectrophotometer settings:

Follow the decrease in absorption at 550 nm at room temperature (25 °C) using a kinetic program: 5 second
delay; 10 second interval; 6 readings. Set up the instrument prior to starting any reaction. The wavelength setting is very critical and can deviate by no more than 2 nm. No signal is observed with a deviation of 10 nm.

Table 1. Reaction Scheme

Sample	Assay Buffer	Enzyme Dilution		Sample (µl)
	Ferrocytochrome c (µl)	Buffer (µl)		Substrate Solution(µl)
Blank	950	100	–	50
Unknown sample	950	(100–x)	x	50
Positive control	950	60-80	20-40	50

1. Add 0.95 ml of 1X Assay Buffer to a cuvette and zero the spectrophotometer.
2. Add a suitable volume of enzyme solution or mitochondrial suspension to the cuvette, and bring the reaction volume to 1.05 ml with 1X Enzyme Dilution Buffer. Mix by inversion.
3. Start the reaction by the addition of 50 ml of Ferrocytochrome c Substrate Solution and mix by inversion.
4. Read the A550/minute immediately due to the rapid reaction rate of this enzyme.
5. Background values are expected between 0.001 and 0.005 A550/minute.
6. Calculate the activity of the sample.

Calculation:

$$\text{Units/ml} = \frac{\Delta A/\text{min X dil X } 1.1}{(\text{vol of enzyme}) \text{ X } 21.84}$$

ΔA/min = A/minute$_{(sample)}$ – A/minute$_{(blank)}$
dil = dilution factor of enzyme or sample
1.1 = reaction volume in ml
vol of enzyme = volume of enzyme or sample in ml
21.84 = $\Delta\varepsilon^{mM}$ between ferrocytochrome c and ferricytochrome c at 550 nm
Unit definition: One unit will oxidize 1.0 mmole of ferrocytochrome c per minute at pH 7.0 at 25 °C.

B. Measurement of the outer membrane integrity of mitochondria

The integrity of the outer membrane is assessed by measuring cytochrome c oxidase activity in mitochondrial membranes in the presence and absence of the detergent, n-dodecyl b-D-maltoside, which is one of the few detergents that allows the maintenance of the cytochrome c oxidase dimer in solution at low

detergent concentrations. The ratio between activity with and without n-dodecyl b-D-maltoside present is a
measure of the integrity of the mitochondrial outer membrane, since the membrane is a barrier for the entrance of cytochrome c into the organelle. Membrane integrity of mitochondria from various organs is dependent on the mode of preparation. Some tissues are much more difficult to homogenize and the shearing forces involved may cause considerable damage to the mitochondrial outer membrane. Outer membrane damage in various tissues is shown in Table 2.
Use of frozen tissues may cause rupture of the subcellular organelles and therefore, it is recommended to use freshly prepared tissues.

Table 2. Percent damage to outer mitochondrial membranes from various tissues8

Organ	% Damage of outer membrane
Rat liver	5–10%
Rat heart	20–44%
Rat brain	8–30%
Rat kidney	22%
Rabbit heart	16%
Beef heart	16%

Note: The described procedure is for a mitochondrial suspension and not for the purified enzyme.
1. Dilute two parallel samples of the mitochondrial suspension to 0.1–0.2 mg protein/ml with either 1´ Enzyme Dilution Buffer (cytochrome c oxidase activity in intact mitochondria) or with the Enzyme Dilution Buffer containing 1 mM n-dodecyl b-D-maltoside (total cytochrome c oxidase activity).
2. Incubate the samples at 2–8 °C for at least 10 minutes before assaying.
3. Take 1–2 mg of mitochondrial protein and assay for cytochrome c oxidase activity (Section A, steps 1-6).
4. Determine the DA550/minute for each sample:
$\Delta A_{(intact)} = \Delta A_{(intact\ sample)} - \Delta A_{(blank)}$
$\Delta A_{(total)} = \Delta A_{(total\ sample)} - \Delta A_{(blank)}$
5. Calculate the degree of mitochondrial integrity:

% mitochondria with undamaged outer membranes

$$\% = \frac{(\Delta A_{(total)} - \Delta A_{(intact)}) \text{ X } 100}{\Delta A_{(total)}}$$

Storage/Stability
The kit ships on wet ice and storage at –20 °C is recommended. When stored unopened, the components in this kit are stable for 24 months. After initial thawing of the 1 M Dithiothreitol Solution, divide the solution into undiluted working aliquots (still at 1 M concentration) and store at –20 °C.