

**ab109714 –  
ATP Synthase  
Enzyme Activity  
Microplate Assay Kit**

**Instructions for Use**

For the quantitative measurement of ATP Synthase activity in samples from Human, Rat and Cow

[View kit datasheet: www.abcam.com/ab109714](http://www.abcam.com/ab109714)

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This product is for research use only and is not intended for diagnostic use.



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# 1. Introduction

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Abcam's enzyme activity assays apply a novel approach, whereby target enzymes are first immunocaptured from tissue or cell samples before subsequent functional analysis. All of our ELISA kits utilize highly validated monoclonal antibodies and proprietary buffers, which are able to capture even very large enzyme complexes in their fully-intact, functionally-active states.

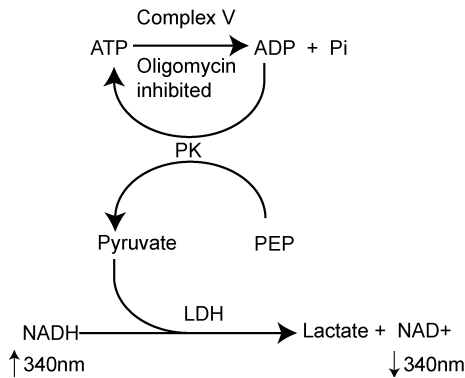
Capture antibodies are pre-coated in the wells of premium Nunc MaxiSorp™ modular microplates, which can be broken into 8-well strips. After the target has been immobilized in the well, substrate is added, and enzyme activity is analyzed by measuring the change in absorbance of either the substrate or the product of the reaction (depending upon which enzyme is being analyzed). By analyzing the enzyme's activity in an isolated context, outside of the cell and free from any other variables, an accurate measurement of the enzyme's functional state can be understood.

The ATP synthase complex (EC 3.6.3.14), also called Complex V or  $F_1F_0$  ATPase, is responsible for ATP production in the oxidative phosphorylation process and can work in reverse as a proton pumping ATPase. The enzyme was thought to be localized exclusively in the mitochondria, but it has now also been identified on the plasma membrane of several cell types, including hepatocytes (where it acts as an HDL receptor), on endothelial cells

(where it may act as an angiostatin receptor), and on the surface of cancer cells.

ab109714 is used to determine the activity of ATP Synthase in a sample. ATP Synthase is immunocaptured within the wells. The enzyme functions by hydrolyzing ATP to ADP and phosphate. This production of ADP is ultimately coupled, as shown below, to the oxidation of NADH to NAD<sup>+</sup> which is monitored as a decrease in absorbance at 340 nm (this assay is fully described in Lotscher, DeJong, and Capaldi (1984) *Biochemistry* 23, 4134-40). The ATP hydrolysis activity and therefore the coupled reaction is inhibited by oligomycin (a specific inhibitor of ATP Synthase).

The overall reaction is as follows:



*PK- Pyruvate kinase, LDH-Lactate dehydrogenase, PEP-phosphoenolpyruvate*

In addition to this activity microplate, an ATP synthase Specific Activity Microplate Assay Kit (ab109716/MS543) to establish the specific activity.

ab109714 ATP synthase Enzyme Activity Microplate Assay Kit has been developed for use with human, rat and bovine samples. Mouse samples are not appropriate for use. Other species have not been tested.

This assay is designed for use with purified mitochondria. However, homogenized tissue and whole cells can also be used, but some sample optimization may be necessary. As described below, homogenized samples should be frozen, thawed, pelleted, and then resuspended to 5.5 mg/mL protein. The proteins are detergent extracted and loaded to within the linear range of the assay (see below). A **control** or normal sample should always be included in the assay as a reference. Also, include a **null** or buffer control to act as a background reference measurement.

Typical linear ranges are listed below. The ranges may be extended by using a non-linear fit of the data from a normal sample.

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Heart mitochondria	0.2 - 20 µg/well
Brain mitochondria	1 - 5 µg/well
Liver mitochondria	2 - 15 µg/well
Whole cultured cell extract	20-100 µg/well

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Note: Ranges for tissue extract may vary slightly. The lowest amount indicated is the limit of detection. For sample loading use the recommended amount specified on page 9.

## 2. Assay Summary

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### Prepare Sample (1-3 hours)

- Homogenize sample → Freeze → Thaw → Pellet.
- Bring up sample to 5.5 mg/ml in Solution 1.
- Perform detergent extraction with 1/10 volume detergent followed by 16,000 rpm centrifugation for 20 minutes. Take supernatant.
- Adjust concentration to recommended dilution for plate loading.



### Load Plate (3 hours)

- Load sample(s) on plate being sure to include positive control sample and buffer control as null reference.
- Incubate 3 hours at room temperature.



### Measure (2 hours)

- Rinse wells twice with Solution 1.
- Add 40  $\mu$ l of Lipid mix to wells
- Add 200  $\mu$ l reagent mix to the lipid mix in the wells.
- Measure OD<sub>340</sub> at 1 minute intervals for 1-2 hours at 30°C.



### 3. Kit Contents

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Sufficient materials are provided for 96 measurements in a microplate.

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<b>Item</b>	<b>Quantity</b>
Tube 1 (Buffer)	10 ml
Detergent	1 ml
Reagent Mix	20 ml
Lipid Mix	6 ml
96 – well pre-coated microplate (12 strips)	1

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### 4. Storage and Handling

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Store Buffer (Tube 1), Detergent, and the covered microplate at 4°C. Store the Lipid Mix and Reagent Mix at -80°C. For multiple experiments the Reagent Mix may be aliquoted and stored at -80°C.

## 5. Additional Materials Required

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- Spectrophotometer that measures absorbance at **340nm**
- Method for determining protein concentration
- Deionized water
- Multichannel pipette

## 6. Preparation of Samples

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### A. Sample Preparation

1. Prepare the buffer solution by adding TUBE 1 (10 ml) to 190 ml deionized H<sub>2</sub>O. Label this solution as SOLUTION 1.
2. Freeze the homogenized sample (for homogenization see Notes section).
3. Once frozen, thaw the sample and pellet by centrifugation at ~16,000 rpm at 4°C.
4. Resuspend the sample by adding 4 volumes of SOLUTION 1. Determine the protein concentration by a standard method and then adjust the protein concentration to 5.5 mg/ml.

*Note: If the sample is less than 5.5 mg/ml, centrifuge to pellet again and take up in a smaller volume to concentrate the pellet and repeat protein concentration measurement. The optimal protein concentration for detergent extraction is 5.5 mg/ml.*

5. Add 1/10 volume of DETERGENT to the sample (e.g. if the total sample volume is 500  $\mu$ l, add 50  $\mu$ l of DETERGENT). Therefore, the final protein concentration is now 5 mg/ml.
6. Mix immediately and then incubate on ice for 30 minutes.
7. Spin in tabletop microfuge at maximum speed (~16,000 rpm) for 20 minutes at 4°C. Carefully collect the supernatant and save as sample. Discard the pellet.
8. The microplate wells are designed for 50  $\mu$ l sample volume, so dilute samples to the following recommended concentrations by adding SOLUTION 1:

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<b>Sample Type</b>	<b>Recommended concentration</b>
Heart mitochondria	1 µg/50 µl
Brain mitochondria	5 µg/50 µl
Liver mitochondria	10 µg/50 µl
Whole cultured cell extract	50 µg/50 µl

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9. Keep diluted samples on ice until ready to proceed.

## 7. Assay Method

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### A. Plate Loading

1. Add 50 µl of each diluted sample into individual wells on the plate. Include a normal sample as a positive control. Include a buffer control (50 µl SOLUTION 1) as a null or background reference.
2. Incubate for 3 hours at room temperature.

## **B. Measurement of ATP Synthase activity**

1. The bound monoclonal antibody has immobilized the enzyme in the wells. Empty the wells by turning the plate over and shaking out any remaining liquid.
2. Once emptied, add 300  $\mu$ l of SOLUTION 1 to each well used.
3. Empty the wells again and add another 300  $\mu$ l of SOLUTION 1 to each well used.
4. Empty the wells again and add 40  $\mu$ l of LIPID MIX to all wells used.
5. Incubate the Lipid Mix in the wells at room temperature for 45 minutes.
6. DO NOT empty the wells. Instead add 200  $\mu$ l of REAGENT MIX into wells already containing 40  $\mu$ l of LIPID MIX. Any bubbles in the wells should be popped with a fine needle as rapidly as possible.
7. Set the plate in the reader. Measure the absorbance of each well at 340 nm at 30°C. Using a kinetic program, take absorbance measurements for 60-120 minutes. The interval should be 1 minute between readings (though may be up to 5 minutes between readings).

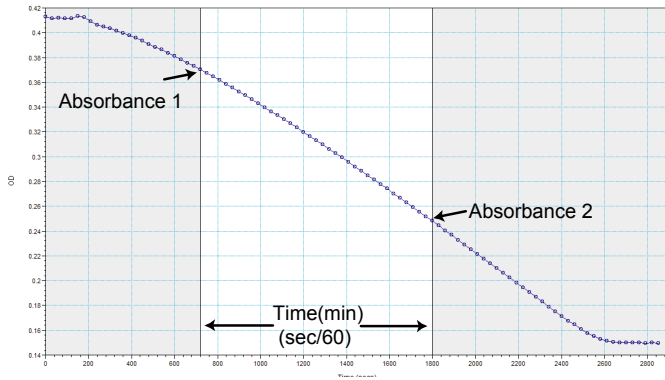
## 8. Data Analysis

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### A. Calculation of ATP Synthase activity

The activity of the ATP synthase enzyme is coupled to the molar conversion of NADH to NAD<sup>+</sup> measured as a decrease in absorbance at OD 340 nm. The activity rate is expressed as the change in absorbance at 340 nm/minute/amount of sample loaded into the well.

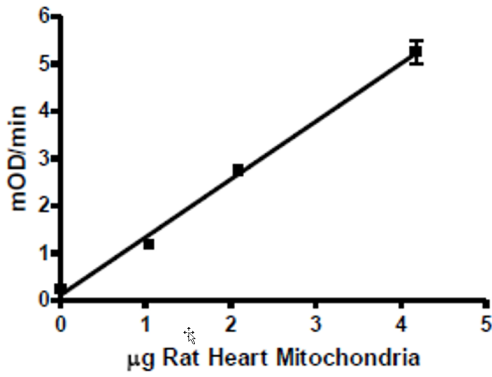
To do this, examine the rate of decrease in absorbance at 340 nm over time. This assay starts slowly and takes time to stabilize. The fastest, most linear rate of activity is most often seen between 12 and 30 minutes. This is shown below where the rate is calculated between these time points. Most microplate analysis software is capable of performing this function. Repeat this calculation for all samples measured.



**Figure 1**

$$\text{Rate (mOD/min)} = \frac{\text{Absorbance 1} - \text{Absorbance 2}}{\text{Time (min)}}$$

For the control or normal sample, the rate versus amount loaded can be plotted as a straight line in the linear region of the assay as shown below in figure 2.



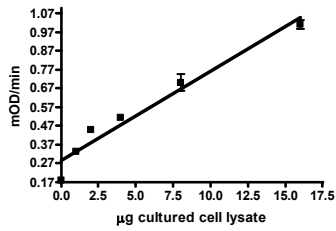
**Figure 2.** ATP Synthase in Rat Heart Mitochondria.

Compare the rates of the **control** (normal) sample and with the rate of the **null** (background) and with your **unknowns**, **experimental** or **treated** samples to get the relative ATP synthase activity.

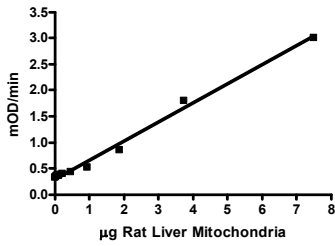
Note: This assay rate should be 90% oligomycin sensitivity. If the sensitivity observed is significantly less than 90%, then sample preparation may need to be optimized to maintain the integrity of the oligomycin binding site (see the Notes section).

Examples of activity/load relationships for other samples are shown in Figures 3, 4 and 5.

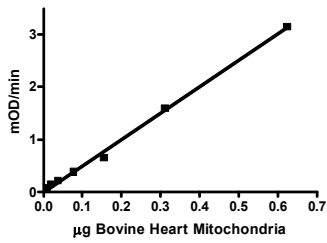




**Figure 3.** ATP Synthase in Culture Cell lysate



**Figure 4.** ATP Synthase in Rat Liver Mitochondria.



**Figure 5.** ATP Synthase in Bovine Heart Mitochondria.

## 9. Specificity

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Species Reactivity: Human, Rat and bovine samples.

Mouse samples are not appropriate for use. Other species have not been tested.

## 10. Notes

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**Sample preparation is crucial to a successful analysis. Key parameters:**

### **Homogenization**

Samples must be completely homogenous. For cultured cells this should only require pipetting up and down to break apart clumps of cells. Similarly, for mitochondrial preparations, pipetting is enough to distribute the mitochondria evenly in solution. For soft tissue, and especially for hard tissues such as muscle, thorough homogenization must occur. This is best accomplished with a hand-held tissue grinder or a Dounce glass tissue. It is recommended to use one of Abcam's Mitochondrial Isolation Kits (ab110168-110171/MS850-MS853).

## **Sample solubilization**

Once completely homogenous, the sample must be frozen, thawed and pelleted as described above. This fractures the membranes and allows the removal of soluble non-membrane associated proteins. Once pelleted the sample should be resuspended in the supplied buffer. It is most convenient to resuspend to approximately 10 mg/mL. Then determine the exact protein concentration by BCA method. Then add solution to a protein concentration of 5.5 mg/mL. The sample can now be extracted by adding 1/10 volume of the supplied detergent. The final protein concentration is now 5 mg/mL, which is the optimal concentration for intact ATP synthase solubilization by the supplied detergent. The sample is incubated, centrifuged and supernatant (detergent extract) is collected.

## **Oligomycin sensitivity**

When measuring activity and following the above steps precisely the ATP synthase  $F_1$  and  $F_0$  domains will be intact and coupled, maintaining the oligomycin binding site. The oligomycin sensitivity of ATP synthase bound in the wells should be approximately 90%. If significantly less oligomycin sensitivity is observed in a normal or control sample then sample solubilization optimization must be performed: consider (i) multiple freeze-thaw cycles (ii) decreasing the amount of detergent from 1/10 volume to 1/15 or 1/20 volume.

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