

## EnzyFluo™ AMPK Phosphorylation Assay Kit (EAMPK-100)

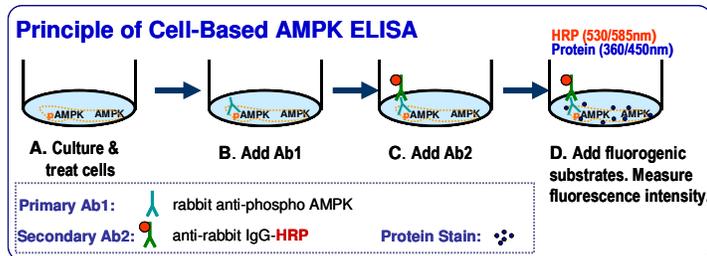
### Fluorimetric Cell-Based Assay for AMPK Phosphorylation Status

#### DESCRIPTION

The 5-AMP-activated protein kinase (AMPK) is a key sensor of intracellular energy balance. AMPK is activated in response to an increase in the AMP/ATP ratio which can be caused by a number of factors such as muscle contraction, starvation, or hypoxia. AMPK is a heterotrimeric protein complex comprising of  $\alpha$ - (63 kDa),  $\beta$ - (38 kDa) and  $\gamma$ - (38 kDa) subunits. For each subunit, isoforms have been identified ( $\alpha$ 1,  $\alpha$ 2,  $\beta$ 1,  $\beta$ 2,  $\gamma$ 1,  $\gamma$ 2,  $\gamma$ 3) which theoretically allow the formation of 12 different proteins. The  $\alpha$ -subunit contains a serine/threonine kinase domain and the regulatory subunits contain binding sites for AMP and ATP ( $\gamma$ -subunit) and for glycogen ( $\beta$ -subunit).

AMPK is activated by phosphorylation on Thr-172 within the catalytic domain. AMP binding results in a 2 to 5-fold increase in AMPK activity compared to the basal level. Binding of AMP to the  $\gamma$ -subunit causes allosteric activation of the kinase and induces a conformational change in the kinase domain that protects AMPK from dephosphorylation of Thr-172.

BioAssay Systems' cell-based ELISA measures phosphorylated AMPK in whole cells and normalizes the signal to the total protein content. The antibody recognizes both  $\alpha$ -subunits and, thus, can be used for cells from all tissues (human, mouse, rat). This simple and efficient assay eliminates the need for cell lysate preparation and can be used to study AMPK regulation in short-term and long-term assays. In this assay, cells grown in 96-well plates are fixed and permeabilized in the wells. AMPK phosphorylation (pAMPK) is measured using a fluorescent ELISA followed by total protein measurement in each well.



#### KEY FEATURES

**Sensitive.** Can measure pAMPK modulation in as little as 500 cells/well.

**New and improved.** Total assay time reduced from the standard 21 hours to 6.5 hours (hands-on time 2.5 hrs).

**Simple and convenient.** Cells are directly cultured in 96-well plates. No cell lysis necessary.

**Accurate and high-throughput.** Protein phosphorylation is normalized to total cellular protein in the same well, greatly minimizing well-to-well variations. Can be readily automated as a high-throughput 96-well plate assay for thousands of samples per day.

#### APPLICATIONS

For quantitative fluorescent immunoenzymatic assay of AMPK phosphorylation status in cultured cells.

Evaluation of direct and indirect modulation of AMPK phosphorylation.

**Species tested:** human, mouse, rat.

#### KIT CONTENTS

<b>Stock Wash Buffer:</b> 25 mL	<b>Blocking Buffer:</b> 25 mL
<b>Protein Stain:</b> 6 mL	<b>Dye Reagent:</b> 120 $\mu$ L
<b>Ab1:</b> 10 $\mu$ L	<b>Ab2 (gR-HRP):</b> 10 $\mu$ L

**Storage conditions:** this kit is shipped on ice. Upon delivery, store all reagents at -20°C. Shelf life of 6 months after receipt.

**Precautions:** reagents are for research use only. Normal precautions for laboratory reagents should be exercised while using the reagents. Please refer to Material Safety Data Sheet for detailed information.

#### ASSAY PROCEDURE

**Important:** 1. To avoid cross-contamination, change pipette tips between

additions of each reagent or sample. We recommend the use of a multi-channel pipette. Use separate reservoirs for each reagent.

Prior to Assay, prepare 1x Wash Buffer by diluting Stock Wash Buffer 20-fold with dH<sub>2</sub>O, e.g. mix 15 mL Stock Wash Buffer and 285 mL dH<sub>2</sub>O. **Important: reserve 6 mL 1x Wash Buffer for Detection Step 2 below.**

- It is recommended that samples be assayed in triplicate or higher.
- Two different blanks are necessary. For each *plate* include a Protein Blank (no cells) in triplicate. For each *sample* include a Sample Blank (cells w/ only Ab2) in triplicate. The blanks are used to determine background fluorescence for total protein and pAMPK respectively.

#### A. Culture and Treat Cells

- Seed 100  $\mu$ L of 1-3  $\times 10^4$  adherent cells (or 4-10  $\times 10^4$  suspension cells) into each well of a black 96-well culture plate. Add 100  $\mu$ L of culture media without cells into three wells for the Protein Blank. Incubate overnight at 37°C in a cell culture incubator.

*Note: The cell number to be used depends on the cell line and AMPK phosphorylation status.*

- Treat the cells as desired (e.g. with ligands or drugs).
- Prepare formaldehyde solutions (**warning:** formaldehyde is toxic. Use chemical hood and wear appropriate gloves and eye protection):

*For adherent cells,* prepare 4% formaldehyde by mixing 1.3 mL of 37% formaldehyde and 10.7 mL of 1x Wash buffer. Simply fix cells in each well by replacing the medium with 100  $\mu$ L of 4% formaldehyde.

*For suspension cells,* prepare 8% formaldehyde by mixing 2.6 mL of 37% formaldehyde and 9.4 mL of 1x Wash buffer. Centrifuge the plate at 500g for 15 min at 4°C and carefully remove as much media as possible without disturbing the cell pellet (repeat this for suspension cells with each wash step below). Fix the cells in each well by adding 100  $\mu$ L of 8% formaldehyde to cell pellet.

Cover the plate and incubate for 20 min at room temperature. Alternatively, the plate containing the fixed cells can be sealed and stored for up to 2 weeks at 2-8°C.

- Remove the formaldehyde solution and wash the cells 3 times with 150  $\mu$ L of 1x Wash Buffer. Each wash step should be performed for 1 min with gentle shaking.
- Prepare Quench Buffer by mixing 2.2 mL of 3% H<sub>2</sub>O<sub>2</sub> and 8.8 mL of 1x Wash Buffer. Remove the Wash Buffer and add 100  $\mu$ L of Quench Buffer to each assay well. Cover plate and incubate for 20 min at room temperature.
- Remove the Quench Buffer and wash the cells 3 times with 150  $\mu$ L of 1x Wash Buffer.
- Remove the Wash Buffer, and add 100  $\mu$ L of Blocking Buffer. Cover plate and incubate for 1 hr at room temperature.

#### B. Add Primary Antibodies (Ab1)

- Prepare 55  $\mu$ L of primary antibody Ab1 Mixture for each well by mixing Ab1 into Blocking Buffer in a 1:625 dilution.
- Remove the Blocking Buffer from all assay wells. Add 50  $\mu$ L of the Blocking Buffer to the Sample Blank wells and 50  $\mu$ L of Ab1 Mixture to the Sample wells. Cover plate and incubate for 90 min at room temperature or overnight at 2-8°C with gentle shaking.
- Remove the Ab1 Mixture and wash the cells 3 times with 150  $\mu$ L of 1x Wash Buffer. Each wash step should be performed for 1 min with gentle shaking.

#### C. Add Secondary Antibodies (Ab2)

- Prepare 55  $\mu$ L of secondary antibody Ab2 Mixture for each well by mixing Ab2 into Blocking Buffer in a 1:625 dilution.
- Remove Wash Buffer and add 50  $\mu$ L of the Ab2 Mixture to all assay wells. Cover plate and incubate for 90 min at room temperature with gentle shaking.

## D. Detection

1. Remove the Ab2 Mixture from each well and thoroughly wash the cells 5 times with 150  $\mu\text{L}$  of 1x Wash Buffer. Each wash step should be performed for 1 min with gentle shaking.
2. Immediately before use, prepare HRP Substrate by mixing 60  $\mu\text{L}$  Dye Reagent with 6 mL 1x Wash Buffer and 6  $\mu\text{L}$  3%  $\text{H}_2\text{O}_2$  (for partial plate assay, adjust the volumes accordingly).  
Remove the Wash Buffer from the plate and add 50  $\mu\text{L}$  of the HRP Substrate to each well. Incubate for 30 min at room temperature in the dark.
3. Add 50  $\mu\text{L}$  of Protein Stain to each well and incubate for an additional 5 min at room temperature in the dark.
4. Read the plate at  $\lambda_{\text{ex/em}} = 530/585 \text{ nm}$  for phosphorylated AMPK (pAMPK) and at  $\lambda_{\text{ex/em}} = 360/450 \text{ nm}$  for total protein.

## CALCULATION

Calculate the mean pAMPK fluorescence intensities at 530/585nm for the Sample Blank wells ( $F_{\text{BLK pAMPK}}$ ) and Sample wells ( $F_{\text{SAMPLE pAMPK}}$ ). Also calculate the mean protein fluorescence intensities at 360/450nm for the Protein Blank (no cells) well ( $F_{\text{BLK Prot}}$ ) and Sample wells ( $F_{\text{SAMPLE Prot}}$ ). Subtract the mean pAMPK fluorescence of the Sample Blank wells from the pAMPK fluorescence of the Sample wells to yield  $\Delta F$  values for the pAMPK ( $\Delta F_{\text{pAMPK}}$ ). Subtract the mean protein fluorescence of the Protein Blank (no cells) well from the protein fluorescence value of the Sample wells to yield  $\Delta F$  values for the total protein ( $\Delta F_{\text{Prot}}$ ).

$$\Delta \bar{F}_{\text{pAMPK}} = \bar{F}_{\text{SAMPLE pAMPK}} - \bar{F}_{\text{BLK pAMPK}}; \quad \Delta \bar{F}_{\text{Prot}} = \bar{F}_{\text{SAMPLE Prot}} - \bar{F}_{\text{BLK Prot}}$$

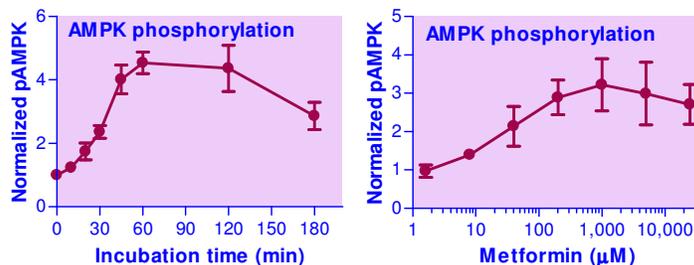
Normalized phosphorylated AMPK (pAMPK) is calculated as,

$$\text{Normalized pAMPK} = \frac{\Delta \bar{F}_{\text{pAMPK}} / \Delta \bar{F}_{\text{Prot}}}{(\Delta \bar{F}_{\text{pAMPK}} / \Delta \bar{F}_{\text{Prot}})_0}$$

where  $(\Delta \bar{F}_{\text{pAMPK}} / \Delta \bar{F}_{\text{Prot}})_0$  is the control reference value (e.g. time zero in kinetic studies or untreated wells in drug potency studies.)

## MATERIALS REQUIRED BUT NOT PROVIDED

37% formaldehyde (Sigma, cat # F8775); 3%  $\text{H}_2\text{O}_2$  (Sigma, cat # 323381); black (clear bottom) cell culture 96-well plate: available separately at BioAssay Systems (cat# P96BCC) or at Sigma (cat# CLS3603); plate sealers: available separately at BioAssay Systems (cat# AB96SL) or at Sigma (cat# A5596); deionized or distilled water; pipetting devices; cell culture incubators; centrifuge tubes; fluorescence plate reader capable of reading at  $\lambda_{\text{ex/em}} = 530/585\text{nm}$  and at  $\lambda_{\text{ex/em}} = 360/450\text{nm}$ .



**Left:** Time course of the induction of AMPK phosphorylation in PANC-1 cells by metformin.

**Right:** Dose response curve of AMPK phosphorylation in PANC-1 cells following 3 hour treatment with metformin. 100% was defined as the basal AMPK phosphorylation in untreated PANC-1 cells.

## PUBLICATIONS

1. Tsuda, Yuichi, et al (2017). Trypsin-Treated beta-Lactoglobulin Improves Glucose Tolerance in C57BL/6 Mice by Enhancing AMPK Activation and Glucose Uptake in Hepatocytes. Biological and Pharmaceutical Bulletin 40.11: 1917-1922.
2. Chen, Hu, et al (2019). 6PGD inhibition sensitizes hepatocellular carcinoma to chemotherapy via AMPK activation and metabolic reprogramming. Biomedicine & Pharmacotherapy 111: 1353-1358.
3. Cao, J. et al (2020). 6PGD Upregulation is Associated with Chemo- and Immuno-Resistance of Renal Cell Carcinoma via AMPK Signaling-Dependent NADPH-Mediated Metabolic Reprogramming. The American journal of the medical sciences, 360(3), 279-286.

