96 well Adipocyte Lipolysis Assay Kit for Detection of Both Free Glycerol and Non-Esterified Fatty Acids
500 point assay kit

Cat# LIP-3RB

INSTRUCTION MANUAL ZBM0048.01

STORAGE CONDITIONS

- **Reagents & Buffers:** 4°C
- **Vehicle & Controls:** -20°C

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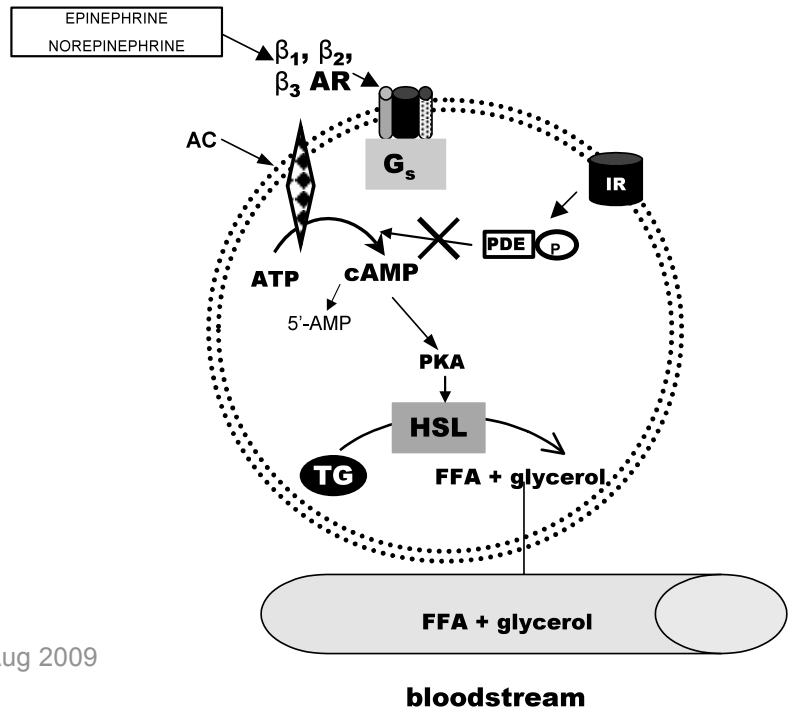
INTRODUCTION

Lipolysis plays a central role in the regulation of energy balance. Lipolysis is the process in which triglycerides are hydrolyzed into glycerol and free fatty acids. This process releases free fatty acids (FFA) into the bloodstream where they may be either re-esterified by the adipocyte or travel to other tissues and exert other effects throughout the body. Elevated adipocyte lipolysis has been observed in obese and diabetic individuals (Arner 1996). Alterations in lipolytic capacity have also been implicated in the susceptibility to obesity of African-American individuals versus their Caucasian cohorts (Danadian *et al.* 2001).

The sympathetic nervous system plays a key role in the regulation of lipid mobilization. The main lipolytic pathway involves beta-agonists (□-agonists), which activate □-adrenergic receptors via the intracellular G_s proteins in adipocytes. This leads to the activation of adenylate cyclase (AC), which then increases cyclic AMP (cAMP) levels. Elevated cAMP acts as a second messenger to activate hormone sensitive lipase (HSL). HSL, the rate-limiting enzyme regulating adipocyte lipolysis, then catalyzes the hydrolysis of triglycerides and results in the release of glycerol and FFA (increased lipolysis). Phosphodiesterases (PDE) are enzymes that hydrolyze cAMP to 5'-AMP (5 prime adenosine monophosphate). This action results in a decrease in lipolysis. PDE inhibitors increase intracellular cAMP levels. 3-isobutyl-1-methylxanthine (IBMX), a non-specific inhibitor of cAMP phosphodiesterases (PDE), is used as the positive control if your test compounds are suspected PDE inhibitors. Isoproterenol, a non-specific □-adrenergic agonist is used as the positive control if your test compounds affect lipolysis via □-adrenergic receptors.

This lipolysis assay kit provides the tool to study chemical compounds that may influence lipolysis in cultured human adipocytes.

Figure 1. Overview of adipocyte lipolysis



ABBREVIATIONS:

AC	adenylate cyclase
AR	adrenergic receptors
G_s	G protein coupled receptor
FFA	free fatty acids
PKA	protein kinase
AMP	adenosine monophosphate
ATP	adenosine triphosphate
IR	insulin receptor
PDE	phosphodiesterase
TG	triglyceride

ITEMS INCLUDED IN THE KIT

ITEM	DESCRIPTION	Cap Color	UNIT	QTY	STORAGE
LIP-2/3 Assay Buffer	500 ml	---	BOTTLE	1	4°C
Wash Buffer	LIP-2/3 Wash Buffer, 250 ml	---	BOTTLE	1	4°C
Vehicle	0.1% DMSO in LIP-2/3 Assay Buffer	PURPLE	1 ml / VIAL	5	-20°C
Positive control	Isoproterenol, 10 mM in DMSO. Dilute to 1 □M in Assay Buffer before use! (i.e.1 □l in 10 ml Assay Buffer)	BLUE	10 □l / VIAL	5	-20°C
FFA Standard	1mM Stock. See page 5 for standard curve preparation	AMBER	100 □l / VIAL	5	4°C
FFA Diluent A		YELLOW	50ML	1	4°C
FFA Diluent B		PINK	25ML	1	4°C
FFA Reagent A	Reconstitute using 50 ml FFA Diluent A. Discard remainder after 10 days	YELLOW	BOTTLE	1	4°C
FFA Reagent B	Reconstitute using 25 ml FFA Diluent B per bottle. Discard remainder after 10 days	PINK	BOTTLE	1	4°C
Glycerol Standard	Glycerol @ 1mM [see page 6 for dilution instructions]	ORANGE	50 □l / VIAL	5	-20°C
Glycerol Reagent A	40-ml- Reconstitute with 40 ml deionized water prior to use.	40ML	BOTTLE	1	4°C

Other equipment/reagents required but not provided with the kit:

- □ Blank 96 well plates
- □ Multi-channel Pipet , single channel pipet and pipet tips
- □ Plate reader with a filter of 540 nm
- □ Incubator at 37^{o}C
- □ Large gauge needle
- □ Cultured human adipocytes
- □ Tubes for diluting glycerol standards

PRINCIPLES OF THE ASSAYS

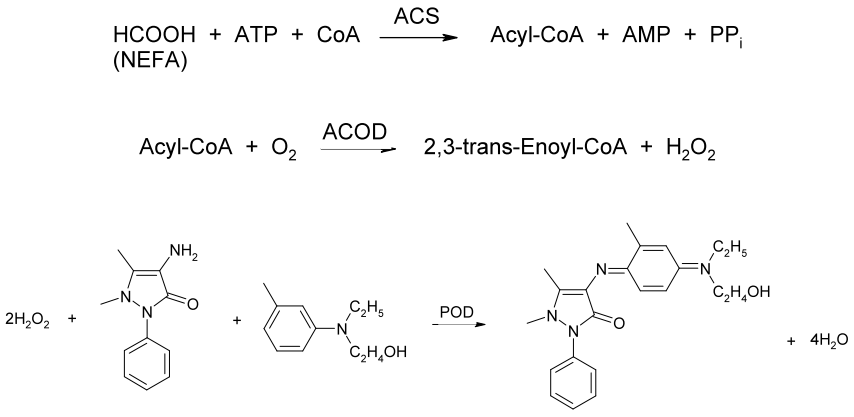
Detection of Free Glycerol

Assessing lipolytic activity by the measurement of glycerol released into the medium. Glycerol released to the medium is phosphorylated by adenosine triphosphate (ATP) forming glycerol-1-phosphate (G-1-P) and adenosine-5'-diphosphate (ADP) in the reaction catalyzed by glycerol kinase. G-1-P is then oxidized by glycerol phosphate oxidase to dihydroxyacetone phosphate (DAP) and hydrogen peroxide (H_2O_2). A quinoneimine dye is produced by the peroxidase catalyzed coupling of 4-aminoantipyrine (4-AAP) and sodium N-ethytl-N-(3-sulfopropyl)m-anisidine (ESPA) with H_2O_2, which shows an absorbance maximum at 540nm. The increase in absorbance at 540nm is directly proportional to glycerol concentration of the sample.

GLYCEROL + ATP □□□□ G-1-P + ADP
G-1-P + O_2 □□□□ DAP + H_2O_2
H_2O_2 +4-AAP + ESPA □□□□ Quinoneimine dye + H_2O

Detection of Non-Esterified Fatty Acids (Free Fatty Acids; FFA)

Assessment of lipolytic activity can also be detected through a coupled reaction to measure non-Esterified fatty acids (NEFA) released by adipocytes. The initial step, carried out by acyl-CoA synthetase (ACS), produces fatty acyl-CoA thiol esters from the NEFA, ATP, Mg, and CoA in the reaction. The acyl-CoA derivatives react with oxygen in the presence of acyl-CoA oxidase (ACOD) to produce hydrogen peroxide. Hydrogen peroxide in the presence of peroxidase (POD) allows the oxidative condensation of 3-methyl-N-ethyl-N-(□-hydroxyethyl)-aniline with 4-aminoantipyrine which forms a purple product that absorbs light at 550nm. This allows the concentration of NEFA to be determined from the optical density measured at 540 - 550nm.



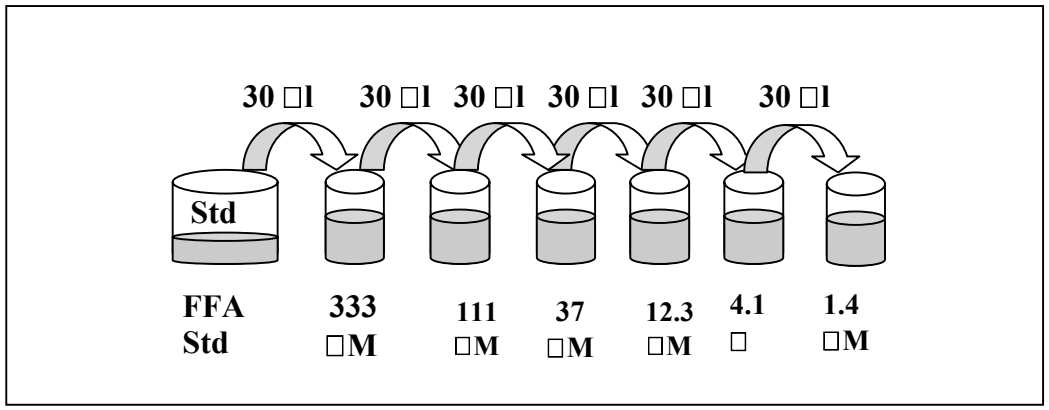
NOTE:
3 fatty acid molecules are released per triglyceride molecule resulting in a 3:1 fatty acid to glycerol concentration.

A. DETECTION OF NON-ESTERIFIED FATTY ACIDS

1. **Prepare the standard curve using the FFA STANDARD SOLUTION as follows:**

   Briefly spin down the contents of the free fatty acid standard tube before reconstitution. Standards are: 0, 1.4, 4.1, 12.3, 37, 111, and 333 □M fatty acid. Prepare as follows:

   The kit standard solution is the 1.0 mM standard. Pipette 60 □l of Dilution Buffer (Assay Buffer) into 6 tubes (not provided). Pipette 30 □l of the FFA Standard Stock into a tube labeled 333 µM. Prepare a dilution series as depicted below. Mix each new dilution thoroughly before proceeding to the next. The Assay Buffer alone serves as the zero standard.

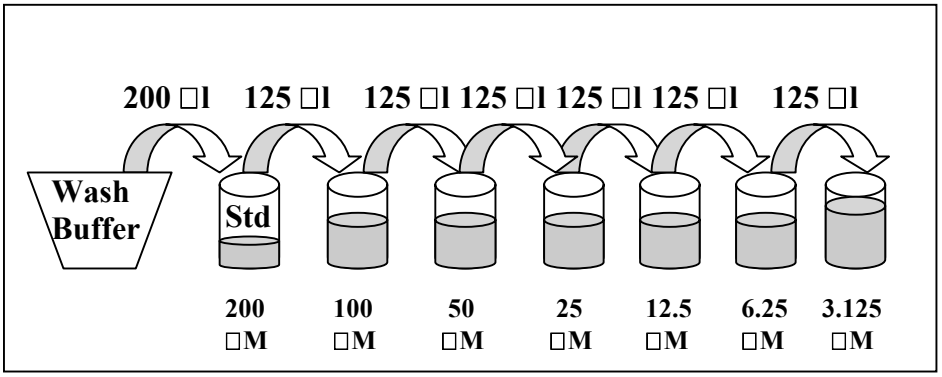


2. Add 50ml FFA Diluent A to the FFA Reagent A bottle and gently invert. DO NOT VORTEX! Store any remaining solution at 2-8°C; it is stable for 10 days after reconstitution refrigerated (2-8°C).
3. At the end of the incubation, 30 □l of the conditioned media is removed and transferred to the corresponding well of a blank plate for assessment of non-esterified fatty acids. [This is most easily accomplished using a multi-channel pipet.] Add 30 □l of each standard to empty wells.
4. Add the reconstituted FFA Reagent A to one of the disposable trays provided in the kit. Add 100 □l of FFA Reagent A to each well. Gently shake the plate to ensure mixing. Place in a 37 °C incubator for 10 minutes.
5. Add 25 ml FFA Diluent B to the FFA Reagent bottle and gently invert. Store any remaining solution at 2-8°C; it is stable for 10 days after reconstitution refrigerated (2-8°C).
6. Add the reconstituted FFA Reagent B to another disposable tray. Add 50 □l of FFA Reagent B to each well. Gently shake the plate to ensure mixing. Place in a 37 °C incubator for 10 minutes.
7. Allow the plate to equilibrate to room temperature for 5 minutes. During this time, ensure that there are no bubbles in the solution mixture. Use a large gauge needle or clean pipet tip to pop any bubbles as this will result in inaccurate absorbance readings.
8. The optical density of each well is then measured at 540 nm.

B. DETECTION OF FREE GLYCEROL

1. One hour prior to the assay, prepare the glycerol standards as follows:

   Briefly spin down the contents of the glycerol standard tube before reconstitution. Pipette 200 □l of Wash Buffer into the 1 mM glycerol standard tube provided and mix well by vortexing. This produces a diluted stock glycerol standard of 200 □M. Pipette 125 □l of wash buffer into 6 tubes (not provided). Using the newly diluted stock glycerol solution, prepare a dilution series as depicted below. Mix each new dilution thoroughly before proceeding to the next. The 200 □M stock dilution serves as the highest standard, and the wash buffer serves as the zero standard.



2. Also at this time prepare the Glycerol Reagent A by adding 40 ml room temperature deionized water per bottle following the instructions on the bottle. Gently invert bottle to mix contents. DO NOT VORTEX! Use a pipet to ensure that the powder is completely dissolved. Store in a light protected bottle. Reconstituted Glycerol Reagent A is stable for 60 days refrigerated (2-8°C); store any remaining solution refrigerated (2-8°C)

3. At the end of the incubation, an additional 50 □l of the conditioned media is removed and transferred to the corresponding well of a blank plate for assessment of free glycerol. [This is most easily accomplished using a multi-channel pipet. Add 50 □l of each glycerol standard to any remaining empty wells in one of the blank assay plates.

4. OPTION: to determine if the compound alone reacts with the Glycerol Reagent A, prepare a fresh plate (not included in kit) containing 50 □l of the compound. This plate can be incubated at 37°C with the treated cells. When performing the assay, add 50 □l of Glycerol Reagent A following the instructions in Steps 5 and 6.

5. Add the reconstituted Glycerol Reagent A solution to one of the disposable trays provided in the kit. Add 50 □l of Reagent A to each well of Plate B and Plate C (if used). Gently, pipet up and down once to mix. Pop the bubbles using a large gauge needle or a clean pipet tip. The plate is then incubated at 25°C (room temperature) for 15 minutes.

6. The optical density of each well is then measured at 540 nm.

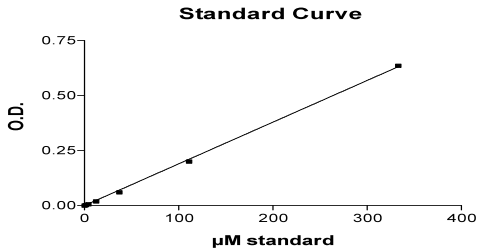
FATTY ACID STANDARD CURVE _____

Generate standard curve: see example below

[DO NOT use this standard curve to generate your data. This is an example.]

Subtract the OD value of the 0□M standard from all OD values including the standard curve. . Note: 1mM standard is commonly omitted from analysis due to lack of linearity between 333 □M and 1mM. Optionally, a 4-parameter fit may be used to calculate standard curve.

□M std	OD	OD - zero
333	0.68	0.636
111	0.244	0.2
37	0.104	0.06
12.3	0.063	0.019
4.1	0.05	0.006
1.4	0.046	0.002
0	0.044	0



y = 0.0019x - 0.0045
R^2 = 0.9995

Data are expressed as □M free fatty acids released.

OPTION: express data as Fold induction over appropriate vehicle

$$\text{Fold induction} = \frac{\text{□M free fatty acids SAMPLE}}{\text{□M free fatty acids VEHICLE}}$$

The R^2 value should be equal or greater then 0.98 for the standard curve to be valid. Any R^2 values below 0.98, must have the standard curve run again.

GLYCEROL STANDARD CURVE _____

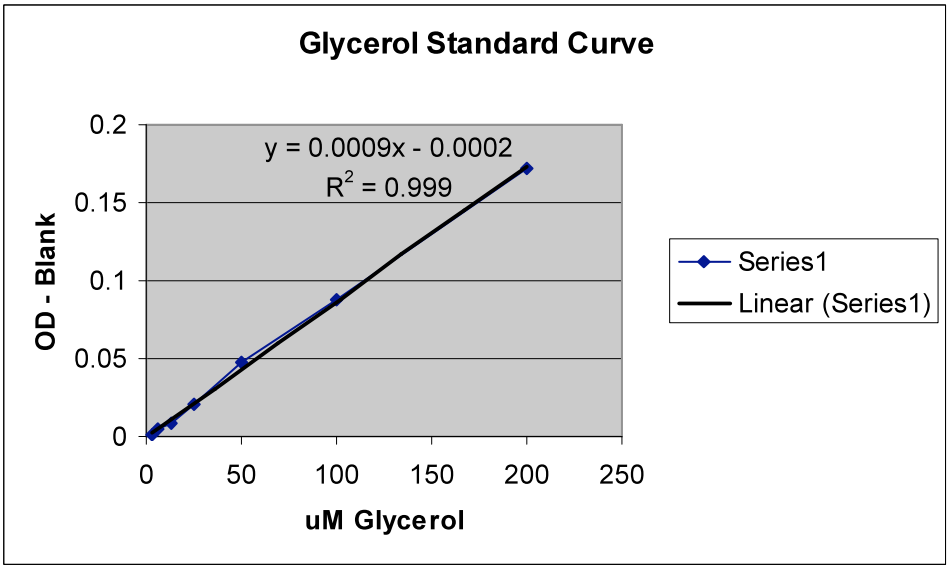
Generate standard curve: see example below

[DO NOT use this standard curve to generate your data. This is an example.]

Subtract the OD value of the 0□M standard from all OD values including the standard curve.

uM Glycerol	OD	OD - blank
0	0.04	
3.125	0.041	0.001
6.25	0.045	0.005
12.5	0.049	0.009
25	0.061	0.021
50	0.087	0.047
100	0.128	0.088
200	0.212	0.172

Slope	0.0009
Intercept	-0.0002
r^2	0.999



y = observed O.D. minus the blank

x = concentration of glycerol in □M

To calculate x for each y, (i.e. to change the observed O.D. into glycerol concentration) use the following equation:

y=(slope) times (x) plus intercept

y=mx+b so x=(y-b)/m

x=(y – 0.0075)/0.003 where 0.003= slope of the line and 0.0075= y intercept. Be careful to enter the proper sign for the y intercept value as it may be a negative number.

Any OD values greater than the highest standard (200 □M)) should be suspect. The compound should be re-assayed using a lower dose of the compound at treatment OR a dilute solution of the condition medium at the time of the assay.

The R^2 value should be equal or greater then 0.98 for the standard curve to be valid. Any R^2 values below 0.98, must have the standard curve run again.

Data are expressed as □M glycerol released.

OPTION: express data as Fold induction over appropriate vehicle

$$\text{Fold induction} = \frac{\square\text{M glycerol SAMPLE}}{\square\text{M glycerol VEHICLE}}$$

APPENDIX A: PLATE LAYOUT _____

H	G	F	E	D	C	B	A	
								1
								2
								3
								4
								5
								6
								7
								8
								9
								10
								11
								12

APPENDIX B: PROCEDURE FLOWCHART

Remove 150□l of the shipping medium and place in your incubator for 5-7 days (3-5 days for international customers)

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ON DAY OF ASSAY

Make all test compound dilutions in Assay Buffer.

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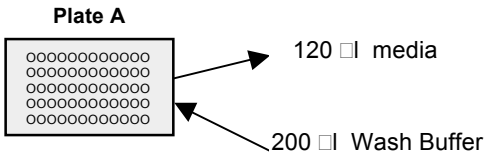
Remove 120 □l media from all wells. Add 200 □l Wash Buffer to all wells.



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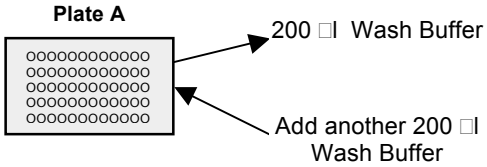
Remove 120 □l media & Wash Buffer. Add another 200 □l Wash Buffer to all wells.



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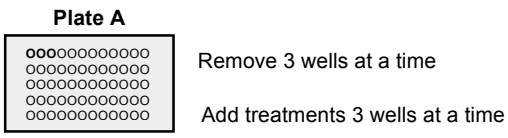
Remove all media & Wash Buffer. Add 100 □l treatments/controls to 3 wells at a time.



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Incubate 3-5 hours at 37°C.

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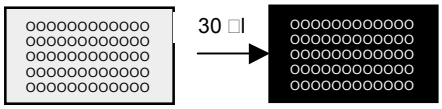
FREE FATTY ACID DETECTION

Remove 30 □l/well conditioned media from Plate A to Plate B.



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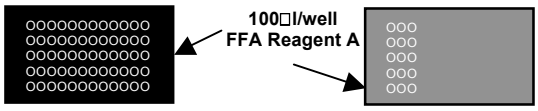
Reconstitute FFA Reagent A using Diluent A. Add 100□l/well. Incubate 10 minutes @ 37°C.



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Reconstitute FFA Reagent B using Diluent B. Add 50□l/well. Incubate 10 minutes @ 37°C.

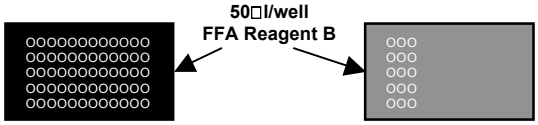

Plate C may be necessary for the assay of standards if al 96 wells of Plate A are used.

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Place at room temp. for 5 minutes. Pop any bubbles in each well using a clean pipet tip or large gauge needle.

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Measure the optical density of each well at 540 nm using a spectrophotometer plate reader.

FREE GLYCEROL DETECTION

One hour prior to assay, reconstitute Glycerol Reagent A and prepare standards. Keep all at room temp.

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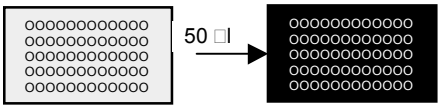
Remove 50 □l/well conditioned media from Plate A to a blank assay plate. Add 50 □l standards to empty wells.



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Add 50 □l/well reconstituted Glycerol Reagent A to a blank assay plate (including the glycerol standards at 50□l/well and optional plate without cells).

Plate C may be necessary for the assay of glycerol standards if al 96 wells of Plate A are used.

↓

Incubate at 25°C (room temperature) for 15 minutes. Pop the **bubbles in each well.**

↓

Measure the optical density of each well at 540 nm using a spectrophotometer plate **reader.**

REFERENCES

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