

MethylFlash™ 5-mC RNA Methylation ELISA Easy Kit (Fluorometric)

Base Catalog # P-9009

PLEASE READ THIS ENTIRE USER GUIDE BEFORE USE

Uses: The MethylFlash™ 5-mC RNA Methylation ELISA Easy Kit (Fluorometric) is suitable for detecting global 5-mC RNA methylation levels using total RNA isolated from any species including mammals, plants, fungi, bacteria, and viruses in a variety of forms including, but not limited to, cultured cells, fresh and frozen tissues, plasma/serum samples and body fluid samples, etc.

Input RNA: The amount of RNA for each assay can be 50 to 300 ng. For the most ideal quantification, the input RNA amount should be 200 ng, as 5-mC in RNA varies from tissue to tissue and can be less than 0.1% of total RNA in some species.

Starting Materials: Starting materials can include various tissue or cell samples such as cells from a flask or microplate cultured cells, fresh and frozen tissues, plasma/serum samples, body fluid samples, etc.

Internal Control: Both negative and positive RNA controls are provided in this kit. A standard curve can be performed (range: 0.05% to 2%). Because global 5-mC in RNA can vary from tissue to tissue, and from normal and diseased states, it is advised to run replicate samples to ensure that the signal generated is validated. This kit will allow the user to quantify an absolute amount of 5-mC in RNA and determine the relative 5-mC states of two different RNA samples.

Precautions: To avoid cross-contamination, carefully pipette the sample or solution into the strip-wells. Use aerosol-barrier pipette tips and always change pipette tips between liquid transfers. Wear gloves throughout the entire procedure. In case of contact between gloves and sample, change gloves immediately.

KIT CONTENTS

Component	48 Reactions Cat. #P-9009-48	96 Reactions Cat. #P-9009-96	Storage Upon Receipt
WB (10X Wash Buffer)	14 ml	28 ml	4°C
BS (Binding Solution)	5 ml	10 ml	RT
NC (Negative Control containing 0% 5-mC, 100 µg/ml)*	50 µl	100 µl	-20°C
PC (Positive Control containing 2% 5-mC, 100 µg/ml)*	10 µl	20 µl	-20°C
mcAb (5-mC Antibody, 1000X)*	5 µl	10 µl	4°C
SI (Signal Indicator, 1000X)*	5 µl	10 µl	-20°C
ES (Enhancer Solution, 1000X)*	5 µl	10 µl	-20°C
FD (Fluoro Developer)	12 µl	24 µl	-20°C
FE (Fluoro Enhancer)	12 µl	24 µl	-20°C
DB (Dilution buffer)	5 ml	10 ml	RT
8-Well Assay Strips (With Frame)	6	12	4°C

* Spin the solution down to the bottom prior to use.



Take Note! The **NC** is unmethylated RNA containing 0% of 5-methylcytosine. The **PC** is methylated RNA containing 2% of 5-methylcytosine.

SHIPPING & STORAGE

The kit is shipped in three parts: the first part at ambient room temperature and the second and third parts on frozen ice packs at 4°C.

Upon receipt: (1) Store **NC**, **PC**, **SI**, **ES**, **FD** and **FE** at -20°C away from light; (2) store **WB**, **mcAb**, and **8-Well Assay Strips** at 4°C away from light; (3) Store **BS** and **DB** at room temperature away from light.

All components of the kit are stable for 6 months from the date of shipment, when stored properly.



Take Note! Check if **WB** contains salt precipitates before use. If so, briefly warm at room temperature or 37°C and shake the buffer until the salts are re-dissolved.

MATERIALS REQUIRED BUT NOT SUPPLIED

- Adjustable 8-channel pipette
- Aerosol resistant pipette tips
- Microplate reader capable of reading fluorescence at 530_{ex}/590_{em} nm
- 1.5 ml microcentrifuge tubes

- Incubator for 37°C incubation
- Plate seal or Parafilm M
- Distilled water
- 1X TE buffer pH 7.5 to 8.0
- Isolated RNA of interest

GENERAL PRODUCT INFORMATION

Quality Control: Each lot of the MethylFlash™ 5-mC RNA Methylation ELISA Easy Kit (Fluorometric) is tested against predetermined specifications to ensure consistent product quality. EpigenTek guarantees the performance of all products in the manner described in our product instructions.

Product Warranty: If this product does not meet your expectations, simply contact our technical support unit or your regional distributor. We also encourage you to contact us if you have any suggestions about product performance or new applications and techniques.

Safety: Suitable lab coat, disposable gloves, and proper eye protection are required when working with this product.

Product Updates: EpigenTek reserves the right to change or modify any product to enhance its performance and design. The information in this User Guide is subject to change at any time without notice. Be sure to use the latest User Guide for this kit which can be accessed online at www.epigentek.com/datasheet.

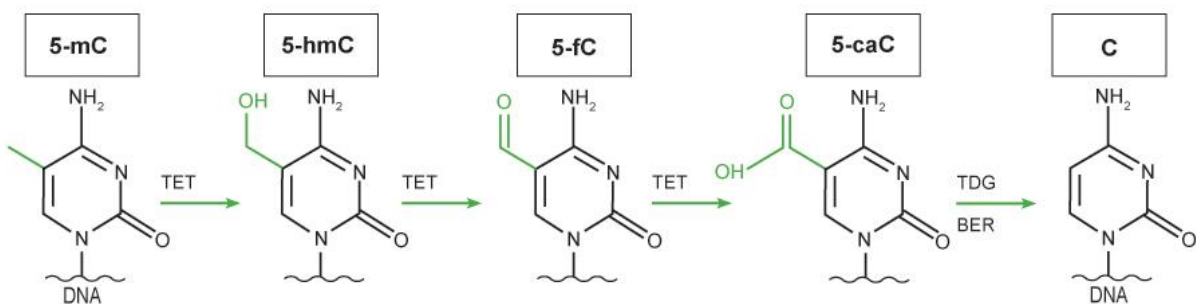
Usage Limitation: The MethylFlash™ 5-mC RNA Methylation ELISA Easy Kit (Fluorometric) is for research use only and is not intended for diagnostic or therapeutic applications.

Intellectual Property: The MethylFlash™ 5-mC RNA Methylation ELISA Easy Kit (Fluorometric) and methods of use contain proprietary technologies by EpigenTek.

A BRIEF OVERVIEW

5-methylcytosine (5-mC) in DNA occurs by the covalent addition of a methyl group at the 5-carbon of the cytosine ring by DNA methyltransferases. This process has been well studied and is generally associated with repression of gene expression. It was also observed that in humans, 5-mC occurs in various RNA molecules including tRNAs, rRNAs, mRNAs and non-coding RNAs (ncRNAs). 5-mC seems to be enriched in some classes of ncRNA, but relatively depleted in mRNAs. Levels of 5-mC are variable in animal genomes, ranging from undetectable amounts in some insects to about 0.1-0.45% of total RNA in human cells. The majority (83%) of 5-mC sites were found in mRNAs. Within these transcripts 5-mC appears to be depleted within protein coding sequences but enriched in 5' and 3' UTRs. Two different methyltransferases, NSUN2 and Dnmt2 are known to catalyze 5-mC modification in eukaryotic RNA. There has been strong evidence that RNA cytosine methylation affects the regulation of various biological processes such as RNA stability and mRNA translation. Furthermore, loss of 5-mC in vault RNAs causes aberrant processing into Argonaute-associated small RNA fragments that can function as microRNAs. Thus, impaired processing of vault ncRNA may contribute to the etiology of human disorders related to NSUN2-deficiency.

Very recently, a few novel modified nucleotides previously found in the DNA such as 5-hydroxymethylcytosine (5-hmC), 5-formylcytosine (5-fC) and 5-carboxycytosine (5-caC) have also been detected in RNA of human and mouse tissues. These modified nucleotides are also generated by iterative oxidation of 5-methylcytosine, a reaction mediated by the TET family of enzymes.



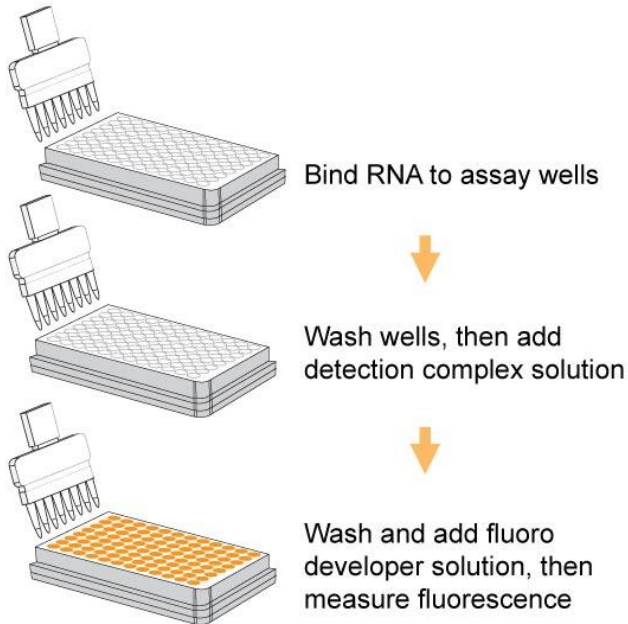
Accurate and convenient detection of 5-mC would be extremely useful for identifying and understanding the 5-mC methylation changes that occur in RNA during various physiological and pathological processes. Currently only chromatography-based techniques such as MS-LC are used for detecting total 5-mC in RNA. However, these methods are time consuming and have low throughput with high costs. To address this problem, EpigenTek developed MethylFlash™ 5-mC RNA Methylation ELISA Easy Kit. This kit has the following advantages and features:

- **Fast** - The entire procedure only needs 2 hours and 40 minutes*
- **Robust** - The kit composition allows the assay to have a large “signal window” with less variation between replicates
- **Convenient** - Inherently low background noise, thereby eliminating the need for plate blocking steps
- **Sensitive** - Detection limit can be as low as 0.02% of 5-mC RNA from 200 ng of input RNA
- **Specific** - High specificity to 5-mC, with no cross-reactivity to unmethylated cytosine or hydroxymethylated cytosine within the indicated concentration range of the sample RNA
- **Universal** – Positive and negative controls allow detection of 5-mC RNA methylation in any species
- **Accurate** - Optimized positive controls that can be fractionalized in percentage scale, allowing the assay to be more accurate and highly comparable with HPLC-MS analysis
- **Flexible** - Strip-well microplate format makes the assay available for manual or high throughput analysis

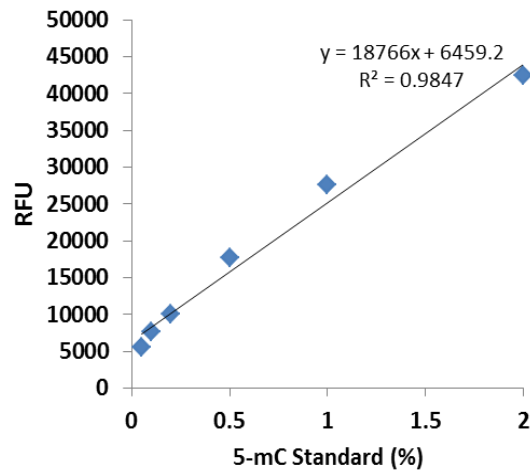
* Based on a single sample assay in duplicate

PRINCIPLE & PROCEDURE

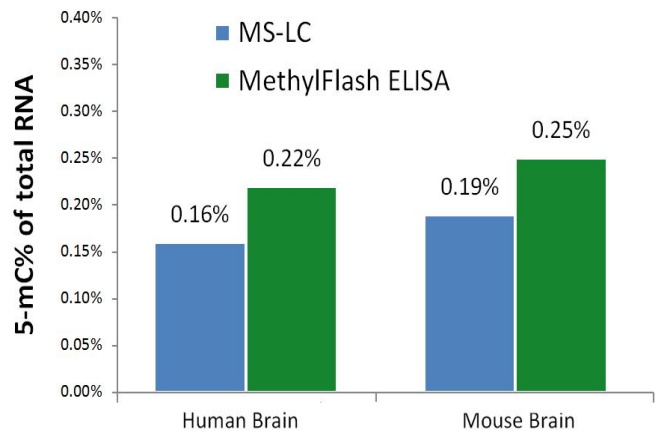
The MethylFlash™ 5-mC RNA Methylation ELISA Easy Kit (Fluorometric) contains all reagents necessary for the quantification of global 5-methylcytosine (5-mC) RNA methylation. In this assay, RNA is bound to strip-wells that are specifically treated to have a high nucleic acid affinity. 5-mC in RNA is detected using capture and detection antibodies and then quantified fluorometrically by reading the fluorescence in a microplate spectrophotometer. The percentage of 5-mC RNA is proportional to the fluorescence intensity measured.



▲ Schematic procedure for the MethylFlash™ 5-mC RNA Methylation ELISA Easy Kit (Fluorometric).



▲ An example of an optimal standard curve generated with 5-mC standard control.



▲ Accurate quantification of 5-mC content of various RNA samples from different species using the MethylFlash™ 5-mC RNA Methylation ELISA Easy Kit (Fluorometric). The results are closely correlated with those obtained by MS-LC.

ASSAY PROTOCOL

Starting Materials

Input RNA Quality and Amount: Input RNA should be highly pure with 260/280 ratio >2.0 and relatively free of DNA. DNase I can be used to remove DNA. RNA should be eluted in RNase-free water. The RNA amount can range from 50 ng to 300 ng per reaction. However, we recommend using 200 ng of RNA, which is the optimized input amount for the best results.

RNA Storage: Isolated RNA can be stored at -20°C until use.

1. Preparation of Working Buffer

Diluted Wash Buffer: For a 48-reaction size kit, prepare **Diluted WB** (1X Wash Buffer) by adding 13 ml of **WB** (10X Wash Buffer) to 117 ml of distilled water and adjust pH to 7.2-7.5. For the 96-reaction size kit, add 26 ml of **WB** (10X Wash Buffer) to 234 ml of distilled water and adjust pH to 7.2-7.5.



Take Note! This **Diluted WB** can now be stored at 4°C for up to six months.

Fluorescence Development Solution: Add 1 μl of **FD** (Fluoro Developer) and 1 μl of **FE** (Fluoro Enhancer) to every 500 μl of **DB** (Dilution Buffer). About 50 μl of this **Fluorescence Development Solution** will be required for each assay well.

The anticipated approximate volumes of reagents needed are reflected below for this assay.

Reagents	1 well	8 wells (1 strip)	16 wells (2 strips)	48 wells (6 strips)	96 wells (12 strips)
Diluted WB	2.5 ml	20 ml	40 ml	120 ml	240 ml
BS	100 μl	800 μl	1600 μl	4800 μl	9600 μl
5-mC Detection Complex	50 μl	400 μl	800 μl	2400 μl	4800 μl
Fluorescence Development Solution	50 μl	400 μl	800 μl	2400 μl	4800 μl
NC	N/A	2 μl	2 μl	4 μl	8 μl
PC	N/A	N/A	Optional	4 μl	8 μl



Take Note! Keep each of the diluted solutions (except **Diluted WB** 1X Wash Buffer) on ice until use. Any remaining diluted solutions, other than **Diluted WB**, should be discarded if not used within the same day.

2. Preparation of Standard Curve

Dilute 1 μl of **PC** with 7 μl of **NC** to make **Diluted PC**. Mix well. Then, prepare 6 concentration points for the control by combining **PC**, **Diluted PC**, and **NC** according to the following chart. Mix well to ensure the accuracy of the concentration.

Control		PC (2.0%)		Diluted PC (0.25%)		NC
0.05% PC/well	=	0.0 µl	+	1.0 µl	+	9.0 µl
0.1% PC/well	=	0.0 µl	+	1.0 µl	+	4.0 µl
0.2% PC/well	=	0.0 µl	+	2.0 µl	+	3.0 µl
0.5% PC/well	=	1.0 µl	+	0.0 µl	+	7.0 µl
1.0% PC/well	=	2.0 µl	+	0.0 µl	+	6.0 µl
2.0% PC/well	=	3.0 µl	+	0.0 µl	+	3.0 µl



Take Note! The above volumes will be sufficient for one standard curve in duplicate (12 wells total).

3. RNA Binding

Review the configuration of the strip-well plate setup for standard curve preparation in a 48-assays format below (for a 96-reaction format, strips 7 through 12 can be configured as *Sample*). The controls and samples can be measured in duplicate, loaded vertically instead of horizontally.

Well #	Strip 1	Strip 2	Strip 3	Strip 4	Strip 5	Strip 6
A	NC	0.5%PC	Sample 2	Sample 6	Sample 10	Sample 14
B	NC	0.5%PC	Sample 2	Sample 6	Sample 10	Sample 14
C	0.05%PC	1%PC	Sample 3	Sample 7	Sample 11	Sample 15
D	0.05%PC	1%PC	Sample 3	Sample 7	Sample 11	Sample 15
E	0.1%PC	2%PC	Sample 4	Sample 8	Sample 12	Sample 16
F	0.1%PC	2%PC	Sample 4	Sample 8	Sample 12	Sample 16
G	0.2%PC	Sample 1	Sample 5	Sample 9	Sample 13	Sample 17
H	0.2%PC	Sample 1	Sample 5	Sample 9	Sample 13	Sample 17

- Predetermine the number of strip-wells required for your experiment. Carefully remove un-needed strip-wells from the plate frame and place them back in the bag (seal the bag tightly and store at 4°C).
- For negative control wells: Add 100 µl of **BS** and 2 µl of **NC**.
- For positive control wells: Add 100 µl of **BS** and 2 µl of **PC** at different concentrations (0.05%-2%) to generate a standard curve (see note below).
- For sample wells: Add 100 µl of **BS** and 200 ng of your sample RNA (2-8 µl).



Take Note! (1) To reduce cross variation between replicates, it is important to load the wells in vertical formation according to the plate layout depicted above. (2) For the positive controls, total RNA is 200 ng per well with different methylation percentages (0.05%, 0.1%, 0.2%, 0.5%, 1%, and 2%). The positive controls should be assayed in parallel with the samples in the same plate and a new positive control standard curve should be generated for each assay. (3) For optimal binding and to reduce pipetting error, sample RNA volume added should be 2 µl or more, but should not exceed 8 µl. If the sample RNA is not 200 ng per well, the amount of positive control RNA should be adjusted accordingly to be equal to the amount of the sample RNA that is used to ensure the accuracy of 5-mC quantification. (4) To ensure that **NC**, **PC**, and sample RNA are completely added into the wells, the input RNA should be mixed well before use and the pipette tip should be placed into the **BS** solution in the well and aspirated in/out 1-2 times. Changing the tips each time when adding the sample will increase sample volume accuracy added into each well.

- e. Mix solution by gently tilting from side to side or by gently shaking the plate several times to ensure the solution coats the bottom of the well evenly. Cover strip plate with plate seal or Parafilm M and incubate at 37°C for 90 minutes.
- f. During the last 10 minutes of sample incubation, prepare the **5-mC Detection Complex Solution**: In each 1 ml of **Diluted WB** add 1 µl of **mcAb**, mix and then add 1 µl of **SI** and 1 µl of **ES**. Mix well.
- g. Remove the **BS** from each well after 90-minute incubation. Wash each well with 150 µl of the **Diluted WB** each time for three times. This can be done by simply pipetting **Diluted WB** in and out of the wells.

4. 5-mC RNA Detection and Signal Measurement

- a. Add 50 µl of the **5-mC Detection Complex Solution** to each well, then cover and incubate at room temperature for 50 minutes.
- b. Remove the **5-mC Detection Complex Solution** from each well.
- c. Wash each well with 150 µl of the **Diluted WB** each time for five times.

5. Signal Detection

- a. Add 50 µl of **Fluorescence Development Solution** to each well and incubate at room temperature for 2 to 4 minutes away from direct light. The **Fluorescence Development Solution** will turn pink in the presence of sufficient 5-mC products.
- b. Read the fluorescence on a fluorescence microplate reader within 2 to 10 minutes at 530_{ex}/590_{em} nm.



Take Note! (1) The fluorescence development time may vary from 1-10 minutes based on the speed of color change, but is typically 3-4 minutes. (2) If the strip-well plate frame does not fit in the microplate reader, transfer the solution to a standard 96-well microplate.

6. 5-mC% Calculation

To calculate percentage of 5-mC RNA, first generate a standard curve and plot the RFU values versus the **PC** at each percentage point. Next, determine the slope (RFU/1%) of the standard curve using linear regression (*Microsoft Excel* can be used) and the most linear part (at least 4 concentration points including 0 point) of the standard curve for optimal slope calculation. Now, calculate the percentage of methylated RNA (5-mC) in total RNA using the following formula:

$$5\text{-mC}\% = \frac{\text{Sample RFU} - \text{NC RFU}}{\text{Slope} \times S} \times 100\%$$

S is the amount of input sample RNA in ng.

Example Calculation:

Average RFU of NC is 1250
 Average RFU of sample is 11250
 Slope is 25000/1%
 S is 200 ng

$$5\text{-mC}\% = \frac{11250 - 1250}{25000 \times 200} \times 100\% = 0.2\%$$



Take Note! (1) The calculated 5-mC% is $5\text{-mC}/\text{total RNA (A+G+C+U)}$. If the 5-mC% would be presented as $5\text{-mC}/(5\text{-mC}+C)$, simply divide the calculated 5-mC% by cytosine content of the species if it is available. (2) In the event that the standard curve is flat due to high RFUs starting from the lowest %PC or is flat at high %PCs because of a saturated signal intensity due to extended fluoro development time, the 5-mC% can be calculated with logarithmic or polynomial second order regression, respectively (see the Appendix).

TROUBLESHOOTING

Problem	Possible Cause	Suggestion
No signal in both the positive control and sample wells	Reagents are added incorrectly.	Check if reagents are added in the proper order and if any steps in the protocol may have been omitted by mistake.
	The well is incorrectly washed before RNA binding.	Ensure the well is not washed prior to adding the positive control and sample.
	The bottom of the well is not completely covered by the BS (Binding Solution).	Ensure the solution coats the bottom of the well by gently tilting from side to side or gently shaking the plate several times.
	Incubation time and temperature are incorrect.	Ensure the incubation time and temperature described in the protocol are followed correctly.
	Insufficient input materials.	Ensure that a sufficient amount of positive control and samples are added into the wells.
	Incorrect absorbance reading.	Check if appropriate absorbance wavelength ($530_{\text{ex}}/590_{\text{em}}$ nm) is used.
	Kit was not stored or handled properly.	Ensure all components of the kit were stored at the appropriate temperature and the caps are tightly capped after each opening or use.
No signal or weak signal in only the positive control wells	The PC (Positive Control) is insufficiently added to the well in Step 3c .	Ensure a sufficient amount of positive control RNA is added.
	The PC (Positive Control) is degraded due to improper storage conditions.	Follow the Shipping & Storage guidance in this User Guide for storage of PC (Positive Control).
High background present in the negative control wells	Insufficient washing of wells.	Check if washing recommendations at each step are performed according to the protocol.
	Contaminated by sample or positive control.	Ensure the well is not contaminated from adding sample or positive control accidentally or from using contaminated tips.
	Incubation time is too long.	The incubation time at Step 4a should not exceed 2 hours.
	Over development of fluorescence.	Decrease the development time at Step 5a .
Large variation between replicate wells	Horizontal positioning of well replicates causes inconsistent delays in pipetting and loading of reagents.	Follow the vertical layout example provided in Step 3 . Ensure loading of reagents is also in vertical order with a multi-channel pipette, especially when adding Fluorescence Development Solution at Step 5a .

	Residue wash buffer is present in some of the wells.	Ensure the wash buffer is completely removed at each wash step.
	Solutions or antibodies were not actually added into the wells.	Do not allow pipette tip to touch the outer edges or inner sides of the wells to prevent solutions from sticking to the surface.
	Did not use the same pipette device throughout the experiment.	Use the same multi-channel pipette device throughout the entire experiment, as different pipette devices may have slight variations in performance.
	Splashing of reagents between wells.	Pipette carefully against the sides of the wells to avoid splashing.
	Temperature variations across the plate.	Ensure plates are evenly and fully covered during incubation steps in a stable temperature environment, away from drafts.
Large variation between sample replicate wells only	Sample RNA is sedimented or uneven prior to loading to wells.	Mix your sample RNA sufficiently and evenly prior to loading it into wells.
mcAb (5-mC Antibody) vial appears to be empty or insufficient in volume	Buffer evaporated due to the very small volumes, resulting in a higher concentrated antibody.	Add 1X PBS buffer into the mcAb (5-mC Antibody) vial until you restore the correct, intended volume according to the Kit Contents described in this User Guide. Mix and centrifuge prior to use.

APPENDIX

Method 1: 5-mC% Calculation Using Logarithmic Second Order Regression

Use this method when the standard curve is flat due to high RFUs starting from the lowest %PC.

- Plot the average RFU value on the Y-axis versus the known 5-mC percentage of each **PC** point on the X-axis.
- Graph the second order logarithmic curve* (also see "Example Calculation" below) and obtain second order logarithmic regression equation:

$$Y = a \ln(X) + b$$

Here, X = 5-mC%; Y = <Sample RFU>; a is Slope and b is Y-intercept, respectively.

* Microsoft Excel's logarithmic regression function can be used for easy and convenient calculation of 5-mC%.

- Calculate 5-mC% of the samples based on the following equation, derived from the above equation

$$5\text{-mC}\% = e^{[(Y-b)/a]} \div S \times 100\%$$

Here, S is the amount of input sample RNA in ng.

Method 2: 5-mC% Calculation Using Polynomial Second Order Regression

Use this method when the standard curve is flat due to a saturated signal intensity at high %PCs.

- Plot the average RFU values on the Y-axis versus the known 5-mC percentage of each **PC** point on the X-axis.
- Graph the second order polynomial curve* (also see "Example Calculation" below) and obtain second order polynomial regression equation:

$$Y = aX^2 + bX$$

Here, $X = 5\text{-mC}\%$; $Y = \langle \text{Sample RFU} \rangle - \langle \text{NC RFU} \rangle$; a and b is known Slope 1 and Slope 2, respectively.

* Microsoft Excel's polynomial regression function can be used for easy and convenient calculation of 5-mC%.

- Calculate 5-mC% of the samples based on the following equation, derived from the above equation.

$$5\text{-mC}\% = \frac{(b^2 + 4aY)^{0.5} - b}{2a} \div S \times 100\%$$

Here, S is the amount of input sample RNA in ng.

RELATED PRODUCTS

DNA Methylation Studies

P-1030	MethylFlash™ Global DNA Methylation (5-mC) ELISA Easy Kit
P-1032	MethylFlash™ Global DNA Hydroxymethylation (5-hmC) ELISA Easy Kit
P-1001	Methylamp™ DNA Modification Kit
P-1015	Methylamp™ Methylated DNA Capture (MeDIP) Kit
A-1014	5-methylcytosine Monoclonal Antibody, Clone 33D3

RNA Methylation Studies

P-9003	Methylamp™ RNA Bisulfite Conversion Kit
P-9005	EpiQuik m6A RNA Methylation Quantification Kit (Colorimetric)
P-9007	EpiNext™ RNA Bisulfite-Seq Easy Kit (Illumina)