Intended Use

PCSK9 (Human) ELISA Kit is used for the quantitative measurement of Human PCSK9 in serum, plasma, cell culture medium and other biological media.

This assay kit is for research use only and not for use in diagnostic or therapeutic procedures.

Storage

- Upon receipt store all components at 4℃; Do not expose reagents to excessive light.

Introduction

PCSK9 (also known as neural apoptosis-regulated convertase, NARC-1) is a 692-residue extracellular protein expressed primarily in the kidneys, liver and intestines (1) representing the 9th member of the secretory subtilase family. Various genetic observations subsequently mapped PCSK9 as the third gene (along with LDLR and APOB) to cause autosomal dominant hypercholesterolemia (ADH). These studies suggested that gain of function mutations increase plasma levels of LDL-c (2–6), whereas nonsense or missense (loss-of-function) mutations, which interfere with folding or secretion of PCSK9, lead to a reduction of plasma levels of LDL-c and an 88% decrease in the risk of coronary heart disease (CHD) (5). In mice, adenoviral overexpression of PCSK9 results in increased plasma LDL-c level in normal mice but not in LDLR-deficient mice (7). Deletion of PCSK9 causes an increase in level of LDLR protein but not mRNA (8). These findings lead to a hypothesis that PCSK9 exerts its role in cholesterol metabolism through posttranslational down-regulation of LDLR, the receptor responsible for clearing LDL-c from plasma.

Evidence is consistent with the secreted form of PCSK9 binding directly to the LDLR and resulting in degradation of the receptor (9, 10). Zhang et al. (11) localized the binding site of PCSK9 in the LDLR to the first epidermal growth factor-like repeat (EGF-A) of the extracellular domain and showed that PCSK9 binding to this site is required for LDLR degradation. In light of these observations and the fact that PCSK9 in the circulation may cause the degradation of hepatic LDLR in the liver, PCSK9 would seem to be an attractive drug target for lowering LDL-c.

Principle of the Assay

The PCSK9 (Human) ELISA Kit employs the quantitative sandwich enzyme immunoassay technique. A polyclonal antibody specific for PCSK9 has been pre-coated onto a microplate. Standards and samples are pipetted into the wells and the immobilized antibody binds any PCSK9 present. After washing away any unbound substances, an HRP conjugated monoclonal antibody specific for PCSK9 is added to the wells. Following a wash to remove any unbound antibody HRP conjugate, the remaining conjugate is allowed to react with the substrate H_2O_2- tetramethylbenzidine. The reaction is stopped by addition of acidic solution and absorbance of the resulting yellow product is measured at 450 nm. The absorbance is proportional to the concentration of PCSK9. A standard curve is constructed by plotting absorbance values versus PCSK9 concentrations of calibrators, and concentrations of unknown samples are determined using this standard curve.

The PCSK9 (Human) ELISA Kit is designed to measure the concentration of human PCSK9 from serum/plasma or conditioned medium.

Summary of Procedure

Add 100 µL of diluted sample to the wells

↓ **Incubate for 1 hour at room temp.** (20-25 ℃)

Wash the wells

↓

Add 100 µL of HRP conjugated anti-PCSK9 monoclonal antibody

↓ **Incubate for 1hour at room temp.** (20-25 ℃)

Wash the wells

↓

Add 100 µL of Substrate Reagent

↓

Add 100 µL of Stop Solution

↓

Measure absorbance at 450 nm

Materials Provided

All samples and standards should be assayed in duplicate. The following components are supplied and are sufficient for the one 96-well microplate kit.

Microplate: One microplate supplied ready to use, with 96 wells (12 strips of 8-wells) in a foil, zip-lock bag with a desiccant pack. Wells are coated with anti-PCSK9 polyclonal antibody as a capture antibody.

10X Wash Buffer: One 100 mL bottle of 10X buffer containing 2%Tween®-20

Dilution Buffer: One bottle containing 60 mL of 1X buffer; use for reconstitution of PCSK9 Standard and sample dilution. Ready to use.

PCSK9 Standard: One vial containing 50 ng of lyophilized recombinant PCSK9

HRP conjugated Detection Antibody: One vial containing 12 mL of HRP (horseradish peroxidase) conjugated anti-PCSK9 monoclonal antibody. Ready to use.

Substrate Reagent: One bottle containing 20 mL of the chromogenic substrate, tetra-methylbenzidine (TMB). Ready to use.

Stop Solution: One bottle containing 20 mL of 1 N H_2SO_4. Ready to use.

Materials Required but not Provided

- **Pipettors:** 2-20 µL, 20-200 µL and 200-1000 µL precision pipettors with disposable tips.
- **Precision repeating pipettor**.
- **Orbital microplate shaker**
- **Microcentrifuge and tubes** for sample preparation.
- **Vortex mixer**.
- **Microplate washer:** optional (Manual washing is possible but not preferable)
- **Plate reader** capable of measuring absorbance in 96-well plates at dual wavelengths of 450 nm/540 nm. Dual wavelengths of 450/550 or 450/595 nm can also be used. The plate can also be read at a single wavelength of 450 nm, which will give a somewhat higher reading.
- **Software package facilitating data generation and analysis:** optional
- **500 or 1000 mL graduated cylinder.**
- **Reagent reservoirs.**
- **Deionized water of the highest quality.**
- **Disposable paper towels.**

Precautions and Recommendations

- Allow all the components to come to room temperature before use.
- All microplate strips that are not immediately required should be returned to the zip-lock pouch, which must be carefully resealed to avoid moisture absorption.
- Do not use kit components beyond the indicated kit expiration date.
- Use only the microtiter wells provided with the kit.
- Rinse all detergent residues from glassware.
- Use deionized water of the highest quality.
- Do not mix reagents from different kits.
- The buffers and reagents used in this kit contain NaN_3 as preservatives. Care should be taken to avoid direct contact with these reagents.
- Do not mouth pipette or ingest any of the reagents.
- Do not smoke, eat, or drink when performing the assay or in areas where samples or reagents are handled.
- Dispose of tetra-methylbenzidine (TMB) containing solutions in compliance with local regulations.
- Avoid contact with the acidic Stop Solution and Substrate Solution, which contains hydrogen peroxide.
- Wear gloves and eye protection when handling immunodiagnostic materials and samples of human origin, and these reagents. In case of contact with the Stop Solution and the Substrate Solution, wash skin thoroughly with water and seek medical attention, when necessary.
- **Human samples may be contaminated with infectious agents. Do not ingest, expose to open wounds or breathe aerosols. Wear protective gloves and dispose of biological samples properly.**
- **CAUTION**: **Sulfuric Acid is a strong acid. Wear disposable gloves and eye protection when handling Stop Solution.**

Sample Collection and Preparation

Serum: Use a serum separator tube and allow samples to clot for 60 ± 30 minutes. Centrifuge the samples at 4℃ for 10 minutes at 1,000 x g. Remove serum and assay immediately or store samples on ice for up to 6 hours before assaying. Aliquots of serum may also be stored at -70℃ for extended periods of time. Avoid repeated freeze-thaw cycles.

Plasma: Collect plasma using EDTA-Na_2 as the anticoagulant. If possible, collect the plasma into a mixture of EDTA-Na_2 and Futhan5 to stabilize the sample against spontaneous in vitro complement activation. Immediately centrifuge samples at 4℃ for 15 minutes at 1,000 x g. Assay immediately or store samples on ice for up to 6 hours before assaying. Aliquots of plasma may also be stored at -70℃ for extended periods of time. Avoid repeated freeze-thaw cycles.

Note: Citrate plasma has not been validated for use in this assay.

Other biological samples: Remove any particulates by centrifugation and assay immediately or aliquot and store samples at -70° C. Avoid repeated freeze-thaw cycles

Detailed Protocol

The PCSK9 (Human) ELISA Kit is provided with removable strips of wells so the assay can be carried out on separate occasions using only the number of strips required for the particular determination. Since experimental conditions may vary, an aliquot of the PCSK9 Standard within the kit, should be included in each assay as a calibrator. Disposable pipette tips and reagent troughs should be used for all liquid transfers to avoid cross-contamination of reagents or samples.

Preparation of Reagents

All reagents need to be brought to room temperature prior to the assay. Assay reagents are supplied ready-to-use, with the exception of 10X Wash Buffer and PCSK9 Standard.

1. Prepare a working solution of Wash Buffer by adding 100 mL of the 10X Wash Buffer (provided) to 900 mL of deionized (distilled) water. Mix well.

2. Reconstitute PCSK9 Standard with 0.5 mL of ddH_2O. The concentration of the PCSK9 in vial should be 100 ng/mL, which is referred as a Master Standard of PCSK9.

Prepare Standard solutions as follows:

Use the Master Standard to produce a dilution series (below). Mix each tube thoroughly before the next transfer. The 10 ng/mL standard (Std.1) serves as the high standard. The Dilution Buffer serves as the zero standard (Blank).

	Volume of Standard	Dilution Buffer	Concentration
Std.1	60 µL of Master Standard	540 µL	10 ng/mL
Std.2	300 µL of Std. 1 (10 ng/ml)	300 µL	5 ng/mL
Std.3	300 µL of Std. 2 (5 ng/ml)	300 µL	2.5 ng/mL
Std.4	300 µL of Std. 3 (2.5 ng/ml)	300 µL	1.25 ng/mL
Std.5	300 µL of Std. 4 (1.25 ng/ml)	300 µL	0.63 ng/mL
Std.6	300 µL of Std. 5 (0.63 ng/ml)	300 µL	0.31 ng/mL
Std.7	300 µL of Std. 6 (0.31 ng/ml)	300 µL	0.16 ng/mL
Blank	-	300 µL	0 ng/mL

Note: Do not use a Repeating pipette. Change tips for every dilution. Wet tip with Standard before dispensing. Unused portions of Standards should be aliquoted and stored at below

-70 ℃ immediately. Avoid multiple freeze and thaw cycles.

Sample Preparation

- Serum and plasma samples require a 100-fold dilution.
- Other biological samples require neat to appropriate dilution.

Assay Procedure

1. Remove the appropriate number of microtiter wells from the foil pouch and place them into the well holder. Return any unused wells to the foil pouch, refold, seal with tape and store at 4℃.

2. Dilute serum sample 1:100 with Dilution Buffer (e.g. 3 µL serum sample + 297 µL Dilution Buffer).

3. Pipette 100 µL of PCSK9 Standards (Std1-Std7, Blank) and diluted samples in duplicates, into the appropriate wells.

4. Incubate the plate **at room temperature (ca. 20℃) for 1 hour**, shaking at ca. 300 rpm on an orbital microplate shaker.

5. Wash 4-times by filling each well with Wash Buffer (350 µL) using a squirt bottle, multi-channel pipette, manifold dispenser or microplate washer.

6. Add **100 µL** of **HRP conjugated Detection Antibody** into each well.

7. Incubate the plate **at room temperature (ca. 20℃) for 1 hour**, shaking at ca. 300 rpm on an orbital microplate shaker.

8. Wash 4-times by filling each well with Wash Buffer (350 µL) using a squirt bottle, multi-channel pipette, manifold dispenser or microplate washer.

9. **Add 100 µL** of **Substrate Reagent**. (Avoid exposing the microtiter plate to direct sunlight. Covering the plate with e.g. aluminum foil is recommended). Return Substrate Reagent to 2-8℃ immediately after the necessary volume is removed.

10. Incubate the plate **at room temperature** for **15-20 minutes**, shaking at ca. 300 rpm on

an orbital microplate shaker. (The incubation time may be extended up to 30 minutes if the reaction temperature is below than 20℃).

11. Add **100 µL** of **Stop Solution** to each well in the same order as the previously added Substrate Reagent.

12. Measure absorbance in each well using a spectrophotometric microplate reader at dual wavelengths of 450/540 nm. Dual wavelengths of 450/550 or 450/595 nm can also be used. Read the microplate at 450 nm if only a single wavelength can be used. Wells must be read within 30 minutes of adding the Stop Solution.

Note-1: Complete removal of liquid at each step is essential to good performance. After the last wash, remove any remaining Wash Buffer by aspirating or decanting. Invert the plate and blot it against clean paper towels.

Note-2: Reliable standard curves are obtained when either O.D. values do not exceed 0.25 units for the blank (zero concentrations), or 3.0 units for the highest standard concentration. The plate should be monitored at 5-minute intervals for approximately 30 minutes.

Note-3: If the microplate reader is not capable of reading absorbance greater than the absorbance of the highest standard, perform a second reading at 405 nm. A new standard curve, constructed using the values measured at 405 nm, is used to determine PCSK9 concentration of off-scale samples. The readings at 405 nm should not replace the on-scale readings at 450 nm.

Calculations

Average the duplicate readings for each standard, control, and sample and subtract the average zero standard optical density. Plot the optical density for the standards versus the concentration of the standards and draw the best curve. The data can be linearized by using log/log paper and regression analysis may be applied to the log transformation. To determine the PCSK9 concentration of each sample, first find the absorbance value on the y-axis and extend a horizontal line to the standard curve. At the point of intersection, extend a vertical line to the x-axis and read the corresponding PCSK9 concentration. If the samples have been diluted, the concentration read from the standard curve must be multiplied by the dilution factor.

1. The dose-response curve of this assay fits best to a sigmoidal 5-parameter logistic equation. The results of unknown samples can be calculated with any computer program having a 5-parameter logistic function. It is important to make an appropriate mathematical adjustment to accommodate for the dilution factor.

2. Most microtiter plate readers perform automatic calculations of analyte concentration. The calibration curve is constructed by plotting the absorbance (Y) of calibrators versus log of the known concentration (X) of calibrators, using the four-parameter function. Alternatively, the logit log function can be used to linearize the calibration curve (i.e. logit of absorbance (Y) is plotted versus log of the known concentration (X) of calibrators).

Measurement Range

Results exceeding PCSK9 level of 1,000 ng/ml should be repeated with diluted samples. Dilution factors need to be taken into consideration in calculating the PCSK9 concentration.

Troubleshooting

1. The PCSK9 Standard should be run in duplicate, using the protocol described in the Detailed Protocol. Incubation times or temperature significantly different from those specified may give erroneous results.

2. Poor duplicates, accompanied by elevated values for wells containing no sample, indicate insufficient washing. If all instructions in the Detailed Protocol were followed accurately, such results indicate a need for washer maintenance.

3. Overall low signal may indicate that desiccation of the plate has occurred between the final wash and addition of Substrate Reagent. Do not allow the plate to dry out. Add Substrate Reagent immediately after wash.

Reagent Stability

All of the reagents included in the **PCSK9 (Human) ELISA Kit** have been tested for stability. Reagents should not be used beyond the stated expiration date. Upon receipt, kit reagents should be stored at 4℃, except the reconstituted PCSK9 Standard must be stored at below -70℃. Coated assay plates should be stored in the original foil bag sealed by the zip lock and containing a desiccant pack.

Assay Characteristics

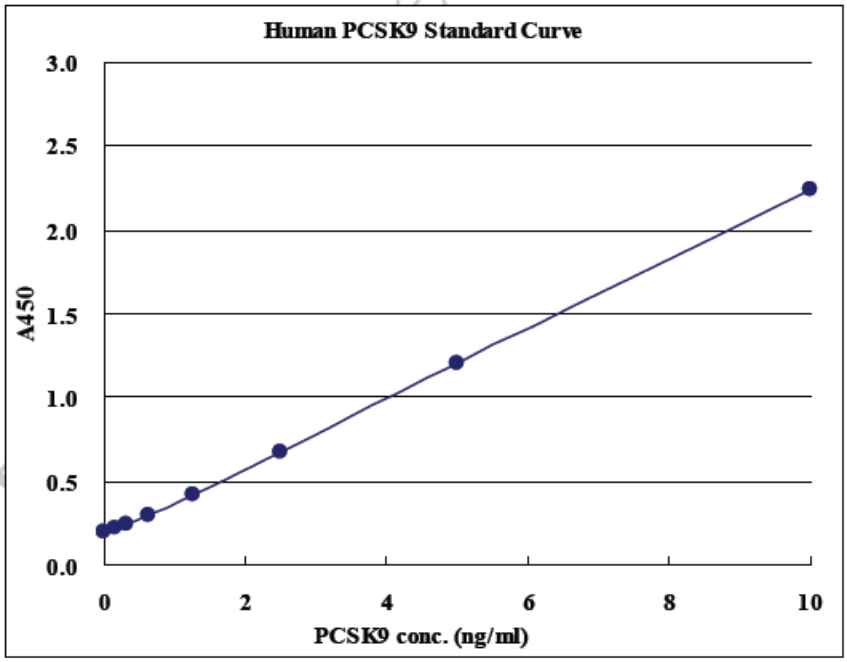
1. Sensitivity

The limit of detection (defined as such a concentration of PCSK9 giving absorbance higher than mean absorbance of blank* plus three standard deviations of the absorbance of blank: A blank + 3SD blank) is better than 0.154 ng/ml of sample.

* Dilution Buffer is pipetted into blank wells, and the microtiter plate is blanked on air.

Eighty assays were evaluated and the minimum detectable dose (MDD) of PCSK9 ranged from 0.138-0.166 ng/mL. The mean MDD was 0.154 ng/mL. The MDD was determined by adding three standard deviations to the mean optical density value of twenty zero standard replicates and calculating the corresponding concentration.

Typical standard curve



2. Precision

Intra-assay Precision (Precision within an assay)

Three samples of known concentration were tested sixteen times on one plate to assess intra-assay precision.

- Intra-assay (Within-Run, n=16) CV=1.5-2.6 %

Human PCSK9 conc. (ng/ml)

	Serum-1	Serum-2	Serum-3
1	83.8	262.1	348.2
2	81.3	253.2	341.9
3	80.9	254.2	339.9
4	75.9	260.1	349.6
5	79.2	264.8	350.3
6	81.3	259.0	352.4
7	81.7	255.9	344.0
8	84.6	257.0	347.2
9	83.3	258.3	345.8
10	80.0	256.6	336.4
11	79.6	252.2	344.0
12	80.5	259.7	339.2
13	82.5	269.3	343.0
14	79.2	263.8	342.3
15	79.2	253.6	337.4
16	81.7	260.7	352.0
Max.	84.60	269.30	352.40
Min.	75.90	252.20	336.40
Mean	80.92	258.78	344.60
S.D.	2.135	4.677	5.036
C.V. (%)	2.6%	1.8%	1.5%

Inter-assay Precision (Precision between assays)

Three samples of known concentration were tested in five separate assays to assess inter-assay precision.

- Inter-assay (Run-to-Run, n=5) CV=2.90-7.09 %

Human PCSK9 conc. (ng/ml)

	Serum-1	Serum-2	Serum-3
1	81.7	259.2	3495.2
2	68.9	252.2	3577.2
3	77.6	266.3	3781.8
4	80.8	251.2	3681.5
5	72.9	247.8	3633.9
Max.	81.7	266.3	3781.8
Min.	68.9	247.8	3495.2
Mean	76.4	255.3	3633.9
S.D.	5.419	7.410	107.931
C.V. (%)	7.09%	2.90%	2.97%

3. Spiking Recover

Serum samples were spiked with different amounts of PCSK9 and assayed.

The recovery of PCSK9 spiked to levels throughout the range of the assay was evaluated.

Sample Average % Recovery Range: Human serum (n=3), 82.25-112.05 %

Serum 1

	None	+ 300 ng/ml	+ 100 ng/ml	+ 30 ng/ml
Average (ng/ml)	68.83	365.55	180.88	101.18
Recovery rate (%)	-	98.91	112.05	107.83

Serum 2

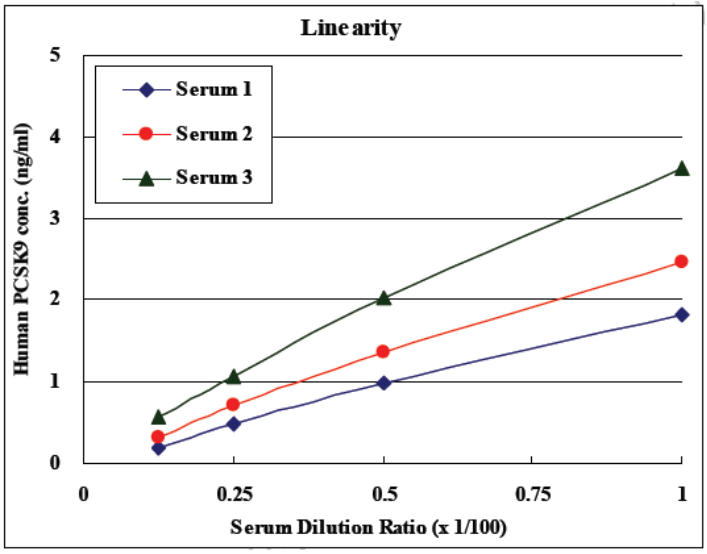
	None	+ 300 ng/ml	+ 100 ng/ml	+ 30 ng/ml
Average (ng/ml)	198.08	465.13	288.90	224.35
Recovery rate (%)	-	89.02	90.83	87.58

Serum 3

	None	+ 300 ng/ml	+ 100 ng/ml	+ 30 ng/ml
Average (ng/ml)	273.40	524.73	355.65	302.15
Recovery rate (%)	-	83.78	82.25	95.83

4. Linearity

To assess the linearity of the assay, samples containing and/or spiked with high concentrations of PCSK9 were serially diluted with the Dilution Buffer to produce samples with values within the dynamic range of the assay.



Example of Test Results

Fig.1 Concentrations of PCSK9 in healthy Japanese volunteers sera, n = 37 (Male: 21, Female: 16).

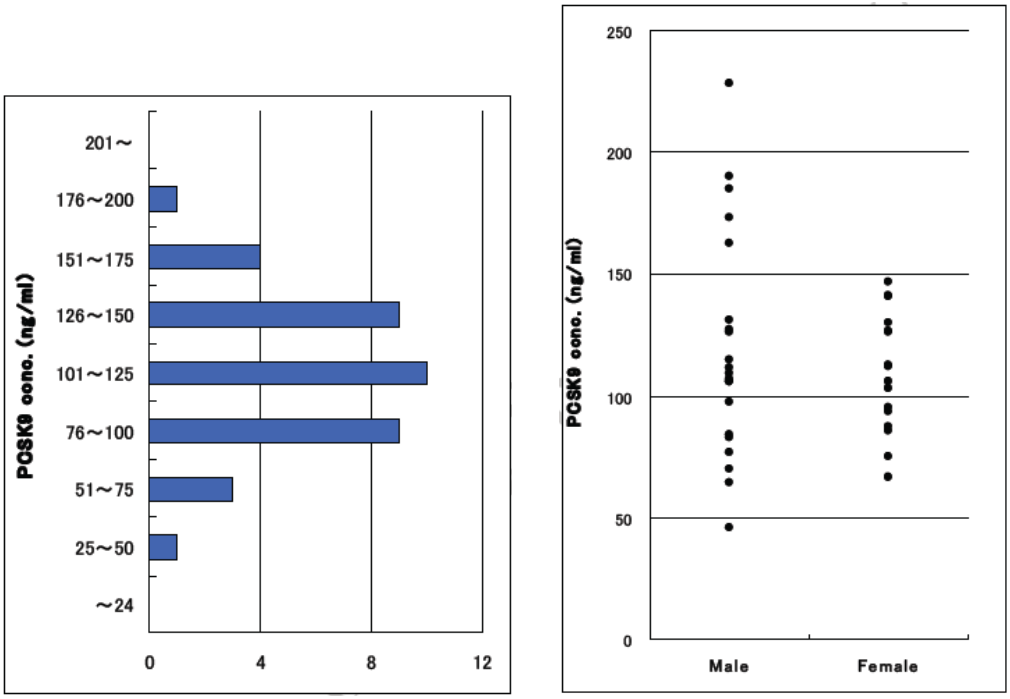


Fig.2 Stability of PCSK9 in Human Serum

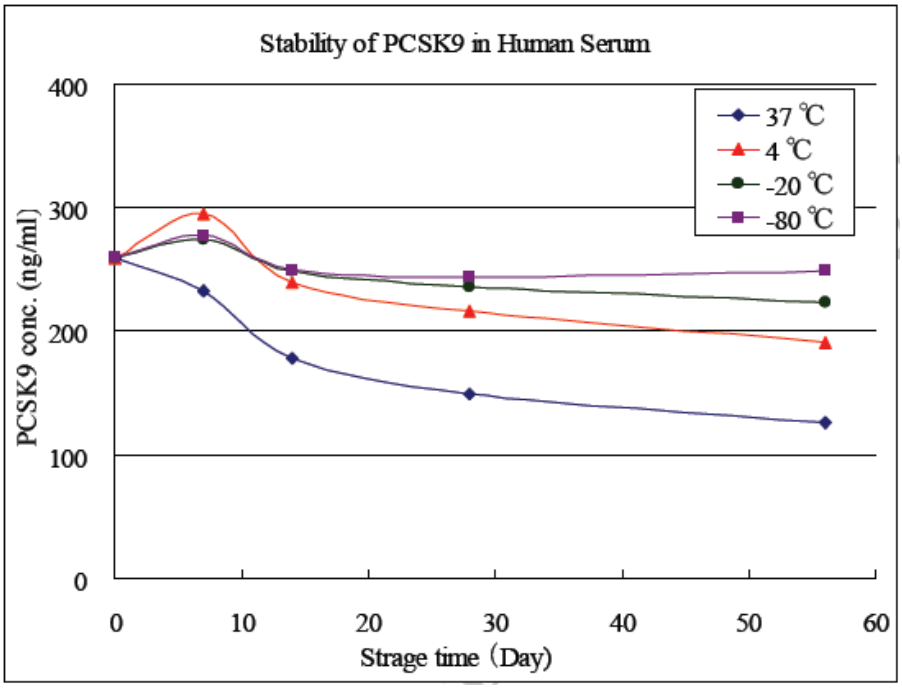


Fig.3 PCSK9 conc. in various conditioned media

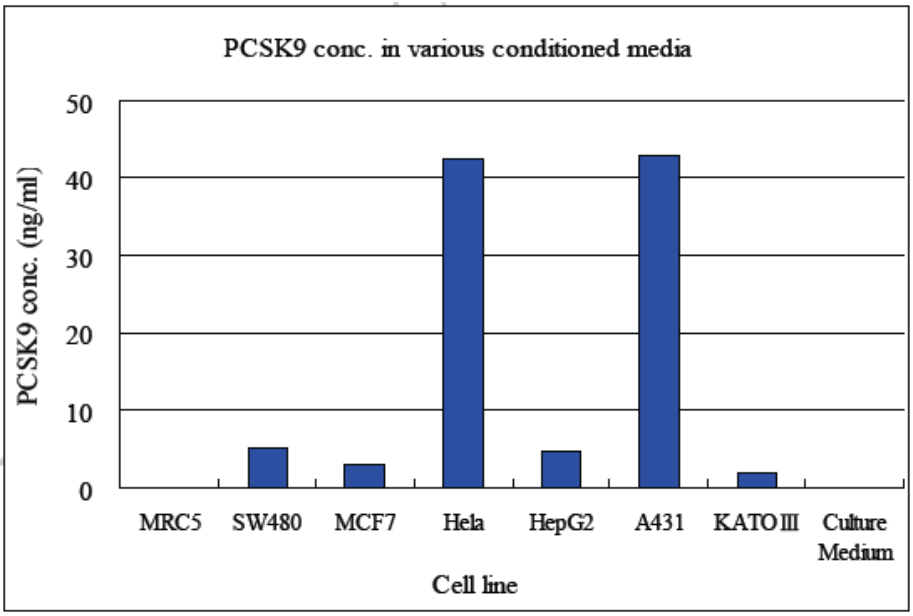
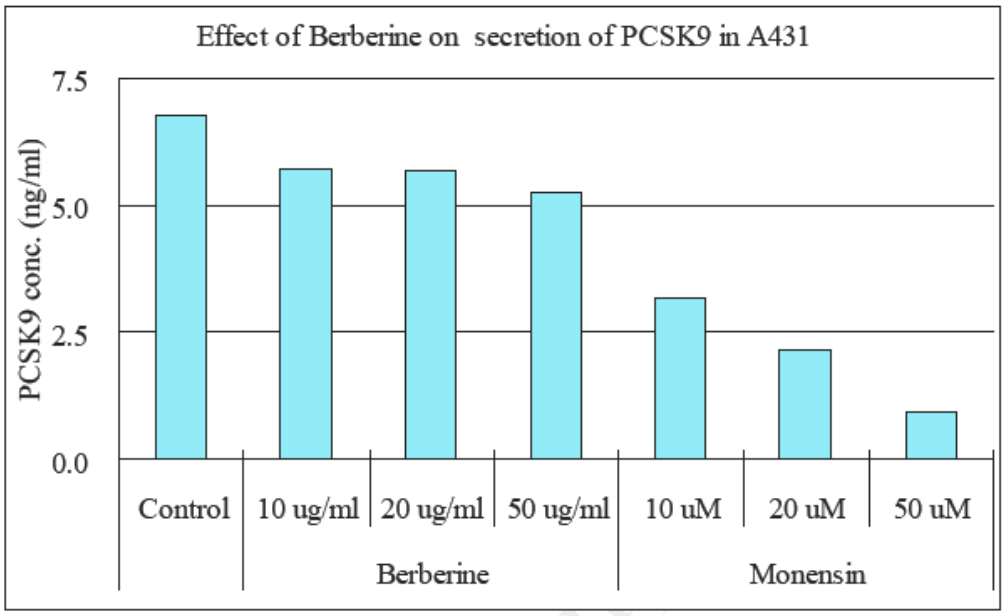
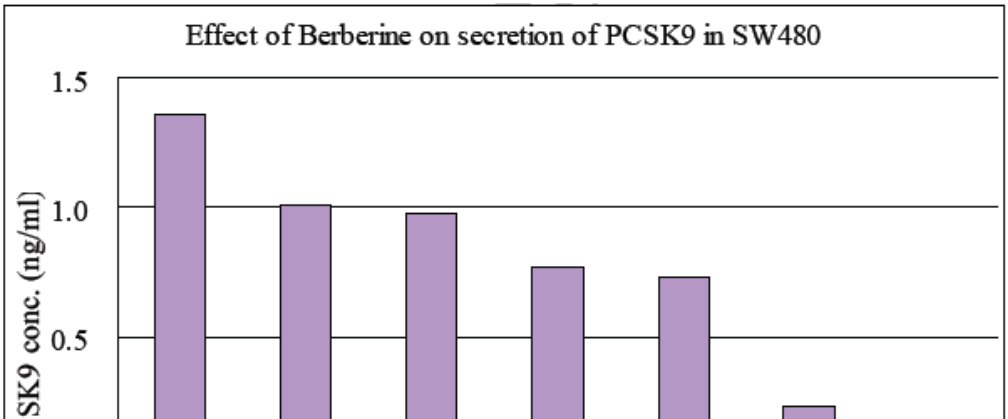


Fig.4 Effect of Berberine on secretion of PCSK9 in A431 and SW480.





References

1. Seidah NG, Benjannet S, Wickham L, Marcinkiewicz J, Jasmin SB, Stifani S, Basak A, Prat A, Chretien M (2003) Proc Natl Acad Sci USA 100:928–933.
2. Abifadel M, Varret M, Rabes JP, Allard D, Ouguerram K, Devillers M, Cruaud C, Benjannet S, Wickham L, Erlich D, et al. (2003) Nat Genet 34:154–156.
3. Leren TP (2004) Clin Genet 65:419–422.
4. Allard D, Amsellem S, Abifadel M, Trillard M, Devillers M, Luc G, Krempf M, Reznik Y, Girardet JP, Fredenrich A, et al. (2005) Hum Mutat 26:497.
5. Cohen JC, Boerwinkle E, Mosley TH, Jr, Hobbs HH (2006) N Engl J Med 354, 1264–1272.
6. Berge KE, Ose L, Leren TP (2006) Arterioscler Thromb Vasc Biol 26:1094–1100.
7. Maxwell KN, Breslow JL (2004) Proc Natl Acad Sci USA 101:7100–7105.
8. Rashid S, Curtis DE, Garuti R, Anderson NN, Bashmakov Y, Ho YK, Hammer RE, Moon YA, Horton JD (2005) Proc Natl Acad Sci USA 102:5374–5379.
9. Lagace, T. A., Curtis, D. E., Garuti, R., McNutt, M. C., Park, S. W., Prather, H. B., Anderson, N. N., Ho, Y. K., Hammer, R. E., and Horton, J. D. (2006) J. Clin. Investig. 116, 2995–3005.
10. Cameron, J., Holla, O. L., Ranheim, T., Kulseth, M. A., Berge, K. E., and Leren, T. P. (2006) Hum. Mol. Genet. 15, 1551–1558.
11. Zhang, D. W., Lagace, T. A., Garuti, R., Zhao, Z., McDonald, M., Horton, J. D., Cohen, J. C., and Hobbs, H. H. (2007) J. Biol. Chem. 282, 18602–18612.