

Collagenase Assay Kit

Catalog # 3001 and 3002

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INTRODUCTION

The collagenases are members of the matrix metalloproteinase (MMP) family and degrade collagen types I, II and III. At least three distinct forms of collagenase (MMP-1, MMP-8 and MMP-13) have been identified. Collagenases are produced by many myeloid and non-myeloid cell types. Increased collagenase has been found in both physiological conditions, such as post-partum uterine tissue and metamorphosis of the tadpole tail, and pathological conditions, such as inflammation and tumor metastasis.

Substrate specificities of these collagenases are almost identical. However, individual collagenases may play different physiological and pathological roles in the turnover of collagen depending on the tissues and cell types. Interestingly, it has been reported that MMP-13 digests type II collagen ten times faster than type I collagen.

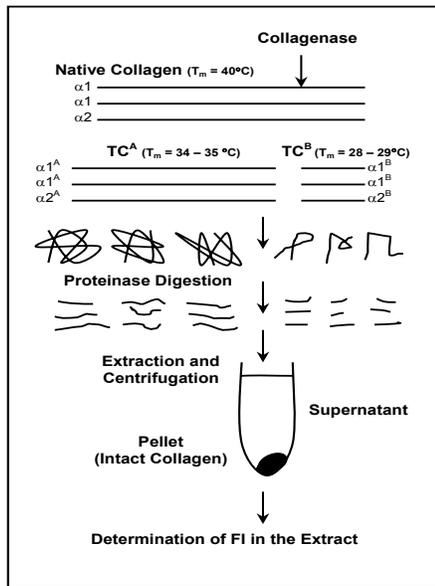
This kit is designed to assay for mammalian collagenase activity within two hours (1) using FITC-labeled telopeptide-free soluble bovine type I collagen (catalog # 3001) or bovine type II collagen (catalog # 3002) as a substrate (2). This assay is ten times faster than that of conventional assay methods using collagen gel as a substrate, and is more sensitive than assays using radioisotope-labeled collagen.

Principle of Rapid Assay Method for Mammalian Collagenase

Mammalian collagenases cleave all three alpha-chains of the collagen molecule, yielding 3/4 and 1/4 collagen fragments, TC^A and TC^B (Figure 1). The denaturation temperature of these fragments is 34-35°C and 28-29°C, respectively, whereas the denaturation temperature of intact collagen is 40°C. Therefore, these cleaved fragments are selectively denatured into a random coil conformation at 35°C which can be extracted with an organic solvent. To shorten the denaturation process, which normally takes 60 minutes (1), a proteinase is used to further digest collagenase-degraded products as shown in Figure 1.

Note: When using FITC-labeled type II collagen as a substrate, denaturation temperature of intact type II collagen and its TC^A fragment is 41°C and 38°C, respectively, and higher than those of type I collagen. Therefore, when type II collagen is used as a substrate, increase the denaturation temperature of collagenase-degradation products from 35°C to 38°C. To shorten the denaturation process as well as assaying collagenase activity using type I collagen as a substrate, add a proteinase such as an Enhancer (elastase) and incubate at 38°C for 20 minutes to digest TC^A and TC^B fragments into smaller fragments (See Collagenase Activity Assay, step 4, page 4).

Figure 1 - Principle of the rapid collagenase assay kit (type I collagen)



This assay consists of four steps:

1. Activation of inactive latent collagenase in sample specimens.
2. Reaction with FITC-labeled soluble collagen for 0-120 minutes.
3. Denaturation and further digestion of the cleaved collagen fragments into smaller fragments.
4. Extraction of the fragments by an organic solvent and determination of the fluorescent intensity (FI) of the extract.

KIT COMPONENTS

Item	Quantity	Amount	Storage
Reference - rec-Human MMP-8	1 vial	25 μ L, 100 units/mL	-80°C
Solution A - FITC-Collagen Dilution Buffer	1 bottle	10 mL	4°C
Solution B - Sample Dilution and Reaction Buffer	1 bottle	50 mL	4°C
FITC-Collagen 2X FITC - Labeled Bovine Type I or Type II Collagen	1 bottle	10 mL, 1 mg/mL in 0.01M acetic acid	-20°C
Activator 1 - 20X APMA (Toxic - Handle With Care)	1 vial	1 mL	RT
Activator 2 - Trypsin	1 vial	1 mg lyophilized	-20°C
Proteinase Inhibitor	1 vial	3 mg lyophilized	-20°C
Enhancer - Elastase	1 vial	1 mg lyophilized	-20°C
Stop Solution - o-Phenanthroline	1 vial	1 mL, 10 mM in ethanol	RT
Extraction Buffer	1 bottle	50 mL	RT
ELISA Plate (Black)	2 each	96-well	RT

Activation of Inactive Collagenase

In general, collagenases are secreted as latent proenzymes and require proteolytic conversion for activation. However, collagenase activity is strictly regulated by tissue inhibitors of metalloproteinase (TIMP) and by α 2 macroglobulin (α 2M) in serum. Thus, different conditions are required for the activation of collagenase depending on the experimental purpose, source of enzyme, and amount of proteinase inhibitors in individual specimens.

The following is a brief description of activation methods of collagenase and is intended to be used as a guideline. See "Tips for Assaying Collagenase Activity" for more detailed information.

1. APMA (4-aminophenylmercuric acetate) is widely used for the activation of latent pro-collagenase (3).
2. Trypsin activates both latent pro-collagenase and collagenase bound by inhibitors such as α 2M and low molecular weight collagenase inhibitors (4, 5). However, soybean trypsin inhibitor (SBTI) must be added to neutralize the added trypsin before assaying collagenase activity.
3. Potassium thiocyanate (KSCN) or potassium iodide (KI) is used to activate collagenase bound by inhibitors such as α 2M (6). These reagents may be useful for denaturing collagenase inhibitors in sample specimens prior to activating procollagenase by APMA (7).
4. Dithiothreitol (DTT) and iodoacetamide have been reported to activate collagenases bound by TIMPs (8). However, these reagents may inactivate collagenase by reducing the S-S bonds and by alkylating glutamic acid at the active site. Therefore, the limitations of this method must be taken into consideration.

SAFETY PRECAUTIONS

Activator 1 (APMA) contains mercury and is very toxic by inhalation, contact with skin or if swallowed. This compound may be irritating to the eyes, respiratory system and skin. Neurological hazard target organs include the kidneys and nerves. Wear suitable protective gloves, clothing, and eyewear.

ASSAY PROCEDURE

Activation of Collagenase

A method to activate collagenase should be chosen depending on the experimental purpose, source of collagenase and the enzyme type to be activated. Pro-collagenase, such as recombinant human neutrophil collagenase, can be activated by either APMA (Activator 1) or trypsin (Activator 2). We recommend selecting one suitable method and optimizing the conditions.

1. Prepare 1.5 mL microcentrifuge tubes for (1) Buffer Alone, (2) 100% Control, (3) Blank, (4) Reference rec-Human MMP-8 and (5) Test Samples as shown on the collagenase assay sheet, page 6.

Note: Proteins in sample specimens may cause quenching, and as a consequence, fluorescent intensity (FI) determined in sample tubes might be underestimated. For example, if the collagenase activity is very low in sample solution which contains a certain amount of contaminant proteins, FI in the samples will be lower than Blank value. In order to avoid this problem, the identical sample mixed with Stop Solution should be added in the Blank tubes and 100% Control tubes. This quenching is mainly caused by the turbidity formed by proteins in the Extraction Buffer. Similarly, color such as red color in cell culture medium also causes quenching. In this case, add the same culture medium to Blank and 100% Control tubes.

2. Add the proper amounts of Solution B, reference rec-Human MMP-8 and test samples to adjust the final volume to 180 μ L as shown on the assay sheet. The buffer tube should only have 380 μ L of Solution B.

Note: The sample volume may be 1-180 μ L. However, the final volume should be adjusted to 180 μ L with Solution B.

3. Activate collagenase with Activator 1 or Activator 2.

To activate collagenase, choose one of the methods described in step 3a OR 3b. In general, it may not be necessary to activate collagenase using a combination of Activator 1 and Activator 2, since the collagenase activated by APMA will be digested and inactivated by trypsin.

APMA-activated collagenase may be inhibited by excess amounts of proteinase inhibitors, such as α 2M, immediately. In these cases, trypsin activation may be more effective than APMA. The trypsin concentration will need to be optimized. Another activation method to consider is to dialyze samples against 3M KSCN dissolved in 0.05M Tris-HCl buffer, pH 7.5, at 4°C overnight. Then, remove the KSCN by dialyzing against 0.05M Tris-HCl buffer, pH 7.8, containing 0.2M NaCl and 5mM CaCl₂.

- a) Add 10 μ L of Activator 1 to the test tubes to be activated with APMA and incubate for 60 minutes at 35°C. **Do not add Activator 1 to undiluted samples, since it is a strong alkaline solution.** OR
- b) Dissolve one vial of trypsin (Activator 2) in 1 mL of Solution B. Add 10 μ L of Activator 2 to the test tubes to be activated with trypsin and incubate for 10 minutes at 35°C.

Note: Trypsin concentration should be optimized for individual samples.

4. Dissolve one vial of proteinase inhibitor in 1 mL of Solution B. Add 10 μ L of proteinase inhibitor into all test tubes to neutralize non-collagenolytic proteinases in sample solutions.

Collagenase Activity Assay

1. Prepare substrate solution by mixing an equal volume of 2X FITC-collagen and Solution A at 4°C (200 μ L of the mixture is required for each sample to be tested) in a container protected from light, such as a dark (amber) colored tube or bottle (FITC is light sensitive).
2. Add 200 μ L of 1X FITC-collagen solution prepared in step 1 into the activated collagenase samples (200 μ L). Mix well and react at 35°C for 10-120 minutes, then denature the FITC-collagen in the 100% control tube by heating in boiling water for 5 minutes.

Note: Incubate reference rec-Human MMP-8 for 60 minutes at 35°C. However, the incubation time will vary depending on the collagenase activity in sample specimens. Do not incubate more than 120 minutes, since the background levels will increase.

3. Stop the collagenase reaction by adding 10 μ L of Stop Solution to each tube and mix well.
4. Dissolve one vial of Enhancer in 1 mL of Solution B. Add 10 μ L of Enhancer to each tube and incubate at 35°C for 10 minutes. This will further digest the collagenase-degradation products into smaller fragment).

Note: If type II collagen is used as a substrate (catalog # 3002), increase the denaturation temperature to 38°C from 35°C. Add 10 μ L of Enhancer to each tube and incubate at 38°C for 20 minutes.

5. Cool samples to room temperature. Add 400 μ L of Extraction Buffer to each tube. Do not use cold buffer. Mix vigorously and centrifuge at 10,000 rpm for 10 minutes.
6. Transfer 100 - 200 μ L of the buffer, 100% control, blank and sample supernatants into the black 96-well plates provided in the kit and determine the fluorescence intensity (FI) at $\lambda_{em} = 520$ nm and $\lambda_{ex} = 490$ nm. Caution: Colored samples such as cell culture media interfere and reduce FI by approximately 5-10%, thus the same culture media must be added to the 100% control tubes.

CALCULATION OF COLLAGENASE ACTIVITY

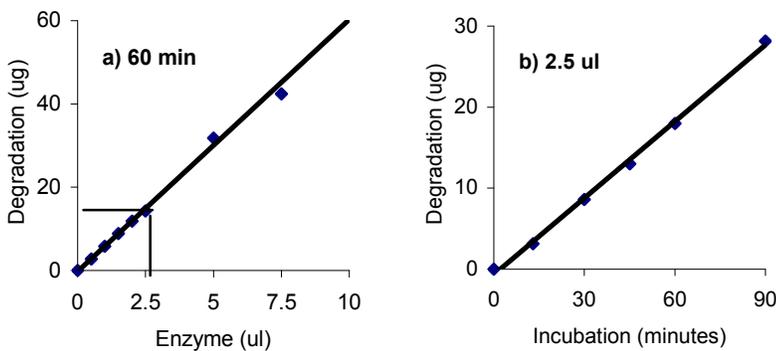
One unit of collagenolytic activity is defined as the cleavage of 1 mg of collagen per minute. Since 100 µg of collagen is used as a substrate per test in this assay kit, collagenolytic activity is calculated by the following equation:

Collagenase Activity (units/mL)

$$= \frac{(FI_{\text{sample}} - FI_{\text{blank}}) \times 100 \mu\text{g}}{(FI_{\text{control}} - FI_{\text{buffer}}) \times \text{Reaction Time (minute)} \times \text{Sample Volume (mL)}}$$

where FI_{buffer} -- FI in buffer alone; FI_{blank} -- FI in blank; FI_{control} -- FI in 100% control; FI_{sample} -- FI in test samples.

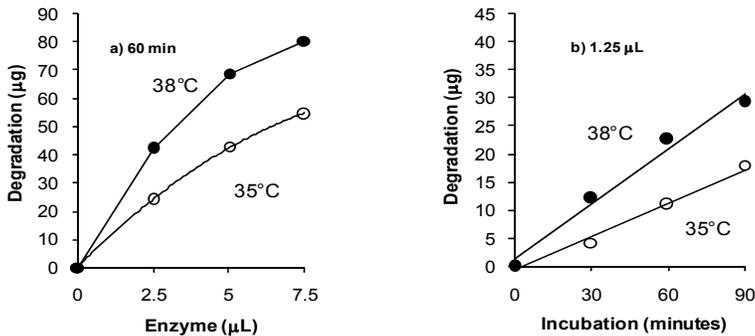
Figure 2 - Standard curve for collagenolytic activity (type I collagen)



a) Dose response curve of MMP-8 using FITC-type I collagen as a substrate - Various amounts (2.5 – 10 µL) of reference rec-MMP-8 (100 units/mL) were reacted with 100 µg of FITC-type I collagen at 35°C for 60 minutes. The reaction mixtures were further incubated at 35°C for 10 minutes after adding 10 µL of Enhancer.

b) Time course curve of MMP-8 using FITC-type I collagen as a substrate - 2.5 µL of MMP-8 (100 units/mL) was reacted with 100 µg of FITC-type I collagen at 35°C for 0 to 90 minutes.

Figure 3 - Standard curve for collagenolytic activity (type II collagen)



a) Dose response curve of MMP-8 using type II collagen as a substrate - Various amounts (2.5-7.5 µL) of reference rec-MMP-8 (100 units/mL) were reacted with 100 µg of FITC-labeled type II collagen for 60 minutes at 35°C and 38°C. The reaction mixtures were further incubated at 38°C for 20 minutes after adding 10 µL of Enhancer.

b) Time course curve of MMP-8 using FITC-type II collagen as a substrate - 1.25 µL of MMP-8 (100 units/mL) was reacted with 100 µg of FITC-type II collagen at 35°C and 38°C for 0 to 90 minutes.

REFERENCES

1. Terato K, Nagai Y, Kawanishi K, Yamamoto S. *Biochimica Biophysica Acta* 445: 753-762 (1976)
2. Terato K, Hashida R, Miyamoto K, et al. *Biomedical Res.* 3: 495-505 (1982)
3. Sellers A, Cartwright E, Murphy G, Reynolds, JJ. *Biochem. J.* 163: 303-307 (1977)
4. Shinkai H, et al. *J. Biochem.* 81: 261-263 (1977)
5. Shinkai H and Nagai Y. *J. Biochem.* 81: 1261-1263 (1977)
6. Abe S and Nagai Y. *Biochimica Biophysica Acta* 278: 125-132 (1972)
7. Murawaki Y, et al. *J. Hepatology* 18: 328-334 (1993)
8. Rajabi MR, Dean DD, Woessner JF. *Obstet. Gynecol.* 159: 971-976 (1988)

Collagenase Assay Sheet

This assay sheet is provided as a guideline. Researchers will need to optimize the assay for their individual needs.

A) Activation

	Buffer	Control (100%)	Blank	Ref 1	Ref 2	Ref 3	Ref 4	Test 1	Test 2
Step 1 Add Reference rhMMP-8 or Test Sample (μL)	0	0	0	2.5	5	7.5	10	100	100
Step 2 Solution B (μL)	380	180	180	177.5	175	172.5	170	80	80
Step 3a Add Activator 1 - APMA (μL)	10	10	10	10	10	10	10	10	10
Incubate at 35°C for 60 minutes OR									
Step 3b Add Activator 2 - Trypsin (μL)	10	10	10	10	10	10	10	10	10
Incubate at 35°C for 10 minutes.									
Step 4 Add Proteinase Inhibitor (μL)	10	10	10	10	10	10	10	10	10
Total Volume (μL)	400	200	200	200	200	200	200	200	200

B) Enzyme Assay - Prepare 1X FITC-collagen solution. Then, add 200 μL of FITC-collagen solution (100 μg of collagen) to the activated enzyme solution.

	Buffer	Control (100%)	Blank	Ref 1	Ref 2	Ref 3	Ref 4	Test 1	Test 2
Activated Enzyme (μL)	400	200	200	200	200	200	200	200	200
Step 5 Add 1X FITC-Collagen (μL)	0	200*	200	200	200	200	200	200	200
React at 35°C (type I substrate) or 38°C (type II substrate) for 0-120 minutes.									
Step 6 Add Stop Solution (μL)	10	10	10	10	10	10	10	10	10
Step 7 Add Enhancer Solution (μL)	10	10	10	10	10	10	10	10	10
Incubate at 35°C (type I substrate) or 38°C (type II substrate) for 10-20 minutes.									
Step 8 Add Extraction Buffer (μL)	400	400	400	400	400	400	400	400	400
Mix well and centrifuge at 10,000 rpm for 5 minutes.									
Transfer 200 μL of supernatant into a 96-well flat bottom black plate.									
Step 9 Determine FI at Em 520/Ex 490	FI _{blank}	FI _{control} = 100 μg collagen	FI ₍₀₎	FI _(2.5)	FI ₍₅₎	FI _(7.5)	FI ₍₁₀₎	FI _(test 1)	FI _(test 2)
Calculate collagenase activity by comparing FI _{test} and FI _{control} *									