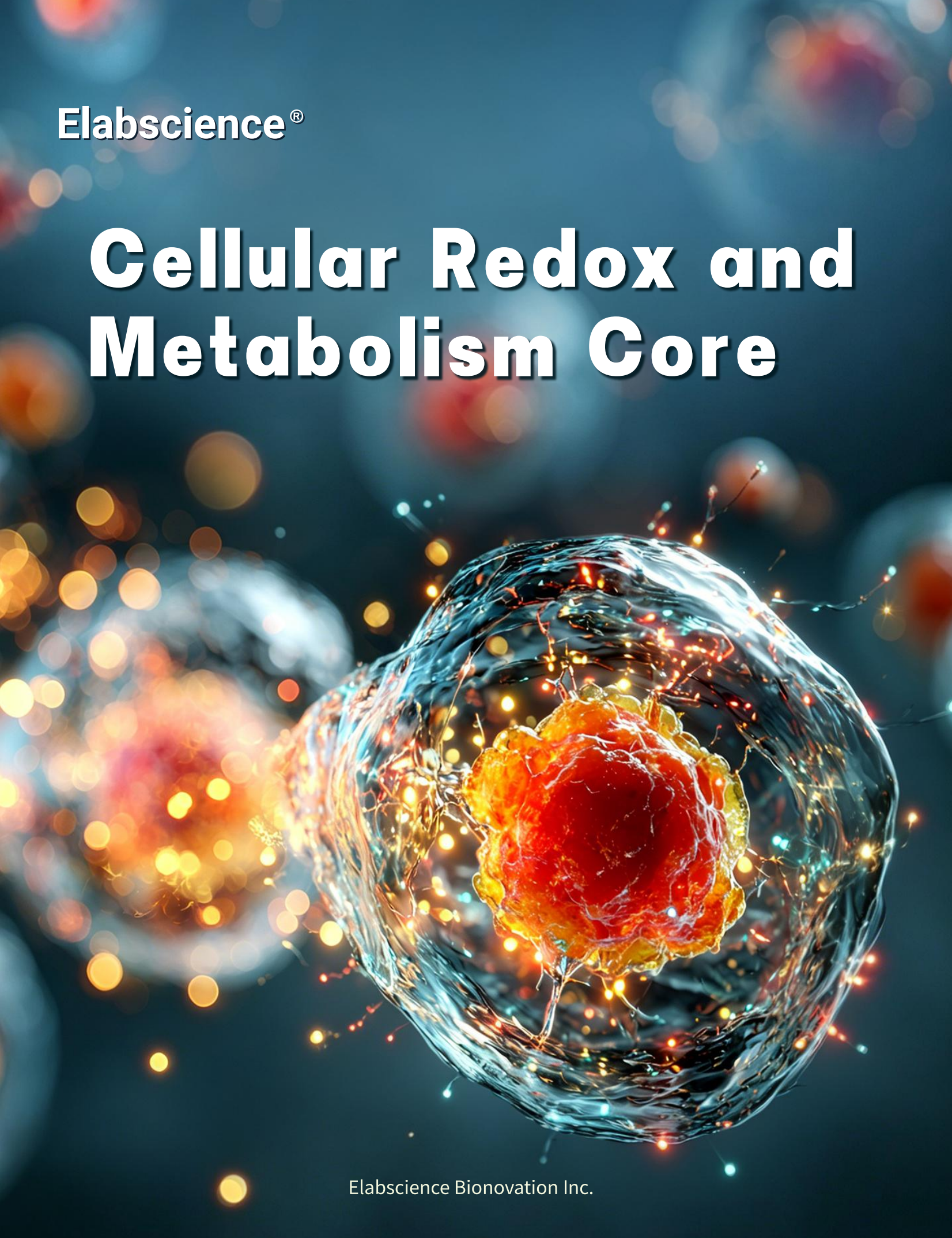
Elabscience®

Cellular Redox and Metabolism Core



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01 Oxidative Stress

Introduction

Oxidative stress arises when the production of reactive oxygen species (ROS) exceeds the cellular antioxidant defense capacity, disrupting redox homeostasis.

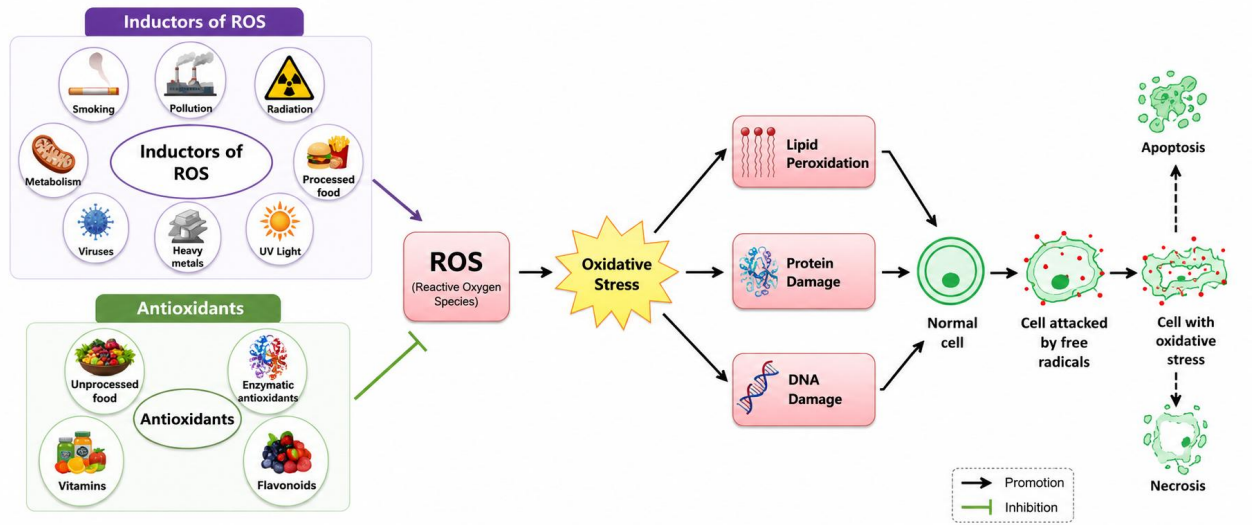


Figure 1. ROS-driven oxidative stress and antioxidant defense mechanisms.

Controlled ROS generation plays essential roles in cell signaling, proliferation, and immune responses. Excessive ROS accumulation can trigger oxidative damage to lipids, proteins, and nucleic acids. This imbalance is increasingly recognized as a key driver of aging and the pathogenesis of numerous diseases, making oxidative stress a central focus of modern biomedical research.

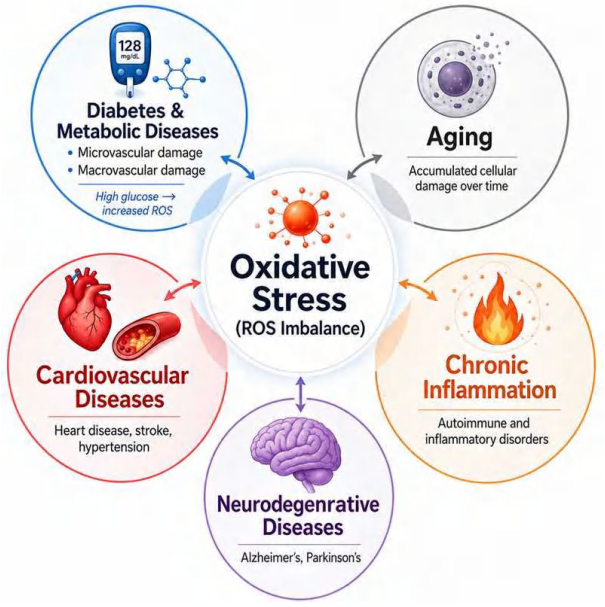


Figure 2. Oxidative stress causes chronic diseases.

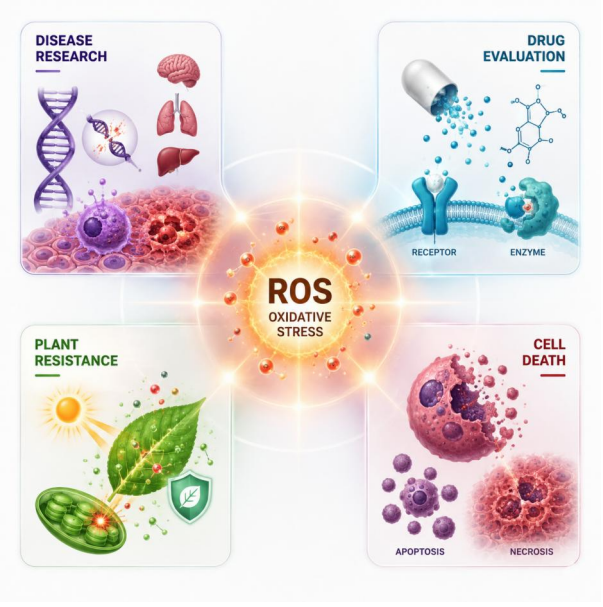


Figure 3. Integrated oxidative stress assay applications

Oxidative Stress Assay

When cells undergo oxidative stress, their redox balance shifts, oxidant production rises while antioxidant defenses decline. This imbalance can be evaluated by measuring reactive oxygen species (ROS), lipid peroxidation products, and antioxidant capacity, providing a direct readout of cellular oxidative status.
Elabscience® offers a focused portfolio of oxidative stress kits for precise quantification of key biomarkers, including reactive oxygen species (ROS), catalase (CAT), and lipid peroxides (MDA), enabling reliable and reproducible assessment of oxidative dynamics across biological systems.

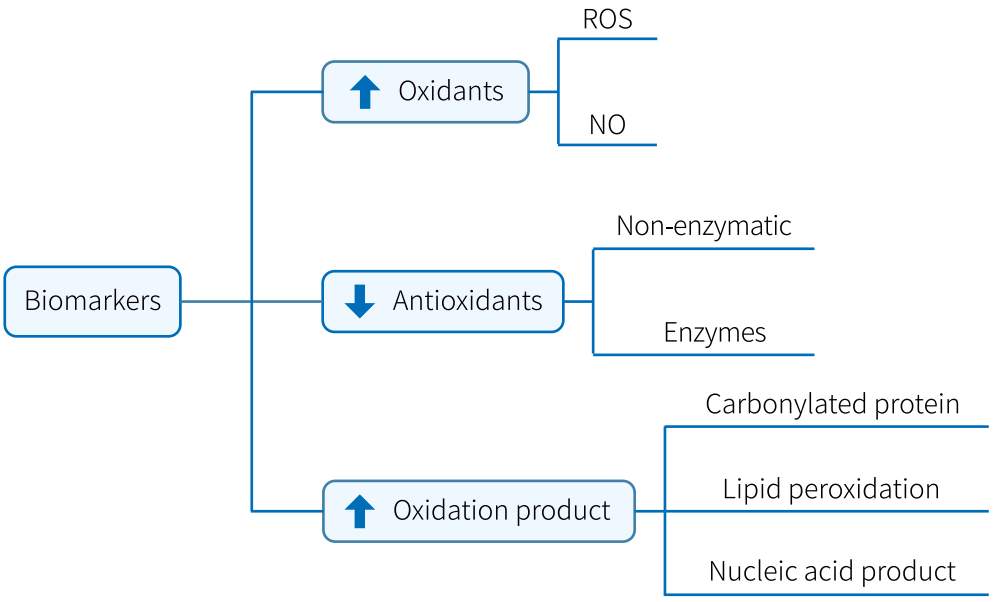


Figure 4. Molecular hallmarks of oxidative stress and redox imbalance

Reactive Oxygen Species

Reactive Oxygen Species (ROS) are highly reactive metabolites formed in the process of metabolism, such as oxygen free radicals and hydrogen peroxide. At controlled levels, they support key biological signaling; when excessive, they disrupt redox balance and drive oxidative stress. ROS and related oxidative stress biomarkers are therefore commonly used to assess oxidative status.

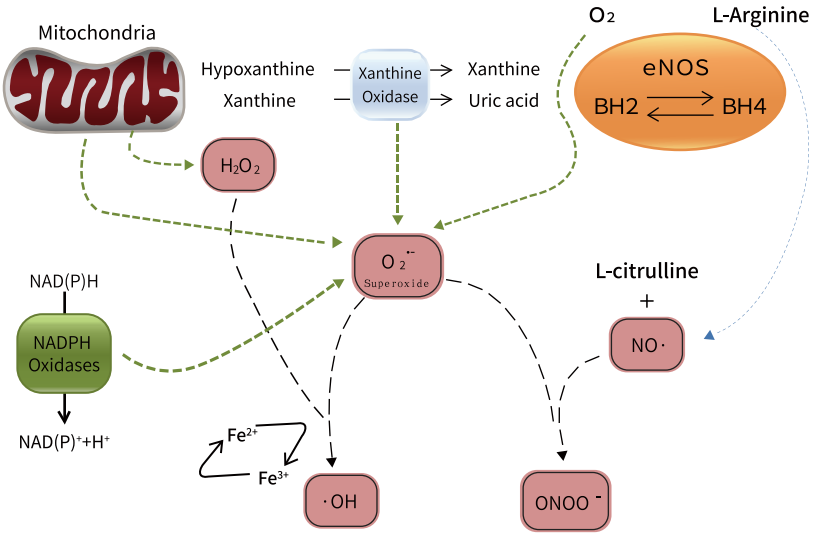


Figure 5. Mechanisms of cellular ROS generation

Table 1. Tools for Reactive Oxygen Species Analysis

Target	Product Name	Cat. No.
Arginase	Arginase Activity Colorimetric Assay Kit	E-BC-K848-M
CPR	Cytochrome P450 Reductase (CPR) Activity Assay Kit	E-BC-K808-M
H_2O_2	Hydrogen Peroxide (H_2O_2) Colorimetric Assay Kit	E-BC-K102-M
	Hydrogen Peroxide (H_2O_2) Fluorometric Assay Kit	E-BC-F001
	Hydrogen Peroxide (H_2O_2) Colorimetric Assay Kit	E-BC-K102-S
Hydroxyl Free Radical	Hydroxyl Free Radical Scavenging Capacity Assay Kit	E-BC-K527-M
	Hydroxyl Free Radical Scavenging Capacity Colorimetric Assay Kit (Fenton Method)	E-BC-K042-M
Mitochondrial Superoxide	Mitochondrial Superoxide Fluorometric Assay Kit	E-BC-F008
NAO	HOT! NADPH Oxidase (NAO) Activity Colorimetric Assay Kit	E-BC-K815-M
Nitrite	Nitrite Colorimetric Assay Kit	E-BC-K070-S
NO	HOT! Nitric Oxide (NO) Colorimetric Assay Kit	E-BC-K035-M
	Nitric Oxide (NO) Colorimetric Assay Kit (Nitrate Reductase Method)	E-BC-K135-M
	Nitric Oxide (NO) Colorimetric Assay Kit	E-BC-K035-S
	HOT! Nitric Oxide (NO) Colorimetric Assay Kit	E-BC-K817-M
	Nitric Oxide (NO) Fluorometric Assay Kit	E-BC-F021
NOX	NADH Oxidase (NOX) Activity Assay Kit	E-BC-K806-M
ROS	HOT! Reactive Oxygen Species (ROS Fluorometric Assay Kit (Green)	E-BC-K138-F
	Reactive Oxygen Species (ROS) Fluorometric Assay Kit (Red)	E-BC-F005
Singlet Oxygen	Singlet Oxygen($^1O_2$) Fluorometric Assay Kit	E-BC-F062
Superoxide Anion	Inhibition And Production of Superoxide Anionic Colorimetric Assay Kit (WST-1 Method)	E-BC-K001-M
TOS	HOT! Total Oxidant Status (TOS) Colorimetric Assay Kit	E-BC-K802-M
XOD	Xanthine Oxidase (XOD) Activity Assay Kit	E-BC-K805-M
	HOT! Xanthine Oxidase (XOD) Activity Fluorometric Assay Kit	E-BC-F019

Product Performance

Total Oxidant Status (TOS) Colorimetric Assay Kit (E-BC-K802-M)

Features

① Minimal Sample Input: Only 20 μL of sample

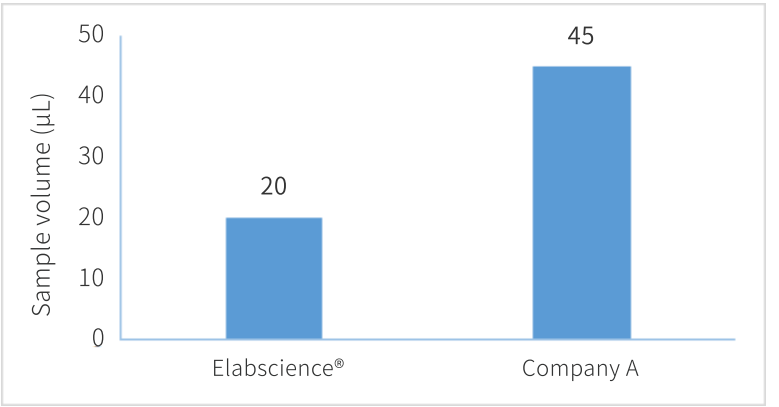


Figure 6. Sample volume comparison between Elabscience® and company A

② Rapid Reaction Kinetics: only 5 minutes

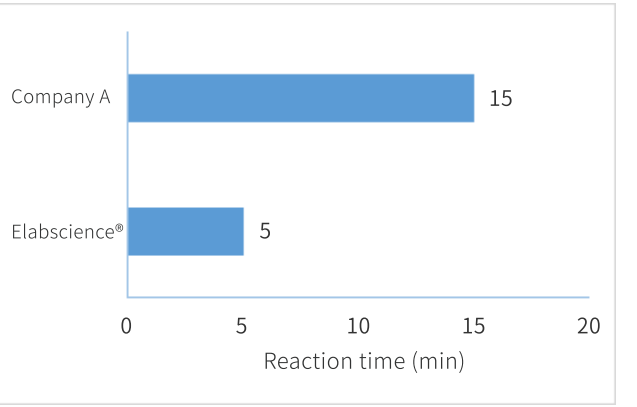


Figure 7. Reaction time comparison between Elabscience® and company A

③ Research Applications

Investigating Age-Related Decline

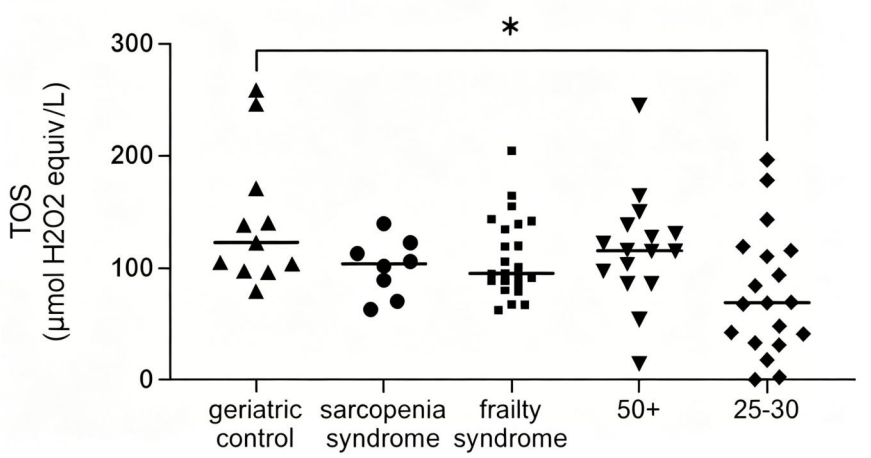


Figure 8. Comparison of total oxidant status among five study groups

- **Sample type:** Human serum
- **Result:** Aged 50+ has shown significantly higher TOS values in geriatric control compared to healthy control patients aged 25-30 years old.
- **Reference:** Kmiołek T, Filipowicz G, Bogucka D, et al. Aging and the impact of global DNA methylation, telomere shortening, and total oxidative status on sarcopenia and frailty syndrome. *Immunity & Ageing*, 2023, 20(1): 61. IF:7.9

Antioxidant Capacity

There are multiple antioxidant mechanisms within living organisms that maintain redox homeostasis. This antioxidant mechanism can be broadly classified as enzymatic antioxidants and non-enzymatic antioxidants. Measuring the activity of antioxidant enzymes, including superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase, as well as the levels of non-enzymatic antioxidants such as glutathione and vitamins, provides valuable information for evaluating oxidative stress status.

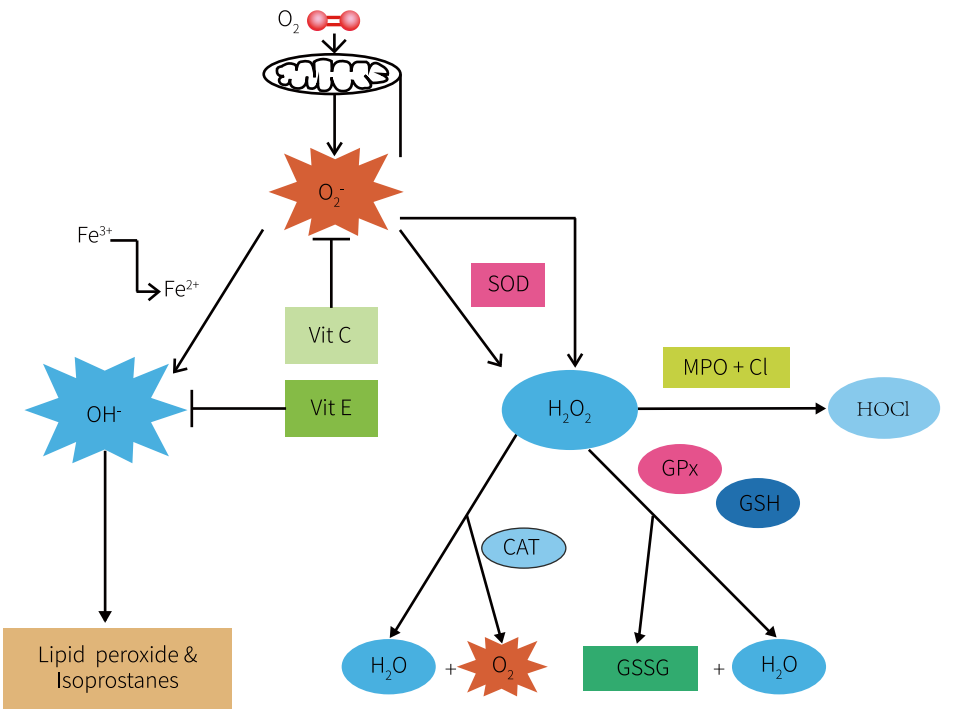


Figure 9. ROS scavenging mechanisms

Table 2. Tools for Antioxidant Activity Analysis

Target	Product Name	Cat. No.
APX	Ascorbate Peroxidase (APX) Activity Assay Kit	E-BC-K353-S
ARKs	Aldo-Keto Reductase (ARKs) Activity Assay Kit	E-BC-K810-M
ATPase	ATPase Activity Assay Kit	E-BC-K831-M
Catalase	Catalase (CAT) Activity Assay Kit	E-BC-K031-M
	Catalase (CAT) Activity Fluorometric Assay Kit	E-BC-F006
CBS	Cystathionine-β-synthase (CBS) Activity Colorimetric Assay Kit	E-BC-K811-M
Citrate	Citrate Fluorometric Assay Kit	E-BC-F153
Coenzyme Q10	Coenzyme Q10 (CoQ10) Colorimetric Assay Kit	E-BC-K885-M
CuZn-SOD/Mn-SOD	CuZn/Mn Superoxide Dismutase (CuZn-SOD/Mn-SOD) Activity Assay Kit (Hydroxylamine Method)	E-BC-K022-M
GPX4	Glutathione Peroxidase 4 (GPX4) Activity Assay Kit	E-BC-K883-M
GR	Glutathione Reductase (GR) Activity Assay Kit	E-BC-K099-M
GSH	Reduced Glutathione (GSH) Colorimetric Assay Kit	E-BC-K030-M
	Total Glutathione (T-GSH) And Reduced Glutathione (GSH) Fluorometric Assay Kit	E-BC-F045
GSH/GSSG	Total Glutathione (T-GSH)/Oxidized Glutathione (GSSG) Colorimetric Assay Kit	E-BC-K097-M
GSH-Px	Glutathione Peroxidase (GSH-Px) Activity Assay Kit	E-BC-K096-M
	Cell Glutathione Peroxidase (GPX) Activity Assay Kit	E-BC-K809-M
GST	Glutathione-S-Transferase (GST) Activity Assay Kit (DTNB Method)	E-BC-K800-M
H2S	Cell Hydrogen Sulfide (H2S) Fluorometric Assay Kit	E-BC-F103
MPO	Myeloperoxidase (MPO) Activity Assay Kit	E-BC-K074-M
	Myeloperoxidase (MPO) Peroxidation Activity Fluorometric Assay Kit	E-BC-F013
Na+/K+-ATPase	Na+k+-ATPase Activity Assay Kit	E-BC-K539-M
NAD+/NADH	NAD+/NADH Colorimetric Assay Kit (WST-8)	E-BC-K804-M
NADP+/NADPH	NADP+/NADPH Colorimetric Assay Kit (WST-8)	E-BC-K803-M
NADPH	NADPH Fluorometric Assay Kit	E-BC-F170
Plant Flavonoids	Plant Flavonoids Colorimetric Assay Kit	E-BC-K284-M
POD	Peroxidase (POD) Activity Assay Kit (Plant samples)	E-BC-K227-M
	Peroxidase (POD) Activity Fluorometric Assay Kit	E-BC-F012
SOD	Total Superoxide Dismutase (T-SOD) Activity Assay Kit (WST-1 Method)	E-BC-K020-M
	Total Superoxide Dismutase (T-SOD) Activity Assay Kit (Hydroxylamine Method)	E-BC-K019-S
	Total Superoxide Dismutase (T-SOD) Activity Assay Kit (Hydroxylamine Method)	E-BC-K019-M
T-AOC	Total Antioxidant Capacity (T-AOC) Colorimetric Assay Kit	E-BC-K136-M
	Total Antioxidant Capacity (T-AOC) Colorimetric Assay Kit (ABTS, Enzyme Method)	E-BC-K219-M
	Total Antioxidant Capacity (T-AOC) Colorimetric Assay Kit	E-BC-K136-S
	Total Antioxidant Capacity (T-AOC) Colorimetric Assay Kit (FRAP Method)	E-BC-K225-M
	Total Antioxidant Capacity (T-AOC) Colorimetric Assay Kit (ABTS, Chemical Method)	E-BC-K271-M
	DPPH Free Radical Scavenging Capacity Colorimetric Assay Kit	E-BC-K807-M
TAS	Total Antioxidant Status (TAS) Colorimetric Assay Kit	E-BC-K801-M
Total Phenols	Total Phenols Colorimetric Assay Kit (Plant samples)	E-BC-K354-S
	Total Phenols Colorimetric Assay Kit (Plant samples)	E-BC-K354-M
Total Thiol	Total Sulfhydryl Group/Total Thiol (-SH) Colorimetric Assay Kit	E-BC-K265-M
TrxR	Thioredoxin Reductase (TrxR) Activity Assay Kit	E-BC-K548-M
Vitamin C	Vitamin C (VC) Colorimetric Assay Kit	E-BC-K034-M
	Vitamin C (VC) Colorimetric Assay Kit	E-BC-K034-S
Vitamin E	Vitamin E (VE) Colorimetric Assay Kit	E-BC-K033-S
	Vitamin E (VE) Colorimetric Assay Kit	E-BC-K033-M

Product Performance

Glutathione Peroxidase 4 (GPX4) Activity Assay Kit (E-BC-K883-M)

GPX4 is a member of glutathione peroxidase family, that reduces lipid hydroperoxide to non-toxic fatty alcohol, has the ability of antioxidation. GPX4 is a key regulator of ferroptosis.

Features

① Enhanced Performance: high specificity and recovery

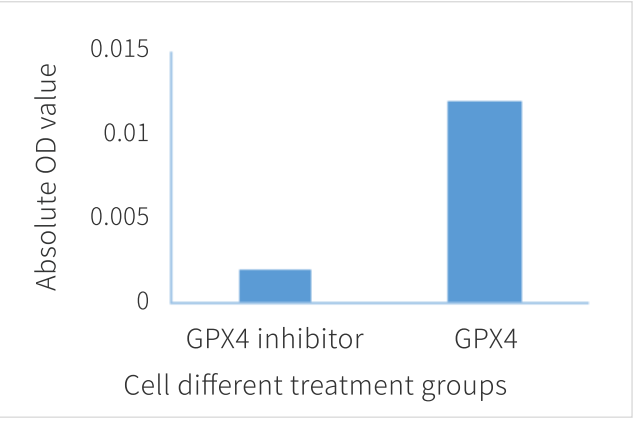


Figure 10. Specificity assessment using a GPX4 inhibitor-based assay.

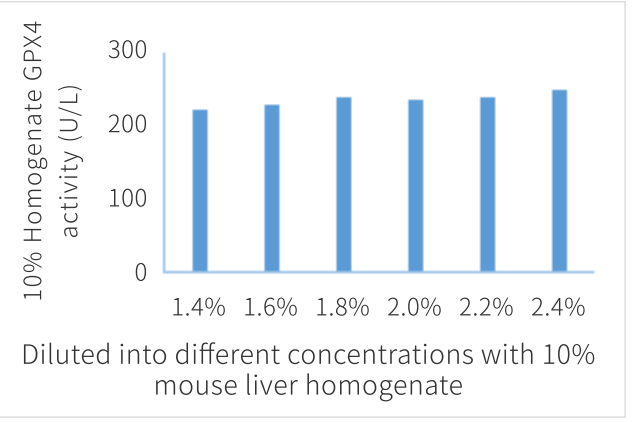


Figure 11. Sample dilution recovery demonstrating 95–100% recovery.

② Sample type: serum, cells and tissues

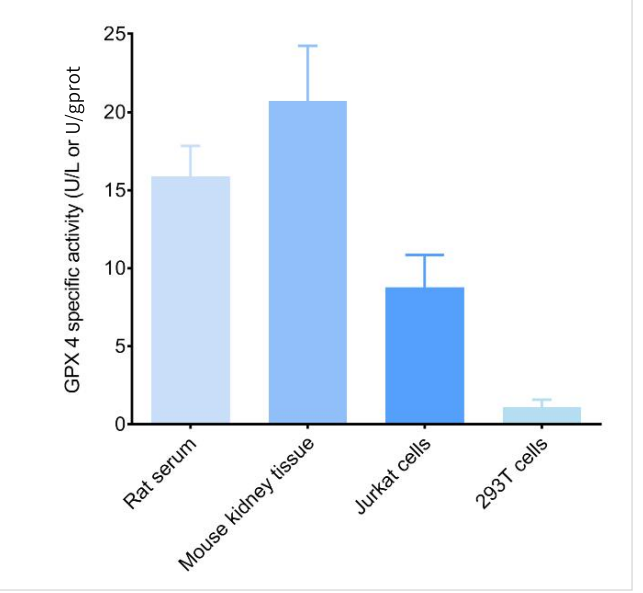


Figure 12. Sample validation in diluted rat serum (2-fold dilution), 10% mouse kidney tissue homogenate (protein concentration: 5.492 g prot./L), 2.7 × 10^6 Jurkat cell homogenate (protein concentration: 0.639 g prot./L), and 2.03 × 10^6 293T cell homogenate (protein concentration: 1.635 g prot./L).

Oxidation Products

Lipid Peroxidation

Lipid peroxidation emerges when reactive oxygen species (ROS) attack lipid carbon–carbon double bonds, initiating a cascading oxidative process that generates reactive aldehydes such as malondialdehyde (MDA) and 4-hydroxynonenal (HNE). These products amplify damage across membranes, disrupting lipid organization, altering permeability and fluidity, and progressively compromising cellular structure and function.

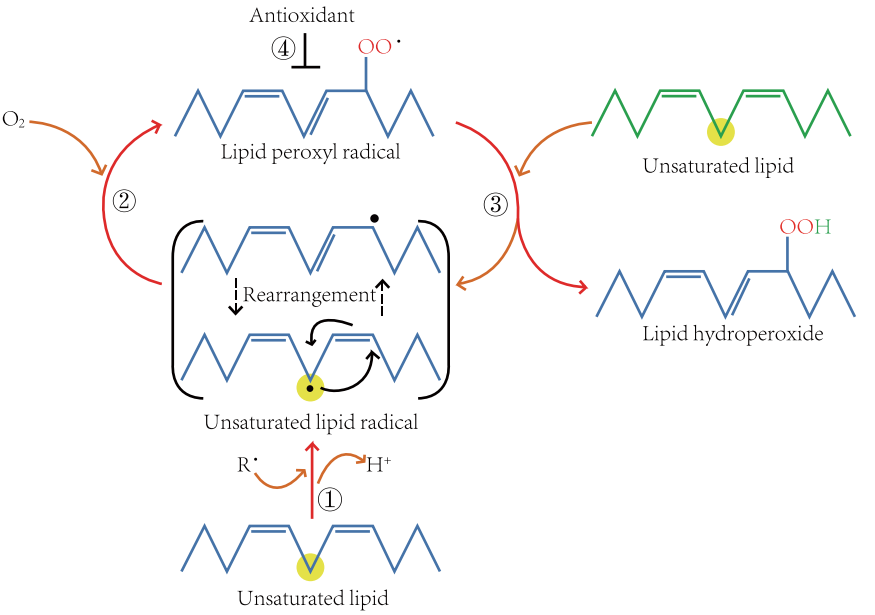


Figure 13. Mechanistic cascade of lipid peroxidation driven by ROS-mediated membrane lipid oxidation.

Table 3. Tools for Lipid Peroxidation Analysis

Target	Product Name	Cat. No.
LPO	Lipid Peroxide (LPO) Colorimetric Assay Kit	E-BC-K176-M
	Lipid Peroxide (LPO) Fluorometric Assay Kit	E-BC-F003
MDA	Malondialdehyde (MDA) Colorimetric Assay Kit (TBA Method)	E-BC-K025-M
	Malondialdehyde (MDA) Colorimetric Assay Kit (TBA Method)	E-BC-K025-S
	Malondialdehyde (MDA) Colorimetric Assay Kit (Plant Samples)	E-BC-K027-M
	Malondialdehyde (MDA) Fluorometric Assay Kit	E-BC-F007
	Enhanced Cell Malondialdehyde (MDA) Colorimetric Assay Kit	E-BC-K814-M
TBARS	Thiobarbituric Acid Reactants (TBARS) Colorimetric Assay Kit	E-BC-K298-M
	Thiobarbituric Acid Reactants (TBARS) Colorimetric Assay Kit	E-BC-K298-F

Product Performance

Lipid Peroxide (LPO) Fluorometric Assay Kit (E-BC-F003)

Lipid peroxidation (LPO) arises when ROS attack polyunsaturated fatty acids. C11-BODIPY 581/591 (C11) is widely used for LPO detection. Under normal conditions it emits a red fluorescence signal; as peroxidation progresses, its spectral profile shifts from red to green providing a clear, visual readout of oxidative membrane dynamics and cellular stress evolution.

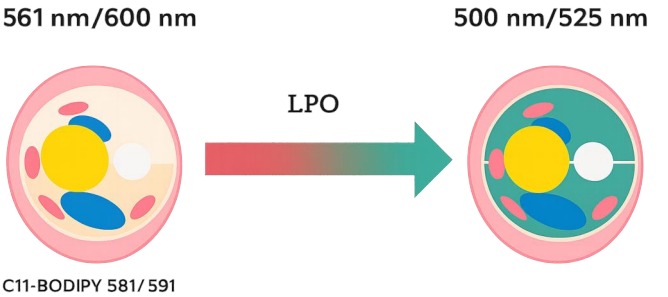


Figure 14. Multichannel fluorescence imaging illustrating wavelength-dependent emission changes in a single cell.

Features

① High sensitivity: suitable for cell sample

Compatible instruments: Fluorescence microplate reader, Fluorescence microscope, Flow cytometry.

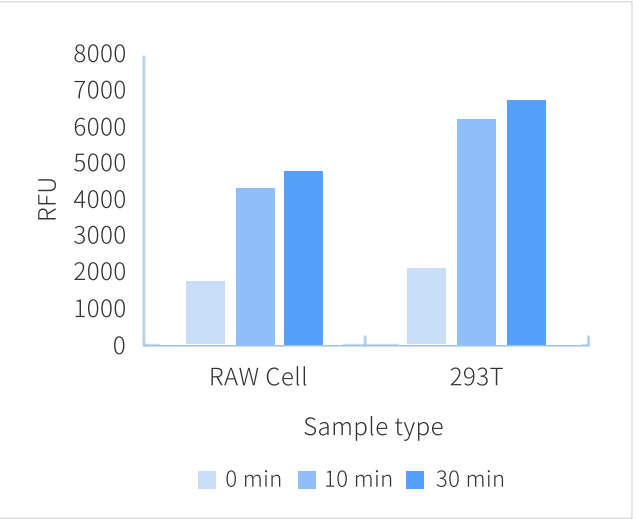


Figure 15. Microplate-based fluorescence assay

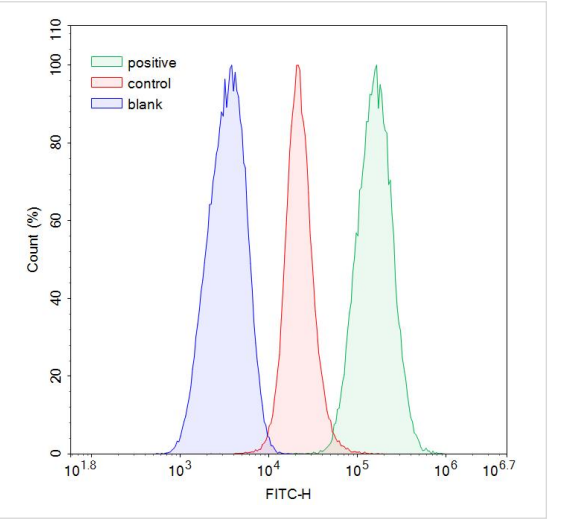


Figure 16. Flow cytometry assay

Protein Oxidation

Reactive oxygen species such as H_2O_2 and superoxide ($O_2^{\bullet-}$) can oxidatively modify amino acid side chains, leading to the formation of carbonylated proteins. As one of the most stable and widely recognized hallmarks of oxidative damage, protein carbonylation serves as a powerful biomarker of oxidative stress, enabling precise assessment of protein oxidation and cellular damage.

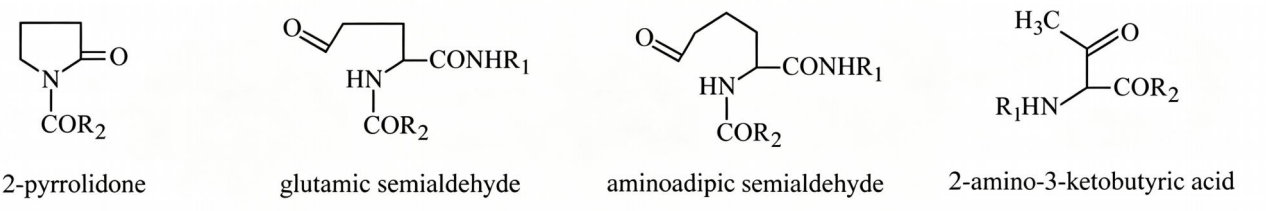


Figure 17. Carbonyl derivative structures produced by direct oxidation of amino acid side chains

Table 4. Tools for Protein Oxidation Analysis

Target	Product Name	Cat. No.
Protein Carbonyl	Protein Carbonyl Colorimetric Assay Kit	E-BC-K117-M
	Protein Carbonyl Colorimetric Assay Kit	E-BC-K117-S
Protein Thiol	Protein Thiol Colorimetric Assay Kit	E-BC-K1403-M

Product Performance

Protein Carbonyl Colorimetric Assay Kit (E-BC-K117-M)

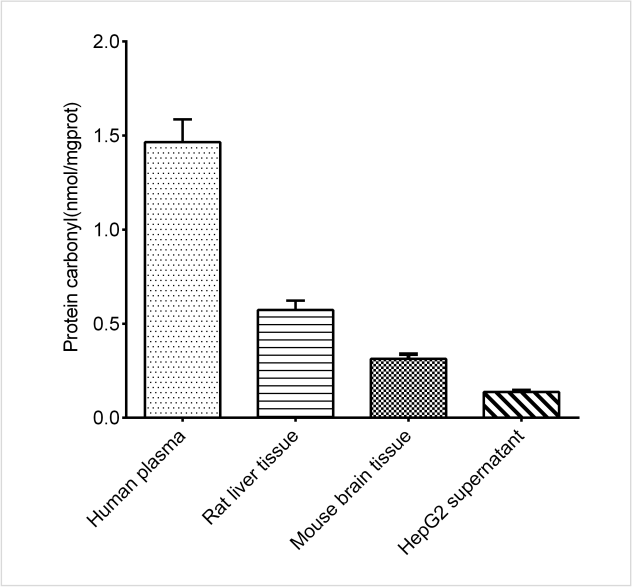


Figure 18. Validation across diverse sample types, including 10-fold diluted human plasma (0.43 mg prot./mL), 2-fold diluted 10% rat liver tissue homogenate (0.29 mg prot./mL), 10% mouse brain tissue homogenate (0.23 mg prot./mL), and HepG2 cell supernatant (0.35 mg prot./mL).

02 Building Reliable Results Through Proper Sample Preparation

Reliable metabolic insights begin with high-quality sample preparation. Proper collection, handling, and processing are essential for preserving metabolic integrity and enabling accurate measurement of key biomarkers involved in cellular energy production, utilization, and regulation.

Serum

Allow freshly collected blood to clot at 25°C for 30 minutes, then centrifuge at 2,000 × g for 15 minutes at 4°C. Carefully collect the upper light-yellow serum layer and keep on ice. For delayed analysis, store at -80°C for up to 1 month.

Plasma

Collect blood using heparin anticoagulant (10–12.5 IU/mL) and centrifuge at 700–1,000 × g for 10 minutes at 4°C. Carefully collect the plasma layer while avoiding the buffy coat containing leukocytes and platelets. Keep on ice or store at -80°C for up to 1 month.

Urine

Centrifuge fresh urine at 10,000 × g for 15 minutes at 4°C. Use the clarified supernatant for analysis. Samples may be stored at -80°C for up to 1 month.

Saliva

Rinse the mouth thoroughly with water before collection. After 30 minutes, collect saliva and centrifuge at 10,000 × g for 5 minutes at 4°C. Use the supernatant directly or store at -80°C for future analysis.

Tissue Homogenates (10%)

Wash 0.02–1 g of fresh tissue with cold homogenization buffer, blot dry, and record the weight. Add ice-cold homogenization medium at a 9:1 ratio (9 mL buffer per 1 g tissue), then homogenize thoroughly. Centrifuge at 10,000 × g for 10 minutes at 4°C and collect the supernatant on ice. Protein concentration is recommended for normalization. Intact tissues may be stored at -80°C for up to 1 month.

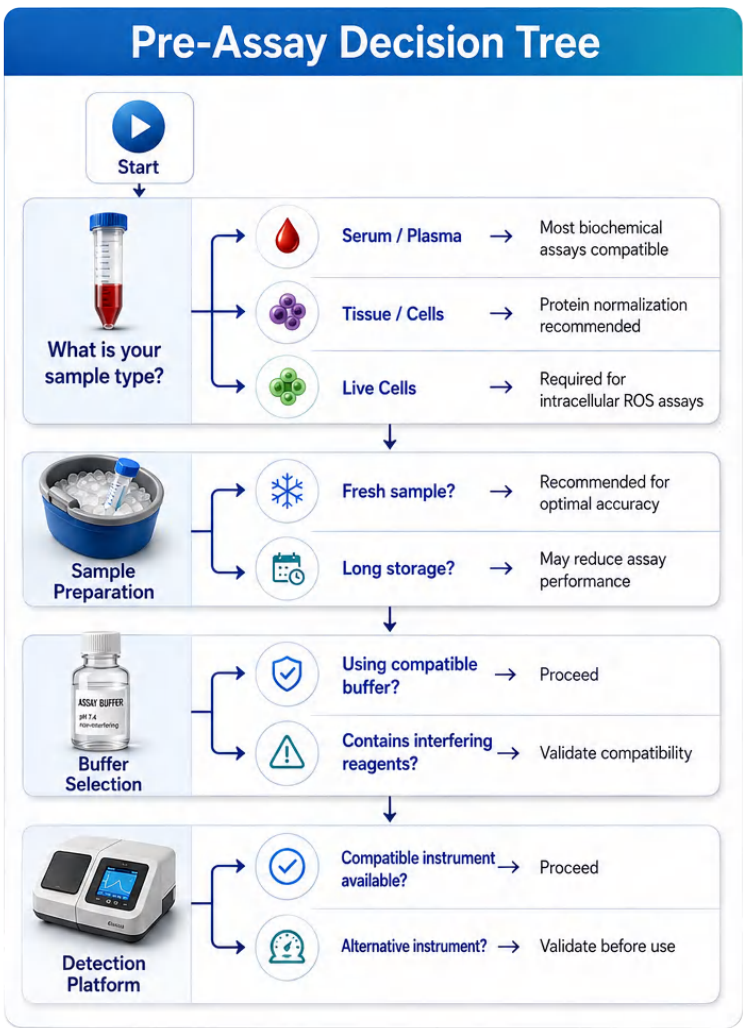
Cell Samples

Suspension Cells: Pellet cells at 1,000–2,000 × g for 10 minutes at 4°C and wash once with cold PBS. Add 200–400 µL ice-cold homogenization buffer per 10^6 cells and homogenize until fully lysed. Centrifuge at 10,000 × g for 10 minutes at 4°C and collect the supernatant.

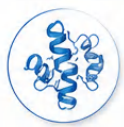
Adherent Cells: Remove culture medium, wash with PBS, and harvest cells by scraping (avoid trypsin or EDTA). Resuspend in PBS and process using the suspension cell workflow. Intact cell pellets may be stored at -80°C for up to 1 month.

03 Experimental Best Practices for Popular Oxidative Stress Assays

Pre-Assay Decision Tree



Critical Technical Alerts



Protein Quantification

Use Bradford assay when buffers contain Tris-HCl or EDTA.
BCA assay is suitable for PBS or normal saline.

Sample Type Compatibility

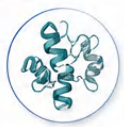
Select assay kits according to sample type.
Not all kits support serum, plasma, tissue, cells, and plants equally.

ROS Detection

Intracellular ROS assays require live cells or fresh tissue prepared as single-cell suspension.

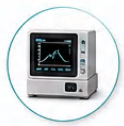
MDA Analysis

Low OD values may result from low sample concentration or prolonged storage.
Fresh samples are recommended.



Enzyme Activity Assays

Avoid detergent-containing lysis buffers such as SDS or NP-40.
Protease inhibitors are generally not recommended.



Instrument Compatibility

UV spectrophotometer-based assays may not perform equivalently on microplate readers without validation.

04 Oxidative Stress Publication Trends

Publication Information	Target	Cat. No.
Li W, Liu X, Yuan X, Zhou Y, et al. Inhibin beta A drives colorectal cancer progression through macrophage M2 polarization and mitochondria-dependent ferroptosis suppression. *Signal Transduction and Targeted Therapy*, 2025.	GPX4	E-BC-K883-M
	GSH	E-BC-K030-M
Duan C, Yu M, Sun J, et al. Photodynamic gel-bombs enhance tumor penetration and downstream synergistic therapies. *Signal Transduction and Targeted Therapy*, 2025; 10: 94.	ROS	E-BC-K138-F
Talukdar PD, Pramanik K, Gatti P, et al. Precise targeting of transcriptional co-activators YAP/TAZ annihilates chemoresistant brCSCs by alteration of their mitochondrial homeostasis. *Signal Transduction and Targeted Therapy* 2025 ; 10(1): 61.	SOD	E-BC-K020-M
	GSH	E-BC-K030-M
Zhang Y, Jing Y, He J, et al. Bile acid receptor FXR promotes intestinal epithelial ferroptosis and subsequent ILC3 dysfunction in neonatal necrotizing enterocolitis. *Immunity* 2025 ; 58(3): 683-700.e10.	LPO	E-BC-K176-M
Liu Y, Wang L, Liu Z, et al. Durable immunomodulatory nanofiber niche for the functional remodeling of cardiovascular tissue. *ACS Nano* 2023.	GPX	E-BC-K096-M
	GSH/GSSG	E-BC-K097-M
	MDA	E-BC-K025-M
	SOD	E-BC-K019-M
Liu J, Chang Y, Zhou W, et al. An esterase-activatable nanoprodrug mitigates severe spinal cord injury via alleviating ferroptosis and reprogramming inflammatory microenvironment. *Nano Today* 2024 ; 56: 102229.	GSH	E-BC-K030-M
Li X, Wu T, Zhang Z, et al. Tumor microenvironment activated nanoreactors for chemiluminescence imaging-guided simultaneous elimination of breast tumors and tumor-resident intracellular pathogens. *Chemical Engineering Journal* 2023.	GSH/GSSG	E-BC-K097-M
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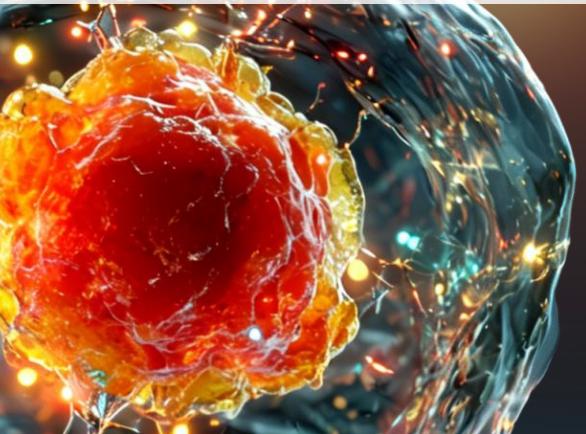

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EBR043-2608v1