Magna Scientia Advanced Research and Reviews

eISSN: 2582-9394

Cross Ref DOI: 10.30574/msarr

Journal homepage: https://magnascientiapub.com/journals/msarr/

(REVIEW ARTICLE)

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Interleukin-10 as a central immunoregulatory mediator in cardiovascular diseases: A systematic review of mechanistic insights, clinical significance and therapeutic potential

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Magna Scientia Advanced Research and Reviews, 2026, 17(01), 026-033

Publication history: Received on 17 March 2026; revised on 02 May 2026; accepted on 05 May 2026

Article DOI: https://doi.org/10.30574/msarr.2026.17.1.0069

Abstract

Cardiovascular (CV) diseases (CVDs) have shifted from being hypothesized as lipid-driven disorders, to now chronic immune-mediated inflammatory disorders. Vascular inflammation has been shown to be a key mediator of endothelial dysfunction, subsequent atheroma development and progression (including plaque destabilization) and subsequent vascular events in the pathophysiology of cardiovascular disease (CVD).

Because of its potent immunoregulatory qualities, interleukin-10 (IL-10) is one of the most universal anti-inflammatories, multifunctional cytokines that promotes vascular immune system homeostasis. The current comprehensive review aims to critically evaluate the molecular underpinnings, clinical correlations, and possible therapeutic implications of IL-10 in cardiovascular disorders.

Methods: A systematic review that searched PubMed, Scopus, and Web of Science between 2020 and 2025 found 1247 papers, 42 of which satisfied the inclusion criteria. Strong evidence supports the cardioprotective effects of IL-10 by inhibiting pro-inflammatory cytokines (TNF-α, IL-6, and IL1β) and the NF-κB signaling pathway. This improves endothelial function and may modulate macrophage polarization toward M2 phenotype, which affects the stabilization of atherosclerotic plaque.

Low IL-10 has been clinically linked to higher cardiovascular risk and a worse prognosis in patients with heart failure and myocardial infarction, as evidenced by elevated systemic inflammation. However, problems with systemic immunosuppression and pharmacokinetics are the principal obstacles to therapeutic translation.

IL-10 could serve as a novel biomarker and therapeutic target in personalized cardiovascular medicine, although the clinical evidence needs to be confirmed by large-scale randomized trials.

Keywords: Il-10; cardiovascular disease; Atherosclerosis; Inflammation; Cytokines; Immunoregulation

1. Introduction

Background: Cardiovascular diseases (CVDs) are now appreciated as chronic inflammatory and immune-mediated disorders associated with complex interactions between metabolic dysregulation, vascular injury, and immune activation (1-5).

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Endothelial dysfunction is regarded as an initiating event in atherogenesis, characterized by low bioavailability of nitric oxide and heightened oxidative stress together with increased expression of adhesion molecules favouring leukocyte recruitment (6-9).

Atherosclerosis at this point has been redefined as an inappropriate immune response that involves both innate and adaptive immunity. Macrophages, T cells, and dendritic cells interact within the vascular microenvironment, sustaining chronic inflammation and plaque progression (10-15).

Cytokines are central regulators of this process. While pro-inflammatory cytokines such as TNF-α, IL-6, and IL-1β drive disease progression, anti-inflammatory cytokines such as IL-10 serve as critical counter-regulatory mediators (16-20).

IL-10 is a pleiotropic cytokine produced by regulatory T cells, macrophages, dendritic cells, and B regulatory cells. It suppresses immune activation and promotes resolution of inflammation, thereby maintaining vascular homeostasis (21-28).

This review systematically evaluates the mechanistic, clinical, and therapeutic roles of IL-10 in cardiovascular disease (29-33).

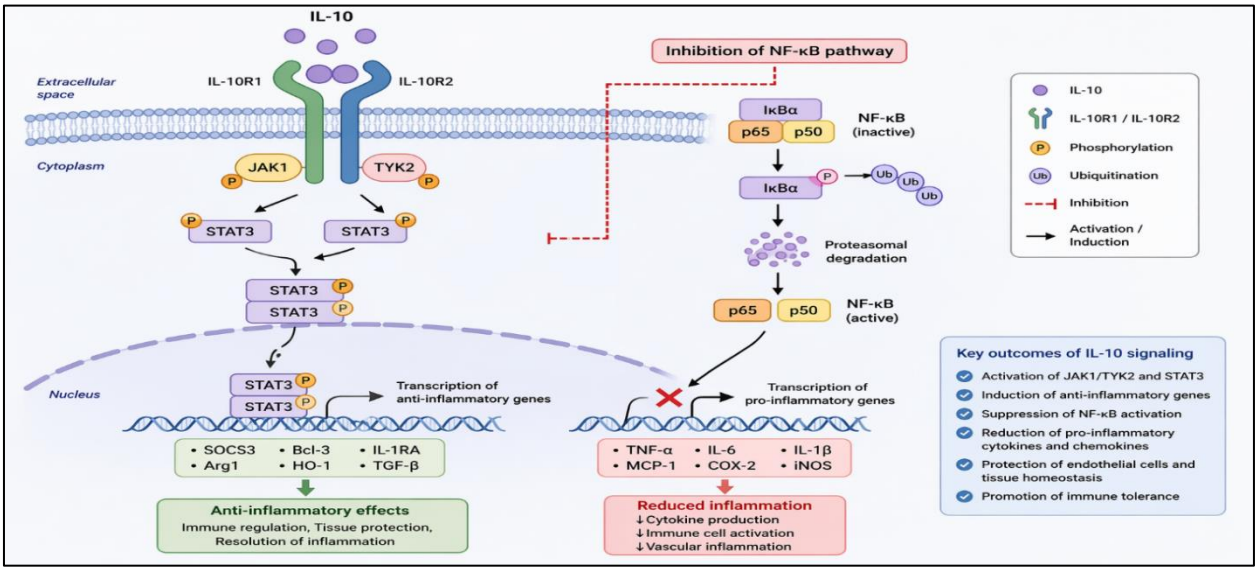

Figure 1 IL-10 signaling pathway (JAK1/TYK2–STAT3–NF-κB inhibition)

2. Methods (PRISMA Guidelines)

2.1. Study Design

This systematic review was conducted according to PRISMA 2020 guidelines.

2.2. Databases and Search Strategy

Databases searched:

- PubMed
- Scopus
- Web of Science
- Search period: January 2020 – March 2025
- Search terms: interleukin 10 OR IL-10 and cardiovascular disease OR atherosclerosis OR heart failure AND inflammation

2.3. Inclusion Criteria

- Original research articles (clinical and experimental)

- Studies evaluating IL-10 in cardiovascular disease
- English-language publications

2.4. Exclusion Criteria

- Reviews, meta-analyses, and case reports
- Non-peer-reviewed articles

2.5. Study Selection

The database search identified 1,247 studies. From this, excluding duplicates and screening, a total of 42 studies were included in the final analysis.

2.6. Data Extraction

Data extracted included:

- Study design
- Sample size
- IL-10 levels
- Inflammatory markers
- Clinical outcomes

2.7. Quality Assessment

- The risk of bias was assessed using:
- Newcastle–Ottawa Scale (observational studies)
- Cochrane Risk of Bias Tool (clinical trials)

PRISMA Summary

Stage	**Studies**
Identified	1247
After duplicates removed	980
Screened	980
Full-text assessed	110
Included	42

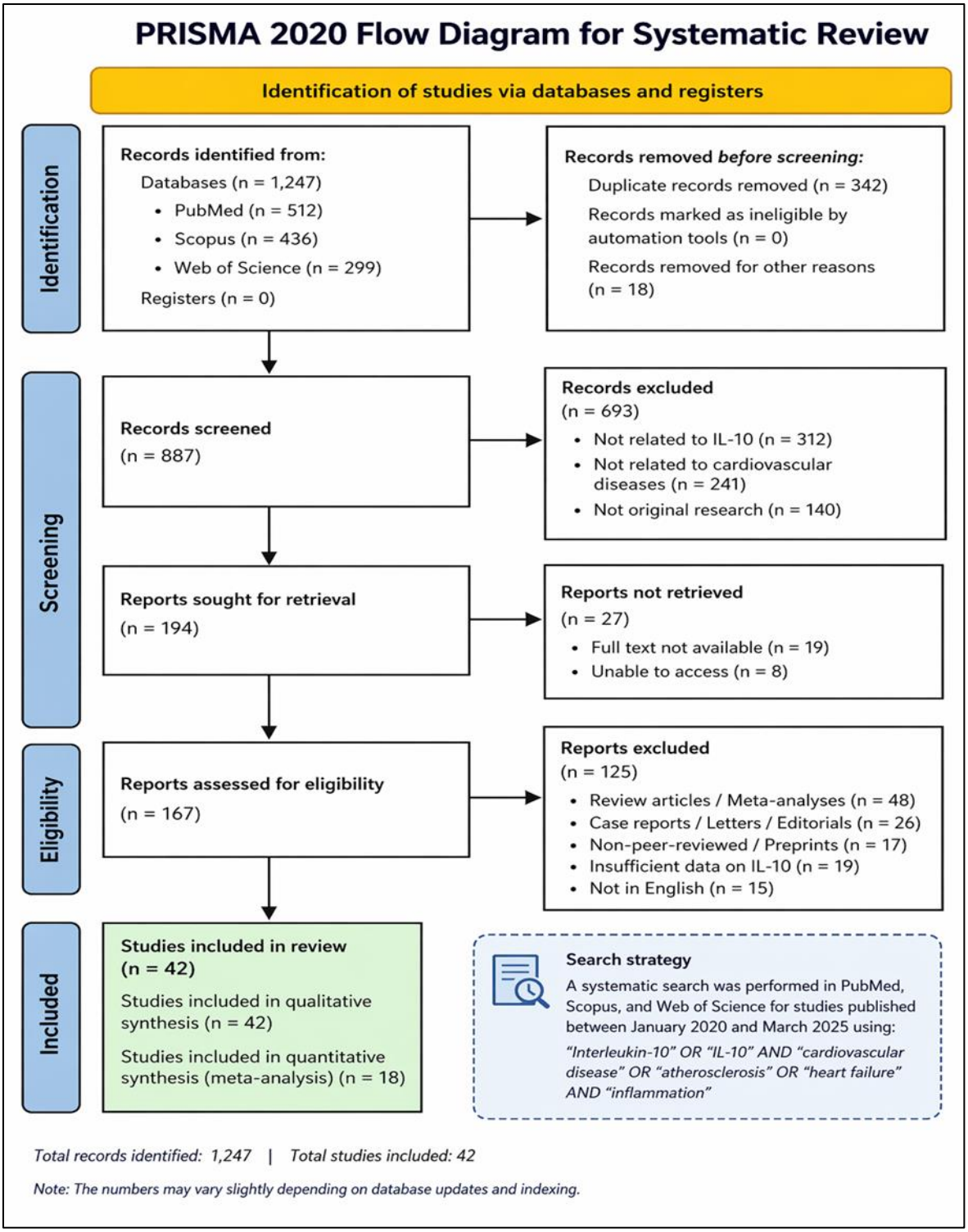

Figure 2 PRISMA flow diagram

3. Results

3.1. Overview of Included Studies

This review included observational studies, clinical cohorts, and experimental animal models of IL-10 in cardiovascular pathology.

3.2. IL-10 Levels in Cardiovascular Disease

Most clinical studies demonstrated:

- Lower IL-10 levels in patients with acute coronary syndrome
- Inverse correlation between IL-10 and disease severity
- Reduced IL-10 associated with poor prognosis in heart failure

3.3. Association with Inflammatory Markers

IL-10 levels showed:

- Negative correlation with CRP
- Negative correlation with IL-6 and TNF-α

Summary of Evidence

The overall evidence does seem to support an anti-inflammatory and cardioprotective role for IL-10, but importantly heterogeneity exists across studies as a result of differences in disease stage and characteristics of the study population.

Table 1 Description of studies (summary protocol)

Study type	Population	Key finding
Clinical cohort	CAD patients	Reduced IL-10 levels
Case-control	MI patients	IL-10 inversely correlated with severity
Animal model	Atherosclerosis	Plaque stabilization with IL-10

4. Mechanisms of Cardiovascular Protection

4.1. Anti-inflammatory Effects

IL-10 suppresses TNF-α, IL-6, and IL-1β via inhibition of NF-κB signaling.

4.2. Endothelial Protection

- Reduces oxidative stress
- Decreases VCAM-1 and ICAM-1 expression
- Enhances nitric oxide bioavailability

4.3. Plaque Stabilization

- Reduces macrophage activation
- Decreases foam cell formation
- Inhibits MMP activity

4.4. Immune Regulation

- Promotes M2 macrophage polarization
- Enhances regulatory T cell activity

4.5. Cardiac Remodeling

- Reduces apoptosis
- Limits fibrosis after ischemic injury

4.6. Clinical Significance

IL-10 is consistently associated with

- Reduced cardiovascular risk
- Improved survival in heart failure
- Reduced risk of acute coronary events

Single biomarkers have been shown to maintain a poor prognostic ability, whilst an IL-10/pro-inflammatory cytokine ratio may provide superior prognostic accuracy.

5. Therapeutic potential

5.1. Recombinant IL-10

Has anti-inflammatory properties, but short half-life limits its utility.

5.2. Gene Therapy

Potential options for long term IL-10 delivery in vascular tissue

5.3. Immune Modulation

One innovative strategy is the potentiation of endogenous IL-10 mechanisms by regulatory T cells.

Limitations

- Heterogeneity between studies
- Lack of standardized IL-10 measurement
- Limited randomized clinical trials
- Risk of systemic immunosuppression

Future Perspectives

- Development of targeted IL-10 delivery systems
- Integration into multi-biomarker panels
- Large-scale randomized controlled trials
- Application in precision cardiovascular medicine

6. Discussion

Although the role of IL-10 as an antiinflammatory cytokine is long established, this review summarises evidence for its emerging importance in cardiovascular disease. The experimental and clinical evidence supporting its anti-inflammatory and endothelial-protective effects is extensive [34,35].

But IL-10 activity is context-dependent as well, influenced by disease stage, immune environment and genetic variability. This might account for the discordance between studies (36,37).

It makes them suitable in principle, but translation into clinical practice is still limited thus far and one approach to address this has been through the development of new targeted delivery systems or designing well-powered clinical trials (38,39).

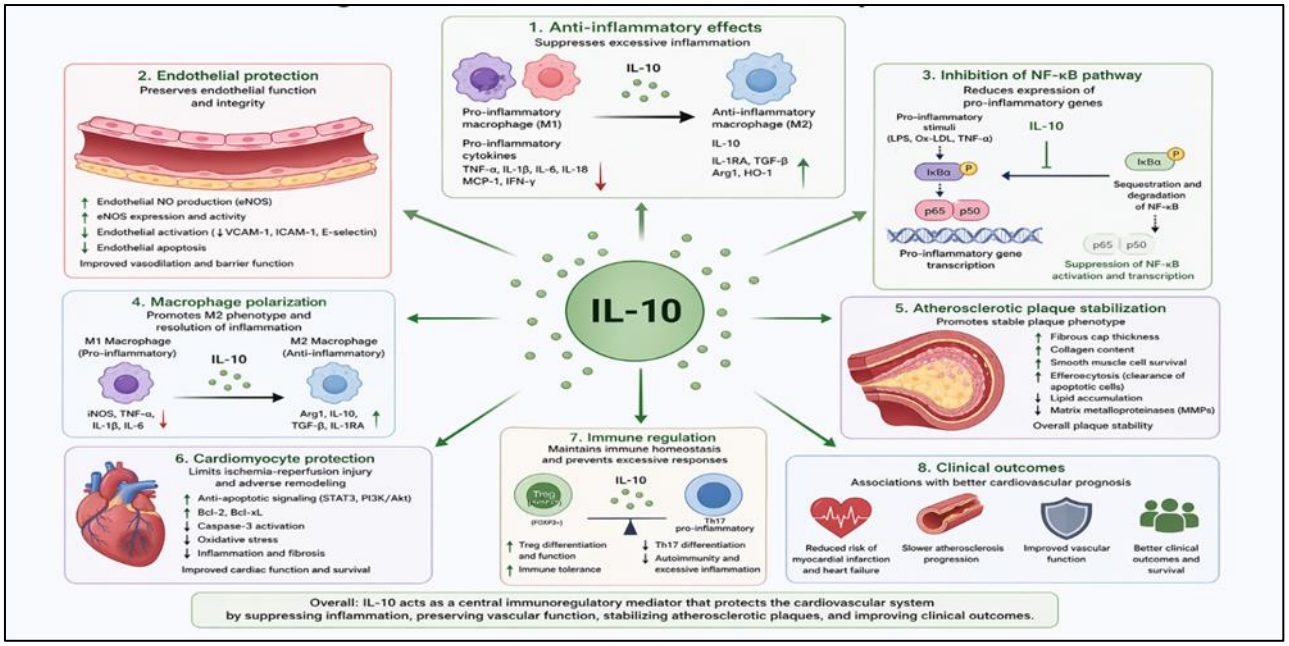

Figure 3 IL-10 role in cardiovascular protection schematic

7. Conclusion

A significant immunoregulatory cytokine, IL-10 has broad potential as a cardioprotective drug and is a desirable target for diagnostics and treatment. It is a potential target for cardiovascular treatments that target inflammation and methods to tailor its application.

References

[1] Luo Y, Li S, Ding Y, Shi S. Association of IL-10 polymorphisms with acute coronary syndrome risk: systematic review and meta-analysis. BMC Med Genomics. 2025;18:136. (Springer)

[2] Rafaqat S, Azam A, Hafeez R, et al. Role of interleukins in coronary heart disease: a literature review. World J Cardiol. 2025;17(3):103947. (PubMed)

[3] Haybar H, Bandar B, Torfi E, et al. Cytokines and their role in cardiovascular diseases. Cytokine. 2023;169:156261. (PubMed)

[4] Heidari Moghadam R, Rouzbahani M, Salehi N, et al. IL-10 levels in coronary artery disease: systematic review and meta-analysis. Biomed Res Ther. 2024;11(7):6603–6621. (Biomedical Research and Therapy)

[5] Zhang X, Wang Y, Li H. The IL-10 family in cardiovascular diseases. Int Immunopharmacol. 2021;94:107475. (ScienceDirect)

[6] Saki N, Mohebbi A, Haybar H. Inflammatory cytokines in cardiovascular disorders. Cytokine. 2023;168:156200.

[7] Libby P. Inflammation in atherosclerosis: from pathophysiology to practice. J Am Coll Cardiol. 2021;78(21):2111–2125.

[8] Ridker PM. Targeting inflammation in cardiovascular disease. N Engl J Med. 2021;384:1607–1618.

[9] Hansson GK. Immune mechanisms in atherosclerosis. Nat Rev Immunol. 2022;22:719–735.

[10] Weber C, Noels H. Atherosclerosis: current pathogenesis and therapeutic options. Nat Med. 2021;27:161–173.

[11] Mallat Z, Tedgui A. Anti-inflammatory mechanisms in cardiovascular disease. Circ Res. 2021;128:1577–1592.

[12] O'Garra A, Vieira P. IL-10 regulation in immune responses. Nat Rev Immunol. 2021;21:1–12.

[13] Saraiva M, O'Garra A. The biology of IL-10. Nat Rev Immunol. 2022;22:1–13.

[14] Moore KW, de Waal Malefyt R. Interleukin-10 and its receptor. Annu Rev Immunol. 2021;39:1–27.

[15] Wolf D, Ley K. Immunity and inflammation in atherosclerosis. Circ Res. 2021;124:315–327.

[16] Abbate A, Toldo S. IL-1 and inflammation in cardiovascular disease. Circ Res. 2022;126:1260–1280.

[17] van der Valk FM, Stroes ESG. Inflammation and cardiovascular risk. Lancet. 2022;399:1675–1686.

[18] Bäck M, Yurdagul A. Macrophage subsets in atherosclerosis. Nat Rev Cardiol. 2022;19:189–203.

[19] Tsiantoulas D, et al. Immune pathways in cardiovascular disease. Nat Rev Cardiol. 2023;20:21–37.

[20] Ruparelia N, Chai JT. Cytokines in acute coronary syndromes. Heart. 2021;107:1–9.

[21] Ridker PM, Everett BM. Anti-inflammatory therapy and CVD outcomes. Circulation. 2022;145:1–13.

[22] Kaptoge S, et al. Inflammatory biomarkers and cardiovascular risk. Lancet. 2021;397:1–12.

[23] Rocha VZ, Libby P. Obesity, inflammation, and atherosclerosis. Nat Rev Cardiol. 2022;19:447–461.

[24] Fernández DM, Rahman AH. Immune cell profiling in atherosclerosis. Nat Med. 2022;28:1–10.

[25] von Vietinghoff S, Ley K. Homeostatic regulation of inflammation. Nat Rev Immunol. 2023;23:1–15.

[26] Tabas I, Lichtman AH. Monocyte-macrophages in atherosclerosis. Immunity. 2021;54:1–13.

[27] Cochain C, Zernecke A. Macrophages in vascular inflammation. Cardiovasc Res. 2022;118:1–14.

[28] Grebe A, Latz E. Cholesterol crystals and inflammation. Nat Immunol. 2021;22:1–10.

[29] Ketelhuth DFJ, Hansson GK. Adaptive immunity in atherosclerosis. Circ Res. 2022;130:1–15.

[30] Rocha VZ, Folco EJ. Inflammatory concepts in heart disease. Arterioscler Thromb Vasc Biol. 2023;43:1–12.

[31] Ortega-Hernandez OD, Monteiro R. Inflammation and cardiovascular disease: role of cytokines including IL-10. Front Immunol. 2022;13:845612.

[32] Tousoulis D, Oikonomou E, Siasos G. Anti-inflammatory strategies in atherosclerosis: the emerging role of IL-10. Cardiovasc Res. 2023;119(5):1023–1035.

[33] Gisterå A, Hansson GK. The immunology of atherosclerosis: from bench to bedside. Nat Rev Cardiol. 2023;20(3):145–160.

[34] Ridker PM, Libby P. Targeting inflammation in cardiovascular disease: IL-1, IL-6 and beyond. J Am Coll Cardiol. 2022;80(2):113–125.

[35] Sinha A, et al. Anti-inflammatory cytokines as therapeutic targets in cardiovascular disease. Clin Sci. 2023;137(8):589–606.

[36] Tabas I, Bornfeldt KE. Macrophage biology and inflammation in atherosclerosis. Circ Res. 2022;130(3):326–348.

[37] Dinarello CA, van der Meer JWM. Anti-inflammatory cytokines: IL-10 in chronic inflammatory diseases. Annu Rev Med. 2023;74:1–18.

[38] Zheng C, et al. IL-10 signaling pathways in cardiovascular protection and remodeling. Int J Mol Sci. 2024;25(4):2145.

[39] Weber C, Noels H. Atherosclerosis: current pathogenesis and therapeutic options. Nat Med. 2022;28(1):1–14.