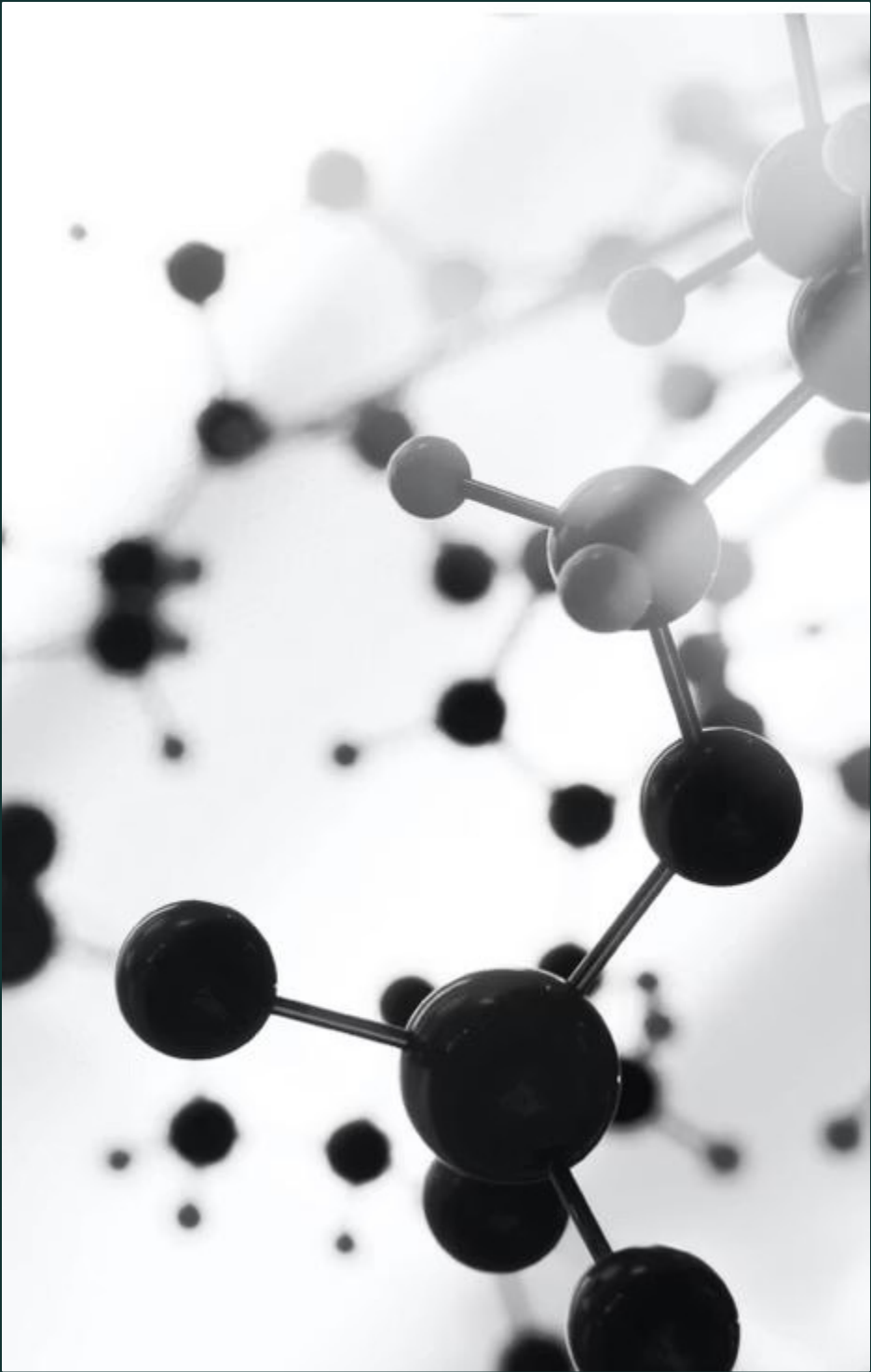


LVL UP RX: Anti-Aging & Longevity Research

The Latest Science for Healthy Aging

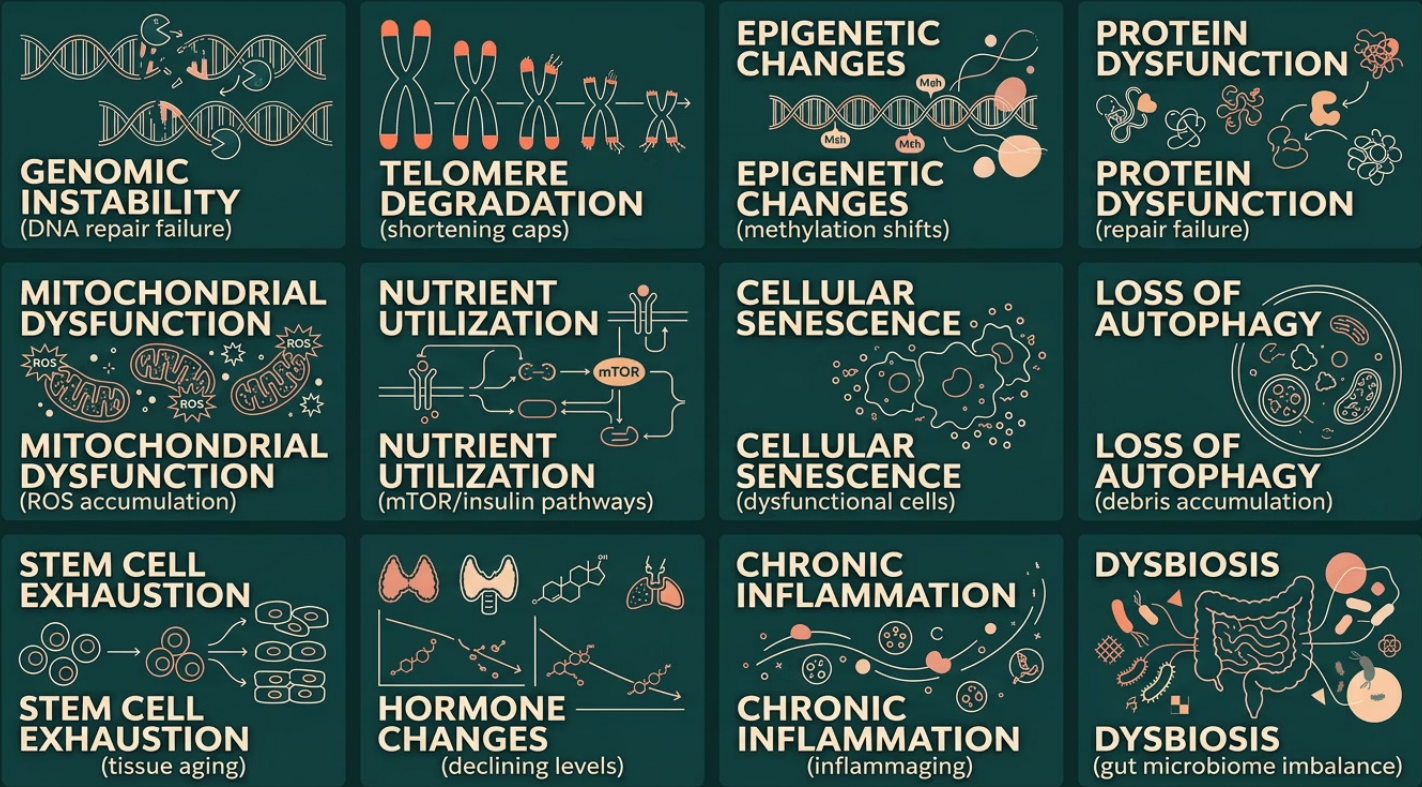
In 2024, *Nature Methods* published *Aging Research Comes of Age*, highlighting a funding surge transforming this once-neglected field. Researchers are now targeting known hallmarks of aging – from inflammation and DNA damage to telomere shortening and declining hormones – as actionable intervention points.





The Hallmarks of Aging

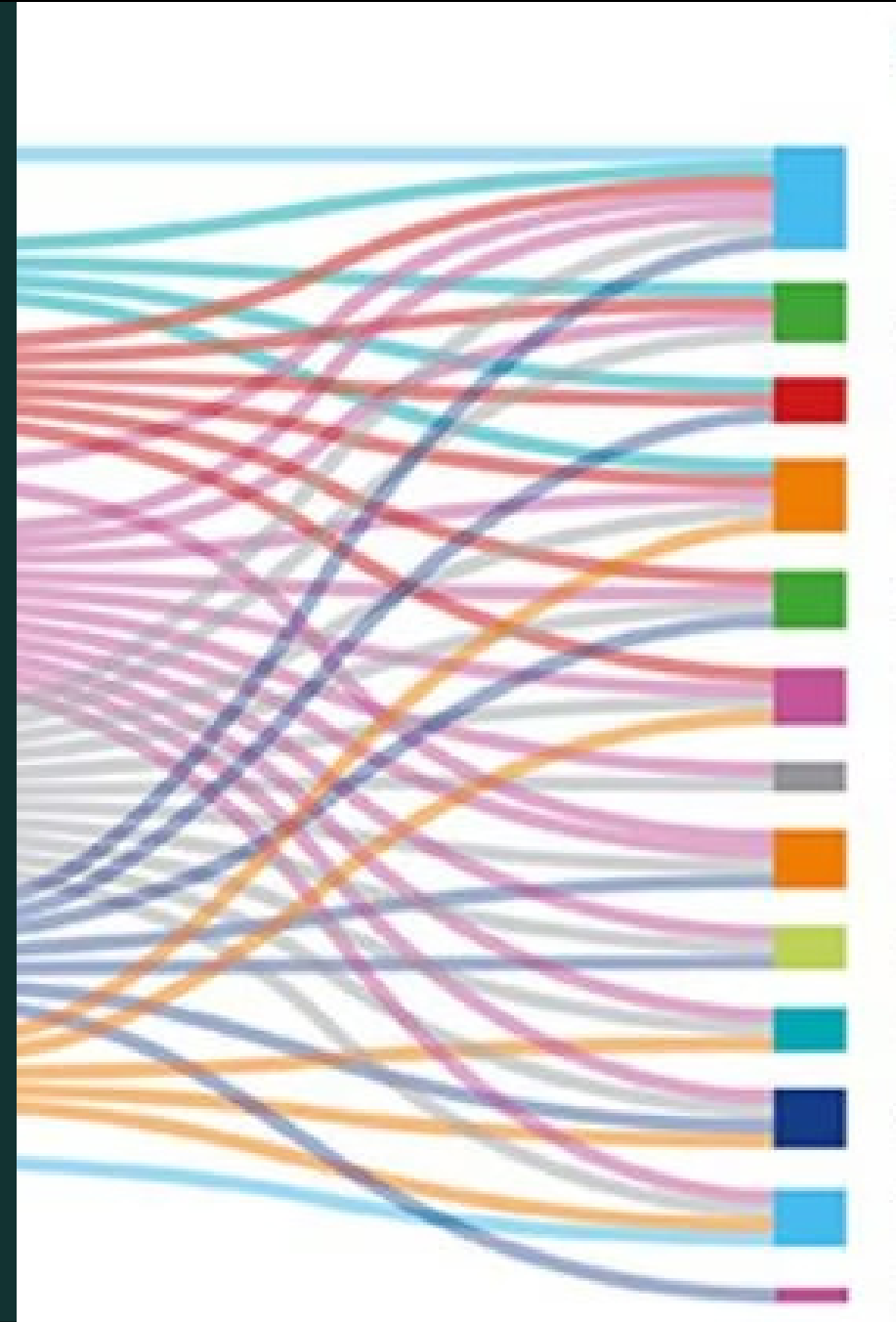
“Perhaps the biggest challenge in aging research is not in defining how aging occurs, but in understanding what causes the damage that underlies the mechanisms of aging”
The Max Planck Institute for Biology of Aging recognizes aging as a complex process governed by a dozen biological functions. Scientists now seek to identify what differentiates these biochemical processes in youth versus old age.



Anti-Aging Strategies: The Big Picture

Fully addressing aging requires intervention across all twelve hallmarks. The diagram below maps key biochemical strategies to the specific hallmarks they target.

Strategies range from stem cell therapy and cellular reprogramming to caloric restriction, physical exercise, and telomere reactivation — each addressing overlapping aspects of the aging process.



Metabolic Manipulation & mTOR

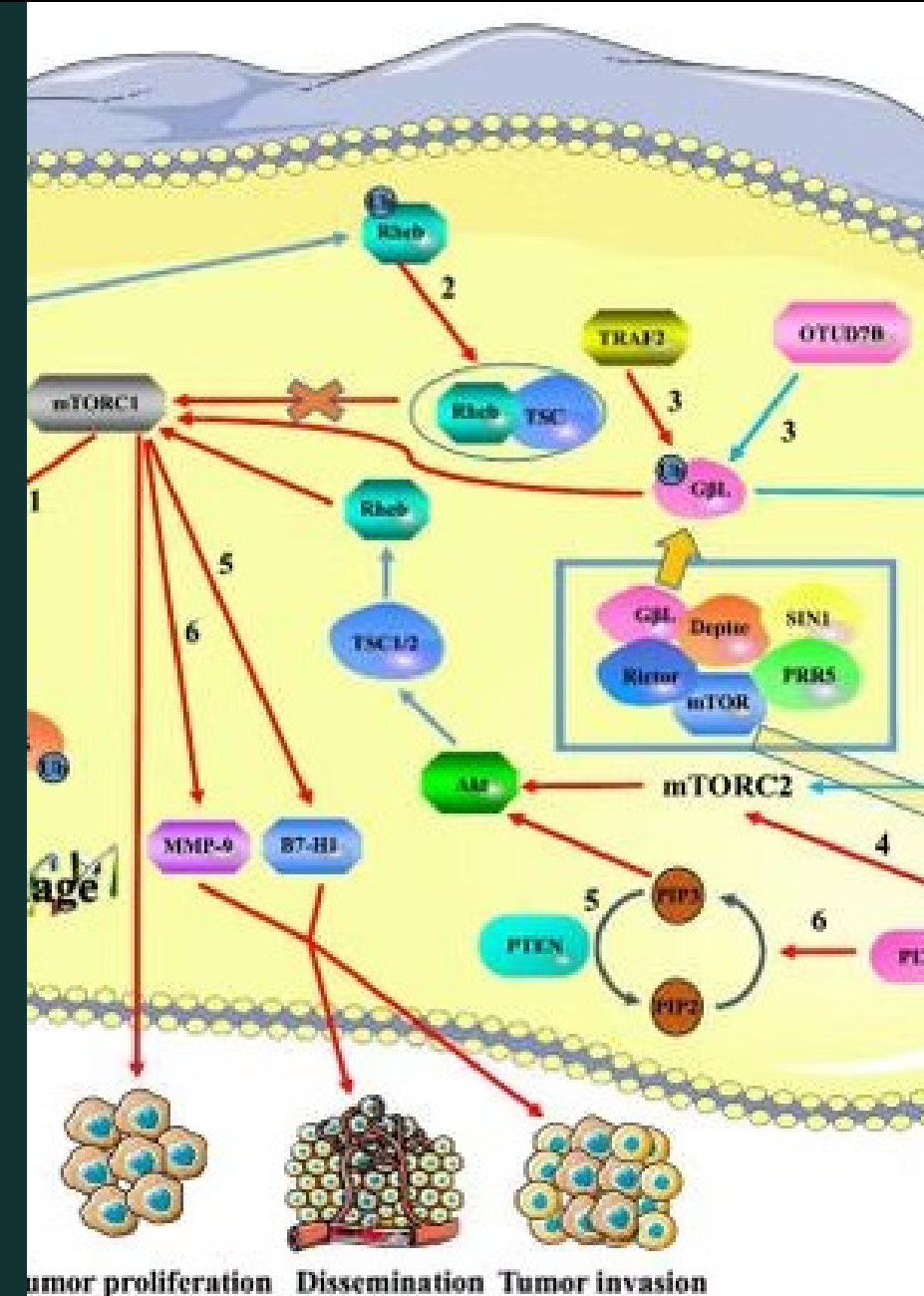
The mTOR pathway regulates cell growth, autophagy, protein synthesis, and DNA transcription. Enhanced mTOR activity drives diabetes, obesity, neurological disease, and cancer. Inhibiting mTOR increases autophagy, reduces senescence, and enhances cancer treatment in mouse models. Rapamycin increases lifespan in mice by up to **14%**.

Calorie Restriction

The primary means of inhibiting mTOR; a well-established anti-aging intervention.

Natural mTOR Inhibitors

- Caffeine, curcumin, berberine
- Quercetin, resveratrol, pterostilbene
- Rapamycin, temsirolimus, everolimus



Intermittent Fasting & Calorie Restriction Mimetics

A 10–30% reduction in caloric intake extends lifespan significantly in rodents via mTOR inhibition and increased autophagy. However, long-term calorie restriction carries risks including mood swings, bowel dysfunction, and cardiovascular concerns — spurring the search for mimetics.

Metformin

Activates AMPK pathway; extends lifespan in animal models. Limited by potential vitamin deficiencies and testosterone impacts.

Resveratrol

Found in red wine and grapes; activates SIRT1, extending lifespan and protecting against age-associated diseases.

Acarbose

Antidiabetic medication shown to extend lifespan in mice by modulating gut microbiota.

FLPNF Peptide

Reduces amyloid deposits in the brain and is thought to increase autophagy.



Antioxidants, Inflammation & Key Peptides

Clinical trials of antioxidant supplements have been disappointing, but peptides offer more specific and potent anti-inflammatory benefits. Key research peptides include:



Thymosin Alpha-1

Modulates inflammation by reducing TNF-alpha and IL-1-beta. Studied for cancer, cystic fibrosis, and pain caused by inflammation.



LL-37

Reduces inflammation by increasing IFN-alpha, down-regulating TLR4 signaling, and altering white blood cell chemotaxis.



KPV

Anti-inflammatory peptide that reduces TNF-alpha activity in the intestine.



SS-31

Reduces oxidative stress by restoring superoxide dismutase (SOD) activity and forestalling cytochrome c release, attenuating neural damage.

i VIP (Vasoactive Intestinal Peptide) modulates TH1 cell function and improves tight junction integrity, preventing proinflammatory pathogens from entering via the GI tract. BPC-157 dramatically reduces reactive oxygen species in the GI tract and vascular system. GHK-Cu promotes wound healing and modulates DNA expression. TB-500 Fragment (17-23) acts as an inflammatory regulator, maintaining balance in inflammatory responses.

Cellular Reprogramming & Telomere Reactivation

Cellular Reprogramming

The Yamanaka factors (Oct3/4, Sox2, Klf4, c-Myc) reset methylation patterns on somatic cells, increasing regenerative potential and combating stem cell exhaustion, senescence, and tissue aging. Agents like 5-azacytidine and decitabine also modulate epigenetic marks. Peptides **Epitalon (AEDG)** and **Pancragen (KEDW)** stimulate tissue differentiation and pancreatic cell development respectively.

Telomere Reactivation

Telomeres shorten with age; telomerase can extend them but overactivation risks cancer. Gene therapy has extended lifespan in mice without increasing cancer. Peptides offer a more accessible path:

- **Epitalon** – increases telomere length by $\geq 33\%$, reduces inflammaging, improves immune function
- **Thymosin Beta-4 (TB-4)** – activates telomerase and combats senescence in endothelial cells
- **L-Glutathione** – without it, telomerase activity can decrease by up to 60%



Senotherapy, Autophagy & NAD⁺ Pathways

Senotherapy targets dysfunctional senescent cells. Natural compounds (quercetin, fisetin, curcumin) and synthetic senolytics (BCL-2 inhibitors, p53-targeting peptides) have shown efficacy against insulin resistance, cognitive decline, osteoporosis, and aging-related cancers.

FOXO4-DRI

Prevents FOXO4 binding to p53, stimulating elimination of senescent cells. Improves insulin sensitivity and removes amyloid beta from the brain in mouse models.

NAD⁺

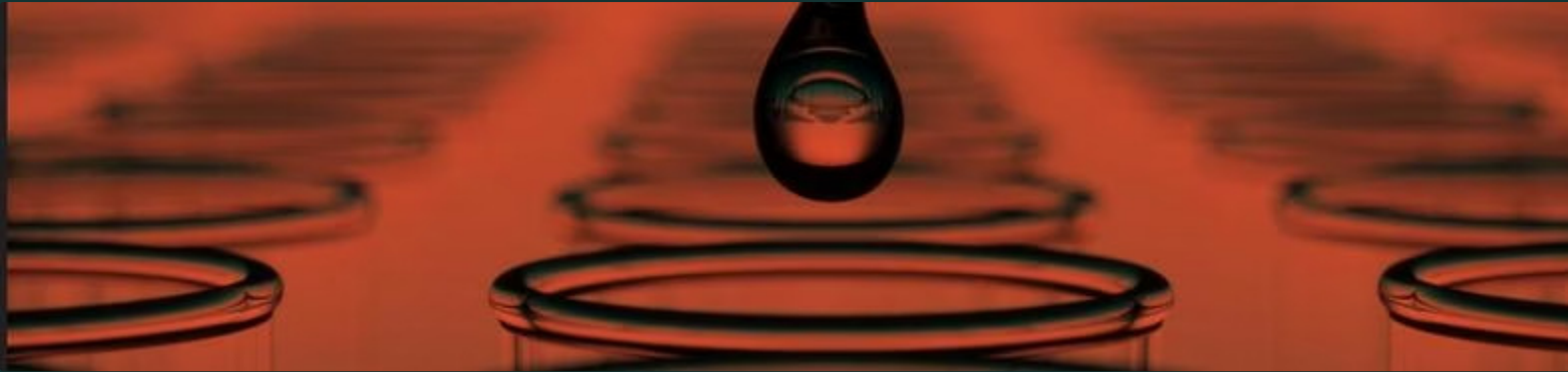
Critical coenzyme for peptide function and DNA protection. NAD⁺ levels decline with age — supplementation becomes increasingly important for longevity.

5-Amino-1MQ

Blocks NNMT to increase NAD⁺ production and activates SIRT1 — the "longevity gene" — reducing risk of obesity, diabetes, heart disease, and neurodegeneration.

Spermidine

A naturally occurring polyamine that promotes autophagy with cardioprotective and lifespan-extending effects.



Hormesis & Neurohormesis

Hormesis is the beneficial effect of low-dose exposure to agents that are harmful at high doses – exercise being the classic example. Mild stressors (hyperthermia, caloric restriction, resveratrol) delay aging and promote longevity in animals. **Neurohormesis** focuses on brain function: stressed neurons activate vitagenes that maintain cellular homeostasis.

Several peptides directly stimulate these adaptive pathways without requiring the stressor:



Pinealon

Geroprotector promoting cellular longevity in the brain; protects against hypoxia.



Selank

Protects against anxiety and neural stressors; enhances learning and cognition via neuroplasticity.



Semax

Increases BDNF levels, helping neurons grow, differentiate, and proliferate.



Thymagen

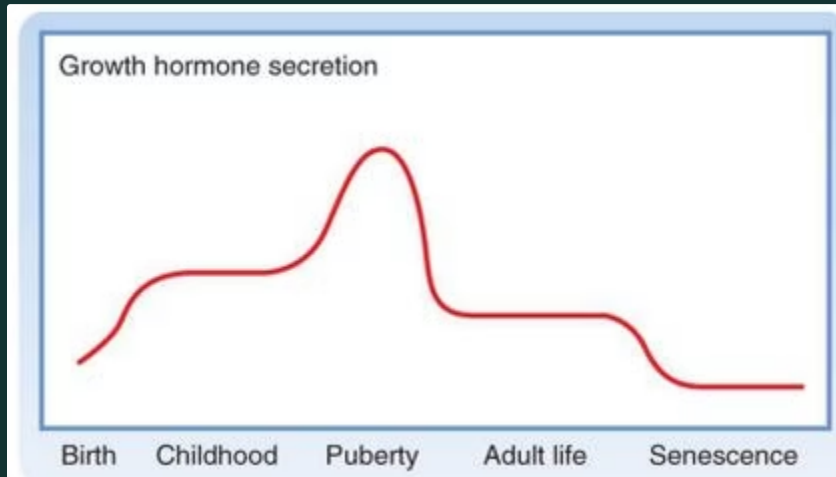
Potent immune regulator; increases T cell production, stimulates interferons, and boosts cyclic nucleotides.



BPC-157

Probably the most potent promoter of healing yet identified – accelerates repair in muscles, tendons, ligaments, GI tract, and lungs without requiring injury or exercise.

Hormonal Replacement & Growth Hormone Peptides



Hormone levels naturally decline with age (somatopause), causing diminished bone density, muscle mass, cognitive ability, and immune function. Peptides offer similar benefits to hormone replacement with fewer side effects.

Sermorelin (GHRH Analogue)

Called "the closest humanity has come to the fountain of youth" by Dr. Paul Walker. Increases bone density, cardiac health, muscle mass, immune function, and wound healing — without direct GH side effects. Related: Tesamorelin, CJC-1295.

Kisspeptin-10

Stimulates testosterone production in men without long-term impact on the gonadal hormone axis — testosterone levels rise without suppressing natural production after withdrawal.

Ghrelin Analogues

Ipamorelin (bone density), Hexarelin (cardiac), GHRP2/GHRP6 (appetite/nutrition), and MK-677 (non-peptide) all increase growth hormone secretion with organ-specific benefits.

Semaglutide & Retatrutide

GLP-1 and triple incretin receptor agonists that improve insulin signaling, fat metabolism, and body composition. Retatrutide reduces weight by up to 20% in animal models in three months.

Stem Cell Therapy, Exercise & Dietary Support

Stem Cell Therapy

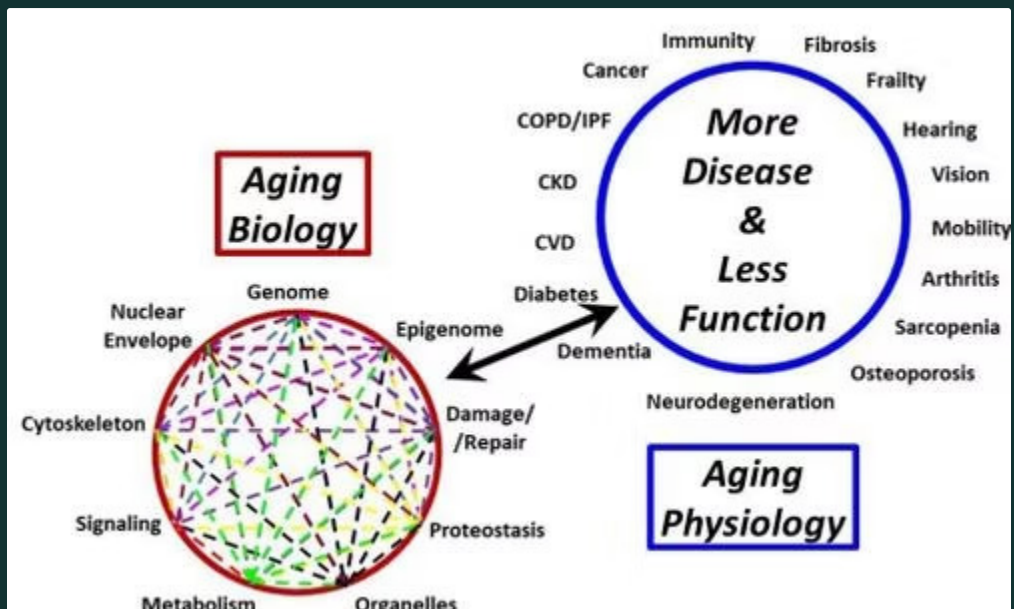
Stem cells contribute to anti-aging by regenerating tissues, boosting natural repair, modulating immune function, reducing chronic inflammation, thwarting oxidative damage, and supporting mitochondrial health. Pluripotent stem cells differentiate under specific stimuli, enabling vast human tissue modeling.

Physical Exercise

Exercise maintains genomic stability, reduces DNA methylation in cancer-linked genes, counteracts telomere shortening, and stimulates neurogenesis. It is one of the most important interventions for healthy brain aging. Peptides like sermorelin and PT-141 can augment or even mimic exercise benefits.

Dietary Supplements

- **Vitamin D** – reduces oxidative stress, boosts immunity, improves DNA repair
- **Vitamin B12** – alleviates cognitive decline, protects nerve function
- **Zinc** – anti-inflammatory and antioxidant immune support



In Summary: The Promise of Geroscience

Humanity's pursuit of the elixir of life has intensified dramatically. **Geroscience** — at the intersection of geriatrics and basic science — posits that targeting the aging process itself, rather than individual diseases, can significantly delay age-related decline, transforming healthcare and compressing morbidity into life's final chapters.

Calorie Restriction Mimetics

Metformin, rapamycin, and resveratrol have extended lifespan in model organisms by up to 30%.

Senolytics

FOXO4-DRI and related peptides purge senescent cells, improving insulin sensitivity and cognitive function.

Epigenetic Modulators

Cellular reprogramming and telomere reactivation offer the potential to reverse biological age at the cellular level.

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