Peptides for your Recovery

Orr Limpisvasti, MD

Last updated: March 2026 • 50+ peer-reviewed sources • ~20 min read

Important Disclaimer

This document is for educational and informational purposes only and does not constitute medical advice, diagnosis, or treatment recommendations. The information presented is derived from peer-reviewed scientific publications and is intended to help patients understand what is currently known and unknown about peptides in orthopaedic recovery. Always consult a qualified healthcare provider before making decisions about any treatment. Many peptides discussed here are not FDA-approved for musculoskeletal use and may carry unknown risks. No advertising, sponsorship, or commercial interest influenced this content.

Contents

1. What Are Peptides?

Peptides are short chains of amino acids, typically between 2 and 50 residues long, linked together by peptide bonds. They act as signaling molecules in the body, binding to specific receptors on cell surfaces and influencing biological processes such as inflammation, blood vessel formation, collagen production, cell growth, and tissue repair. Because they are smaller than full-length proteins, peptides can often penetrate tissues more readily and exert highly targeted effects (Rahman et al., JAAOS Global 2026).

Your body naturally produces many peptides that play essential roles in healing. For example, collagen fragments released during injury signal repair cells to migrate to the damage site, and growth factors released by platelets orchestrate tissue rebuilding. The peptides discussed in this resource are either naturally occurring substances being studied in concentrated or synthetic form, or entirely synthetic molecules designed to mimic or enhance these natural healing processes.

2. Why Are Sports Medicine Physicians Interested?

Injuries to tendons, ligaments, cartilage, and bone present persistent challenges in sports medicine. Tendons and ligaments have naturally poor blood supply, making them inherently slow to heal. Traditional treatments such as anti-inflammatory medications, physical therapy, and cortisone injections can manage symptoms but do not reliably accelerate the biological repair process itself.

This gap has driven interest in regenerative approaches, including peptide-based therapies. According to a January 2026 editorial from the American Orthopaedic Society for Sports Medicine (AOSSM), patient requests for guidance on peptides have increased substantially, driven in part by social media and athlete endorsements. However, the AOSSM also emphasizes that "the translational gap between rodent studies and meaningful clinical human studies is large."

Why peptides seem promising in theory

Key molecular pathways targeted by currently studied peptides include VEGF (blood vessel formation), TGF-beta (collagen production), PI3K/Akt and mTOR (cell growth), FAK-paxillin (cell migration), and GH/IGF-1 (tissue building). These are the same pathways your body uses to heal naturally. The idea is to enhance or amplify them (Rahman et al., 2026).

3. Peptides Under Study

The following peptides are organized from strongest to weakest clinical evidence in humans. This ordering is important: the peptides receiving the most public attention (such as BPC-157) often have the least human clinical data.

Collagen Peptides (Bioactive Collagen Peptides)

Hydrolyzed collagen fragments • Dietary supplement

Strongest Human Evidence • GRAS / OTC

What it is

Hydrolyzed collagen peptides are produced by breaking down native collagen (from bovine, porcine, or marine sources) into small, absorbable fragments. Key bioactive fragments include Pro-Hyp (proline-hydroxyproline) and Hyp-Gly, which are absorbed intact through the gut and accumulate in connective tissues like tendons, ligaments, and cartilage.

How it is proposed to work

These collagen fragments appear to directly stimulate fibroblasts (the cells responsible for building connective tissue) to produce more collagen. They also signal chondrocytes (cartilage cells) to produce proteoglycans. Radiotracer studies have confirmed that orally ingested collagen peptides do reach joint cartilage and surrounding tissues (Fritz et al., 2025).

Key human trial findings

- Significant reduction in activity-related knee pain in athletes (5 g/day for 12 weeks) vs. placebo (Konig et al., 2017)
- Reduced exercise-induced muscle soreness and faster strength recovery at 48 hours post-exercise (Kuwaba et al., 2023)
- Faster recovery of jump height, rate of force development, and maximum strength after muscle damage (15 g/day + training for 12 weeks) (Bischof et al., 2023)
- Significant improvements in WOMAC scores (pain, stiffness, function) for osteoarthritis (10 g/day for 8 weeks) (Demir-Dora et al., 2025)
- A 2024 systematic review with meta-analysis confirmed positive effects on tendon morphology, muscle mass, strength, and recovery (Moitzi et al., Sports Medicine 2024)

Safety profile

Well-established safety as a dietary supplement. Rare side effects include mild gastrointestinal discomfort. Contraindicated for individuals with allergies to the collagen source animal. No significant adverse effects in any published clinical trial.

Regulatory / anti-doping status

FDA: Generally Recognized as Safe (GRAS) as a dietary supplement; available over the counter. WADA: Not banned. NCAA/NFL: Not banned. Athletes can use collagen peptides without anti-doping concerns.

PTH / PTHrP Analogues (Teriparatide, KUR-111, KUR-113)

Parathyroid hormone peptides • Bone healing

Level I RCT Evidence • FDA-Approved (Osteoporosis)

What it is

Teriparatide (Forteo) is a synthetic version of the first 34 amino acids of parathyroid hormone (PTH). It is FDA-approved for osteoporosis treatment. Newer formulations (KUR-111, KUR-113) are investigational bone graft substitutes that combine PTH with fibrin for local delivery at fracture sites.

How it is proposed to work

When given intermittently (as opposed to continuously), PTH stimulates osteoblasts (bone-building cells) to form new bone faster than it is broken down. In fractures, it accelerates the formation and maturation of the fracture callus—the new tissue that bridges the bone gap. It also improves collagen organization at the tendon-to-bone junction (Yoon et al., 2020).

Key human trial findings

- KUR-113 (PTH-based bone graft) achieved 80.4% healing at 6 months vs. 64.6% for standard care in open tibial shaft fractures, with fewer follow-up surgeries needed (Orbeanu et al., JBJS 2021)
- KUR-111 was non-inferior to autograft (the gold standard) for tibial plateau fractures: 83.6% union rate for high-dose group, with lower opioid use (Kanakaris et al., 2026)

- Tendon-to-bone healing applications remain preclinical; a rat rotator cuff model showed local PTH delivery improved load-to-failure strength and collagen organization

Safety profile

Teriparatide carries an FDA black box warning for osteosarcoma risk (based on high-dose rat studies; not confirmed in over 10 years of human use). Contraindicated in patients with prior skeletal radiation, Paget's disease, or skeletal malignancies. Common side effects: mild hypercalcemia, dizziness, leg cramps, nausea. Maximum recommended lifetime exposure: 2 years.

Regulatory / anti-doping status

FDA: Approved for osteoporosis (teriparatide/Forteo, abaloparatide/Tymlos). KUR-111 and KUR-113 are investigational. WADA: Banned in-competition under S4 (Hormone and Metabolic Modulators). Athletes may apply for a Therapeutic Use Exemption (TUE) if clinically indicated.

TPX-100

MEPE-derived 23-amino acid peptide • Knee osteoarthritis

Phase II RCT • Investigational

What it is

TPX-100 is a synthetic 23-amino acid peptide derived from Matrix Extracellular Phosphoglycoprotein (MEPE), a protein produced by bone cells (osteocytes) that is downregulated in osteoarthritis.

How it is proposed to work

TPX-100 promotes osteoblast and chondroblast differentiation, stimulating both bone and cartilage formation. It targets the subchondral bone remodeling that underlies osteoarthritis progression.

Key human trial findings

- In a Phase II RCT (104 patients with bilateral knee OA), intraarticular TPX-100 significantly delayed pathological bone shape deterioration at both 6 months (P=0.02) and 12 months (P=0.01) compared to placebo (McGuire et al., Arthritis Research & Therapy 2021)
- Improved bone shape correlated significantly with cartilage thickness preservation
- This was the first therapy to demonstrate significant effects on bone shape (B-score) in knee OA, making it a candidate for disease modification

Safety profile

Injection site reactions reported; no major safety concerns emerged in the Phase II trial. Larger Phase III trials are needed to confirm the safety profile.

Regulatory status

FDA: Not approved; investigational. Phase III data needed. WADA: Status not specifically addressed.

BPC-157 (Body Protection Compound-157)

Synthetic 15-amino acid pentadecapeptide • Derived from gastric juice protein

Preclinical Only • Not FDA-Approved • WADA Banned

What it is

BPC-157 is a synthetic peptide composed of 15 amino acids, derived from a protein naturally found in human gastric (stomach) juice. It is resistant to degradation in stomach acid. It is not FDA-approved for any medical use and is sold only as a "research chemical." It is one of the most widely discussed peptides in sports medicine circles, but its evidence base is overwhelmingly preclinical.

How it is proposed to work

Animal studies suggest multiple mechanisms: promoting new blood vessel growth (via VEGF), enhancing fibroblast migration to injury sites (via FAK-paxillin signaling), upregulating growth hormone receptors on tendon cells (Chang et al., 2014), modulating nitric oxide pathways, and reducing inflammatory cytokines.

Critical context about the evidence

A comprehensive 2025 systematic review in Sports Health (Vasireddi et al., 2025) screened 544 published articles on BPC-157 (1993–2024) and found 35 preclinical (animal) studies and only 1 human study—a retrospective case series of 12 patients, with no control group. No randomized controlled trials in humans have ever been published. Much of the research comes from a single laboratory group at the University of Zagreb, with limited independent replication (Chornomydz & Klantsa, 2025).

Safety profile

No human clinical safety data exists in the published literature. Animal studies report no adverse effects. Theoretical concerns include potential oncogenic risk due to pro-angiogenic and pro-proliferative activity (i.e., could theoretically stimulate undiagnosed tumor growth). The greatest practical risk comes from unregulated manufacturing: contamination with endotoxins, heavy metals, or bacteria in products sold as "research chemicals."

Regulatory / anti-doping status

FDA: Not approved for any indication. Banned from compounding pharmacies as of September 2023 (Category 2). WADA: Explicitly banned under S0 (Non-Approved Substances)—prohibited at all times. NCAA & NFL: Explicitly named on banned substance lists. Athletes face suspension for positive tests.

TB-500 / Thymosin Beta-4

43-amino acid polypeptide • Actin-sequestering molecule

Preclinical for Sports Injuries • Not FDA-Approved • WADA Banned

What it is

Thymosin Beta-4 (TB4) is a naturally occurring 43-amino acid peptide found in nearly all human cells. It is the body's most abundant actin-sequestering molecule (actin is a protein that forms the cell's structural skeleton). "TB-500" is a synthetic version sold online, though products labeled TB-500 vary in their actual composition. TB4 itself has been studied in registered clinical trials for wound and cardiac healing—but not for sports injuries.

How it is proposed to work

TB4 regulates actin dynamics, which directly controls how cells move. By modulating this system, it promotes the migration of fibroblasts, endothelial cells, and stem cells to injury sites. It also promotes new

blood vessel formation, reduces inflammation via anti-fibrotic effects on TGF-beta signaling, and activates mesenchymal stem cells (Wang et al., 2024).

Current evidence

Phase II clinical trials have been conducted for cardiac repair (post-heart attack), dermal wound healing, and corneal injury—with a generally favorable safety profile. However, no clinical trials have been conducted for tendon, ligament, bone, or muscle injuries. The sports injury use case is extrapolated entirely from non-musculoskeletal trials and animal data (Chornomydz & Klantsa, 2025).

Safety concerns

TB4 is overexpressed in some cancers and has established roles in tumor cell migration and angiogenesis. While this has not been demonstrated at therapeutic doses in non-cancer subjects, it is a legitimate precautionary concern. Grey-market TB-500 products carry contamination risks identical to BPC-157.

Regulatory / anti-doping status

FDA: Not approved for musculoskeletal use. Banned from compounding (Category 2, September 2023). WADA: Banned under S0 (Non-Approved Substances). NCAA & NFL: Banned.

GHK-Cu (Copper Peptide)

Naturally occurring tripeptide–copper complex

Preclinical + Cosmetic Use • Not FDA-Approved (Drug)

What it is

GHK-Cu is a small, naturally occurring tripeptide bound to a copper ion. It is found in human blood plasma, saliva, and urine, and its levels decline with age. GHK is actually a fragment of human type I collagen. It is widely used in cosmetic skincare products and available as a "research chemical," but has no FDA approval as a drug.

How it is proposed to work

GHK-Cu is remarkably broad-acting: it modulates the expression of over 4,000 human genes. It stimulates fibroblasts to produce type I and III collagen, elastin, and proteoglycans. It promotes blood vessel formation and nerve outgrowth. It activates both matrix metalloproteinases (MMPs, which break down damaged tissue) and their inhibitors (TIMPs), enabling controlled tissue remodeling rather than scarring (Pickart & Margolina, 2018).

Current evidence

The evidence base is primarily in skin and wound healing (in vitro and animal models), with some clinical evidence in cosmetic/dermatological contexts. No human clinical trials have been conducted for musculoskeletal applications (tendons, ligaments, fractures, or joints). The biological rationale for orthopaedic use is strong (type I collagen induction, GAG stimulation, angiogenesis), but the translational gap is large (Maquart et al., JCI 1993).

Regulatory / anti-doping status

FDA: Not approved as a drug. Available in cosmetic products. WADA: Not specifically banned as of 2025. However, athletes should verify current status before use, as lists are updated annually.

CJC-1295 / Ipamorelin (Growth Hormone Secretagogues)

Synthetic GHRH analogue + Ghrelin receptor agonist

Indirect Evidence Only • Not FDA-Approved • WADA Banned

What they are

CJC-1295 is a synthetic version of growth hormone-releasing hormone (GHRH) with an extended half-life. Ipamorelin is a small peptide that stimulates growth hormone (GH) release by activating the ghrelin receptor. They are often used together to increase the body's natural GH production, which in turn raises IGF-1 (insulin-like growth factor-1), a key tissue-building hormone.

Current evidence

CJC-1295 has been shown to increase both GH and IGF-1 in healthy men (Sackmann-Sala et al., 2009). GH/IGF-1 has established roles in muscle growth, collagen synthesis, and fracture healing. A pilot RCT using recombinant GH (not a secretagogue) in ACL reconstruction showed improved quadriceps strength (Bedi et al., 2020). However, no published RCTs exist for CJC-1295 or ipamorelin specifically in orthopaedic recovery.

Safety concerns

GH-axis stimulation carries known risks: fluid retention, joint pain, carpal tunnel syndrome, insulin resistance. Theoretical concern exists that elevated IGF-1 may promote growth of pre-existing tumors. Long-term safety data for these secretagogues is absent.

Regulatory / anti-doping status

FDA: Not approved for any indication. WADA: Banned under S2 (Peptide Hormones, Growth Factors). NCAA & NFL: Banned as growth hormone secretagogues.

PRP (Platelet-Rich Plasma) Growth Factors

Autologous multi-peptide delivery system

Multiple RCTs • WADA Permitted

What it is

PRP is not a single peptide but rather a concentrated preparation of your own blood platelets. When activated, these platelets release a cocktail of bioactive growth factors and peptides including PDGF, TGF-beta, VEGF, EGF, IGF-1, and FGF. This makes PRP a natural multi-peptide delivery system (Sanchez Gonzalez et al., 2012).

Current evidence

PRP has the most extensive clinical trial literature of any regenerative therapy in sports medicine, with Level I RCTs for knee osteoarthritis (generally positive short-term pain relief vs. saline), lateral epicondylitis, and Achilles tendinopathy. Evidence for rotator cuff repair and ACL reconstruction remains inconclusive. A significant limitation is composition variability: growth factor concentrations differ by patient, preparation method, and centrifugation protocol (Milano et al., J ISAKOS 2019).

Regulatory / anti-doping status

FDA: Not an approved drug; classified as a medical procedure. WADA: Permitted (removed from prohibited list in 2011). PRP is the only regenerative peptide-based therapy explicitly allowed for athletes in competition.

4. Evidence Summary Table

The following table compares the current state of evidence across all peptides discussed. "Level I" represents the strongest evidence (randomized controlled trials); "Preclinical" means only animal or laboratory studies exist.

Peptide	Best Evidence Level	Human RCTs for Sports/Ortho?	FDA Status	WADA Status
Collagen Peptides	Level I (Multiple RCTs)	Yes (many)	GRAS Dietary Supplement	Not Banned
PTH(1-34) / KUR-111/113	Level I (RCTs)	Yes (fractures)	Approved (Osteoporosis)	Banned (S4, In-Comp.)
PRP Growth Factors	Level I (Multiple RCTs)	Yes (OA, tendinopathy)	Medical Procedure	Permitted
TPX-100	Level I (Phase II)	Yes (knee OA)	Investigational	Not Specifically Listed
BPC-157	Level IV (1 case series, n=12)	No	Not Approved	Banned (S0)
TB-500 / Thymosin Beta-4	Level II (cardiac, not sports)	No (for sports injuries)	Not Approved	Banned (S0)
GHK-Cu	Preclinical + Cosmetic	No (musculoskeletal)	Not Approved (Drug)	Not Banned
CJC-1295 / Ipamorelin	Preclinical / Indirect	No	Not Approved	Banned (S2)

5. Quality and Safety: Research-Grade vs. Pharmaceutical-Grade

For patients considering any peptide therapy, understanding the distinction between product grades is critical for safety.

Feature	Research-Grade ("For Research Only")	Pharmaceutical-Grade (Compounded)
Manufacturing oversight	None or minimal	FDA cGMP standards
Purity testing	Self-reported or absent	Independent third-party verification
Sterility guarantee	None	Required
Endotoxin testing	None	Required (USP <85>)
Prescription required	No	Yes

Legal for human use	No	Yes (with prescription)

Why this matters for injectable peptides

The FDA's impurity threshold for pharmaceutical products is 0.5%. Research-grade products have no such accountability. For injectable peptides, endotoxin contamination can cause fever, sepsis, organ failure, or death—even if the product is technically sterile. The "for research purposes only" label is a liability disclaimer, not a safety certification (AOSSM, January 2026).

6. Regulatory Landscape (United States)

FDA Framework

The FDA categorizes peptides into distinct regulatory buckets. Understanding where a peptide falls determines its legal availability:

- FDA-Approved Drugs: Full clinical trial pathway completed. Examples: teriparatide (Forteo) for osteoporosis, semaglutide (Ozempic/Wegovy) for diabetes/obesity. These can be prescribed for their approved indications or used off-label by physicians.
- Compounded Peptides (503A/503B): Pharmacies can compound non-FDA-approved drugs for individual patients (503A) or in bulk (503B) under specific conditions. However, the FDA placed many peptides in "Category 2" in September 2023, effectively banning them from compounding.
- Research Chemicals: Products labeled "for research use only" or "not for human consumption." These are legally sold for laboratory research but are not legal for human use.
- Dietary Supplements (GRAS): Products like collagen peptides that are Generally Recognized as Safe and sold over the counter.

September 2023 FDA Action

In September 2023, the FDA moved 17 peptides to "Category 2" of the 503A bulk drug substances list, effectively prohibiting traditional compounding pharmacies from preparing them. BPC-157 and Thymosin Beta-4 (TB-500) are both in Category 2. The FDA cited immunogenicity risk, peptide impurities, and limited human safety data as reasons.

Recent Developments (2026)

In February 2026, HHS leadership publicly indicated intent to move approximately 14 peptides from Category 2 back to Category 1 (permitting compounding). However, as of March 2026, no formal FDA rulemaking has been published. These peptides remain legally banned from compounding. A federal court case (Evexias Med. Ctrs. v. FDA) requires a final rule by March 14, 2027.

What this means for patients

Using a peptide that is not FDA-approved for any indication is fundamentally different from "off-label use" of an approved drug. Off-label prescribing (using an approved drug for a non-approved purpose) is a common, accepted medical practice. Prescribing an entirely unapproved substance carries a different legal and safety risk profile. Patients should understand this distinction when evaluating treatment options.

7. Anti-Doping Considerations for Athletes

Athletes subject to anti-doping testing should be aware of the following classifications under the 2025 WADA Prohibited List:

Peptide	WADA Category	Status	Competition Scope
BPC-157	S0 (Non-Approved Substances)	Banned	In- and out-of-competition
TB-500 / Thymosin Beta-4	S0 (Non-Approved Substances)	Banned	In- and out-of-competition
CJC-1295 / Ipamorelin	S2 (Peptide Hormones)	Banned	In- and out-of-competition
PTH / Teriparatide	S4 (Hormone Modulators)	Banned (TUE available)	In-competition
PRP	—	Permitted	All routes
Collagen Peptides	—	Permitted	All contexts
GHK-Cu	—	Not banned (verify annually)	—

Strict liability principle: Under WADA rules, athletes are responsible for any substance found in their body, regardless of how it got there. Contaminated supplements and research-grade peptides can cause inadvertent positive tests. The NCAA and NFL maintain their own banned substance lists that explicitly name BPC-157, TB-500, and growth hormone secretagogues.

8. The Bottom Line

Key takeaways for patients

- Collagen peptides (dietary supplements) have the strongest and most consistent human evidence for joint comfort and exercise recovery. They are safe, legal, not banned in sports, and available over the counter.
- PRP has the most clinical trial data of any regenerative approach in sports medicine and is permitted for athletes. Results are variable due to preparation differences.
- PTH-based therapies show strong clinical evidence for fracture healing, with FDA-approved options (for osteoporosis) and promising investigational bone graft substitutes.
- TPX-100 is an intriguing investigational peptide for knee OA with positive Phase II data, but is not yet available outside of clinical trials.

- BPC-157, TB-500, GHK-Cu, and GH secretagogues have generated significant public interest but have little to no human clinical evidence supporting their use for sports injuries. They are not FDA-approved, and most are banned by major anti-doping agencies.
- The gap between social media claims and published scientific evidence is large. Animal study results frequently do not translate to humans.
- Product quality is a serious safety concern. Research-grade peptides sold online lack manufacturing oversight and may contain dangerous contaminants.
- The regulatory landscape is evolving. Potential policy changes are under discussion, but no formal changes have taken effect as of March 2026.

The field of peptide therapeutics in orthopaedic sports medicine is active and evolving. Well-designed human clinical trials are needed before most peptides can be recommended for clinical use. Patients are encouraged to discuss any interest in peptide therapies with their physician, who can help evaluate the evidence, legal status, and safety profile in the context of individual circumstances.

9. Selected References

This resource draws on over 50 peer-reviewed publications. Key references are listed below with direct links to source publications.

1. Vasireddi N, Hahamyan HA, Salata MJ, et al. Emerging use of BPC-157 in orthopaedic sports medicine: a systematic review. *Sports Health.* 2025. DOI: 10.1177/15563316251355551
2. Rahman OF, Lee S, Seeds WA. Therapeutic peptides in orthopaedics: applications, challenges, and future directions. *JAAOS Global Res Rev.* 2026. DOI: 10.5435/JAAOSGlobal-D-25-00236
3. AOSSM. The boom of peptides in sports medicine: do we know anything more? *Editorial.* January 2026. sportsmed.org
4. Moitzi A, Konig D, Bischof K, Stafilidis S. Impact of collagen peptide supplementation with long-term physical training—systematic review with meta-analysis. *Sports Med.* 2024. DOI: 10.1007/s40279-024-02079-0
5. Konig D, Zdzieblik D, Oesser S, Gollhofer A. Improvement of activity-related knee joint discomfort following collagen peptides. *Appl Physiol Nutr Metab.* 2017. DOI: 10.1139/apnm-2016-0390
6. Bischof K, Stafilidis S, Bundschuh L, et al. Influence of collagen peptides and 12-week concurrent training on recovery. *Front Nutr.* 2023. DOI: 10.3389/fnut.2023.1266056
7. Demir-Dora D, et al. Efficacy and safety of CollaSel PRO type I and III hydrolyzed collagen in osteoarthritis. *J Clin Med.* 2025. DOI: 10.3390/jcm14113655
8. Kuwaba K, et al. Dietary collagen peptides alleviate exercise-induced muscle soreness. *J ISSN.* 2023. DOI: 10.1080/15502783.2023.2206392
9. Kanakaris NK, et al. Novel PTH-based bone graft substitute (KUR-111) in tibial plateau fractures. *Eur J Orthop Surg Traumatol.* 2026. DOI: 10.1007/s00590-025-04645-2
10. Orbeanu V, et al. Novel PTH-based bone graft (KUR-113) in treatment of acute open tibial shaft fracture. *JBJS.* 2021. DOI: 10.2106/JBJS.20.02109
11. McGuire D, et al. Intra-articular TPX-100 significantly delays pathological bone shape change in knee OA. *Arthritis Res Ther.* 2021. DOI: 10.1186/s13075-021-02622-8
12. Chang CH, et al. BPC 157 enhances growth hormone receptor expression in tendon fibroblasts. *Molecules.* 2014. DOI: 10.3390/molecules191119066
13. Pickart L, Margolina A. Regenerative and protective actions of GHK-Cu peptide. *Int J Mol Sci.* 2018. DOI: 10.3390/ijms19071987
14. Sackmann-Sala L, et al. Activation of GH/IGF-1 axis by CJC-1295. *Growth Horm IGF Res.* 2009. DOI: 10.1016/j.ghir.2009.03.001
15. Bedi A, et al. Use of recombinant human GH in patients undergoing ACL reconstruction. *Am J Sports Med.* 2020. DOI: 10.1177/0363546520920591
16. Milano G, et al. Platelet-rich plasma in orthopaedic sports medicine: state of the art. *J ISAKOS.* 2019. DOI: 10.1136/jisakos-2019-000274
17. Chornomydz AV, Klantsa M. The grey zone of pharmacology: BPC-157, TB-500 review. *Pharm Chem Sci.* 2025. DOI: 10.31891/pcs.2025.4.2
18. Matek D, et al. Tendon, ligament, and muscle injury: perspectives with growth factors and BPC 157. *Pharmaceuticals.* 2026. DOI: 10.3390/ph19020309
19. Maquart FX, et al. In vivo stimulation of connective tissue accumulation by GHK-Cu. *JCI.* 1993. DOI: 10.1172/JCI116842
20. Sanchez Gonzalez DJ, et al. Platelet-rich plasma peptides: key for regeneration. *Int J Pept.* 2012. DOI: 10.1155/2012/532519
21. Fritz P, et al. Bioactive collagen peptides and fibroblast-mediated matrix regeneration. *J Recreation.* 2025. DOI: 10.21486/recreation.2025.15.4.1
22. Wang Y, et al. Activation of pro-resolving pathways mediates therapeutic effects of thymosin beta-4. *Front Immunol.* 2024. DOI: 10.3389/fimmu.2024.1458684
23. Yoon J, et al. Is local administration of PTH effective for tendon-to-bone healing? *J Orthop Res.* 2020. DOI: 10.1002/jor.24452
24. Pountos I, et al. The role of peptides in bone healing: a systematic review. *BMC Medicine.* 2016. DOI: 10.1186/s12916-016-0646-y
25. Goulian A, et al. Advancements in regenerative therapies for orthopedics. *J Clin Med.* 2025. DOI: 10.3390/jcm14062061