

The background features a green-tinted image of a runner in profile, wearing a head-mounted display and a backpack, running through a laboratory or industrial setting with various equipment and pipes.

NUTRIENTS TO SUPPORT BONE & CONNECTIVE TISSUE HEALTH

The Gatorade logo, a stylized white lightning bolt with black and grey accents, is positioned above the text.

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OVERVIEW

- The role of nutrition to build and maintain bone
- Issues specific to athletes and bone
- The role of nutrition to support connective tissue health and function

BONE FACTS

Bone is influenced by nutrient intake across the lifespan.

Bone turnover is reduced with feeding vs fasting.



Components of Bone

Collagen Fibers

Non-collagen proteins

Deposited minerals, primarily hydroxyapatite
(a calcium phosphate mineral)

PEAK BONE MASS

90%

90 % of peak bone mass is acquired
by:

Age 18 in girls
Age 20 in boys

Bone can keep growing into
the late 20's

At that point, bones reach
Peak Bone Mass – the
maximum strength and
density of bones

BONE TURNOVER

Even after **peak bone mass** is achieved, bone is continually remodeled throughout life.

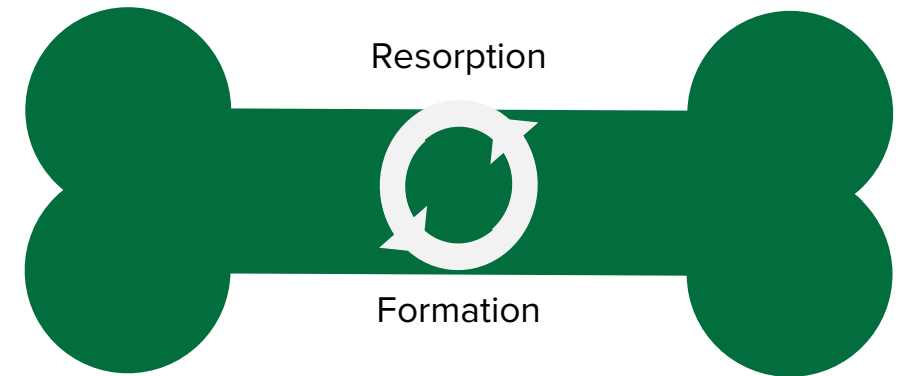
Resorption = bone breakdown

Formation = building of new bone

Entire calcium bone pool turns over about every 5-6 years.

If bone resorption $>$ formation, bone strength will be compromised.

Bone loss increases with aging, but exercise and diet are effective to minimize the loss .



BONE MINERAL DENSITY

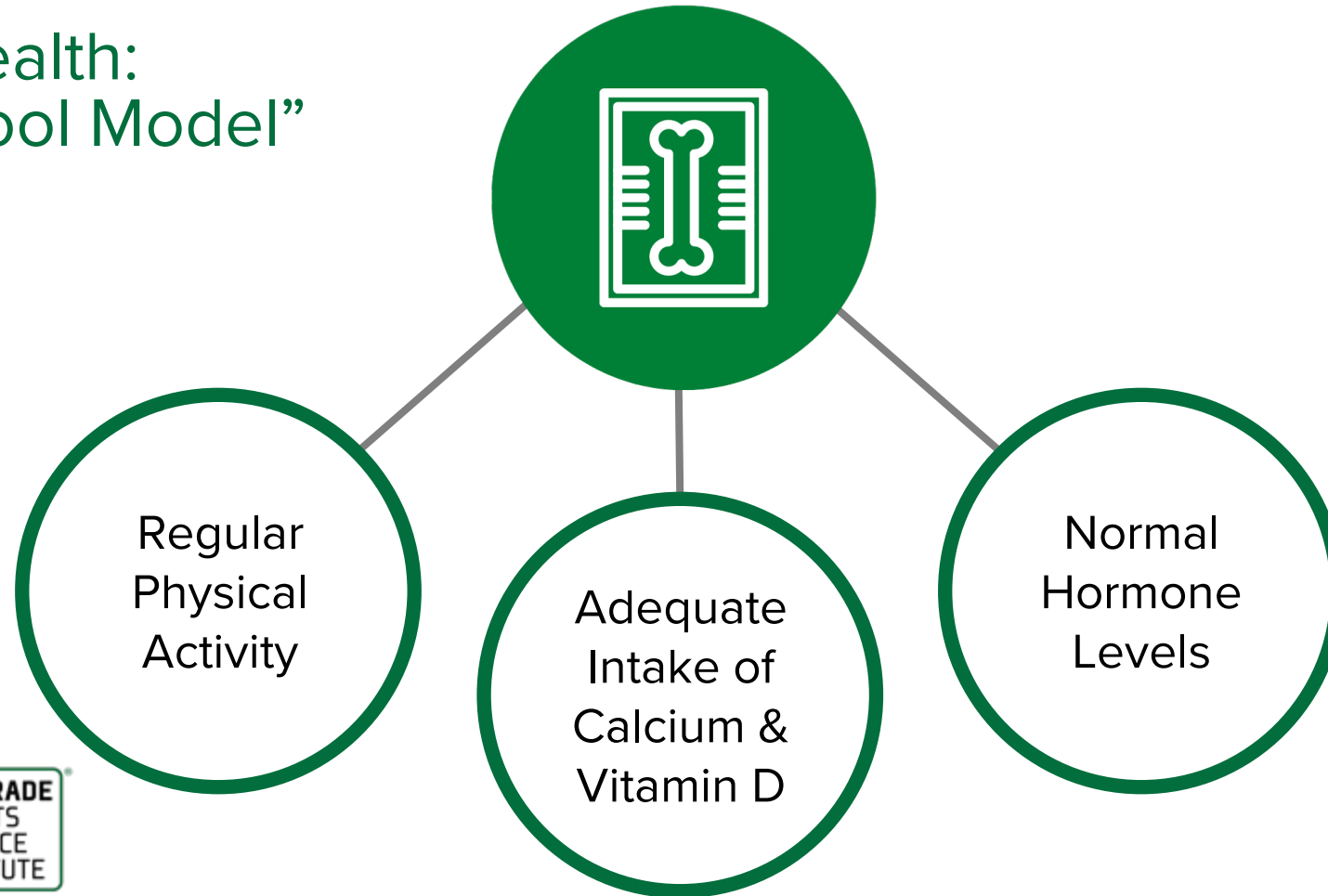
Bone mineral density (BMD) = the amount of bone mineral contained within a standard area of bone.

Fracture risk increases 1.5 to 3-fold for each 10% drop in BMD below values typical to the young, healthy adult.

BMD is used as a surrogate measure of bone strength and resistance to fracture.

Strong bones require:

Bone Health:
“3-Legged Stool Model”



Model developed
by Dr. Robert
Heaney of
Creighton University

SSE#82



Besides Calcium and
Vitamin D, which nutrients
do you think are important
for bone health?

KEY NUTRIENTS TO SUPPORT BONE HEALTH

While Calcium & Vitamin D are important, there are many nutrients that support the bone:

Protein	Manganese
Calcium	Potassium
Vitamin D	Iron
Phosphorous	Vitamin K
Magnesium	Vitamin C
Zinc	Vitamin A
Copper	B Vitamins
Boron	Silica



RISKS TO BONE HEALTH FOR ATHLETES

While exercise is important to stimulate bone formation, too much exercise can cause injuries.

Stress fractures are the most common bone injuries suffered by athletes:

- Occur relatively regularly in many sports
- Caused by the rhythmic and repeated application of mechanical loading
- Nutritional inadequacies could be a risk factor

In some sports, particularly those where a low body weight predicts performance, there is a longer-term risk to bone health:

- Increased risk of **osteopenia** (reduced bone mass) and **osteoporosis** (disease where density and quality of bone are reduced)
- Particularly a concern if peak bone mass was low in early adulthood



Bone Issues Specific to Athletes & Nutrition

- Protein Intake
- Energy Availability
- Vitamin D Intake



It seems unlikely that higher animal protein intakes, in the amounts recommended to athletes, are harmful to bone health

Athletes might need to consume more protein than the general population to support the increased rate of bone turnover caused by athletic training.

Ensure the athlete's diet contains sufficient calcium during periods of higher protein consumption to reduce the potential for negative effects on the bone.



ENERGY AVAILABILITY

Energy Availability = dietary energy intake minus exercise energy expenditure adjusted for muscle mass.

Energy availability of ≥ 45 kcal/kg LBM/d is ideal to support bone health in the athlete, although this is an unrealistic target for many.

Current knowledge would suggest trying to achieve an energy availability > 30 kcal/kg LBM/d to minimize negative effects on the bone.



ENERGY AVAILABILITY BY SEX



The link between chronic low energy availability and bone health is clear in females, studied as part of the Female Athlete Triad.



It is unclear if bone mass suffers as much in males.

Relative Energy Deficiency in Sport (RED-S): Similar to the Female Athlete Triad, but acknowledges men are also impacted.

Female Athlete Triad = low energy availability with or without disordered eating, menstrual dysfunction, low bone density.

SSE#201



CALCIUM & VITAMIN D INTAKE

The RDA for calcium is 1000 mg/d for adults

- There is no need to consume more than the RDA
- The pattern is important – intake should be spaced throughout the day to maximize absorption

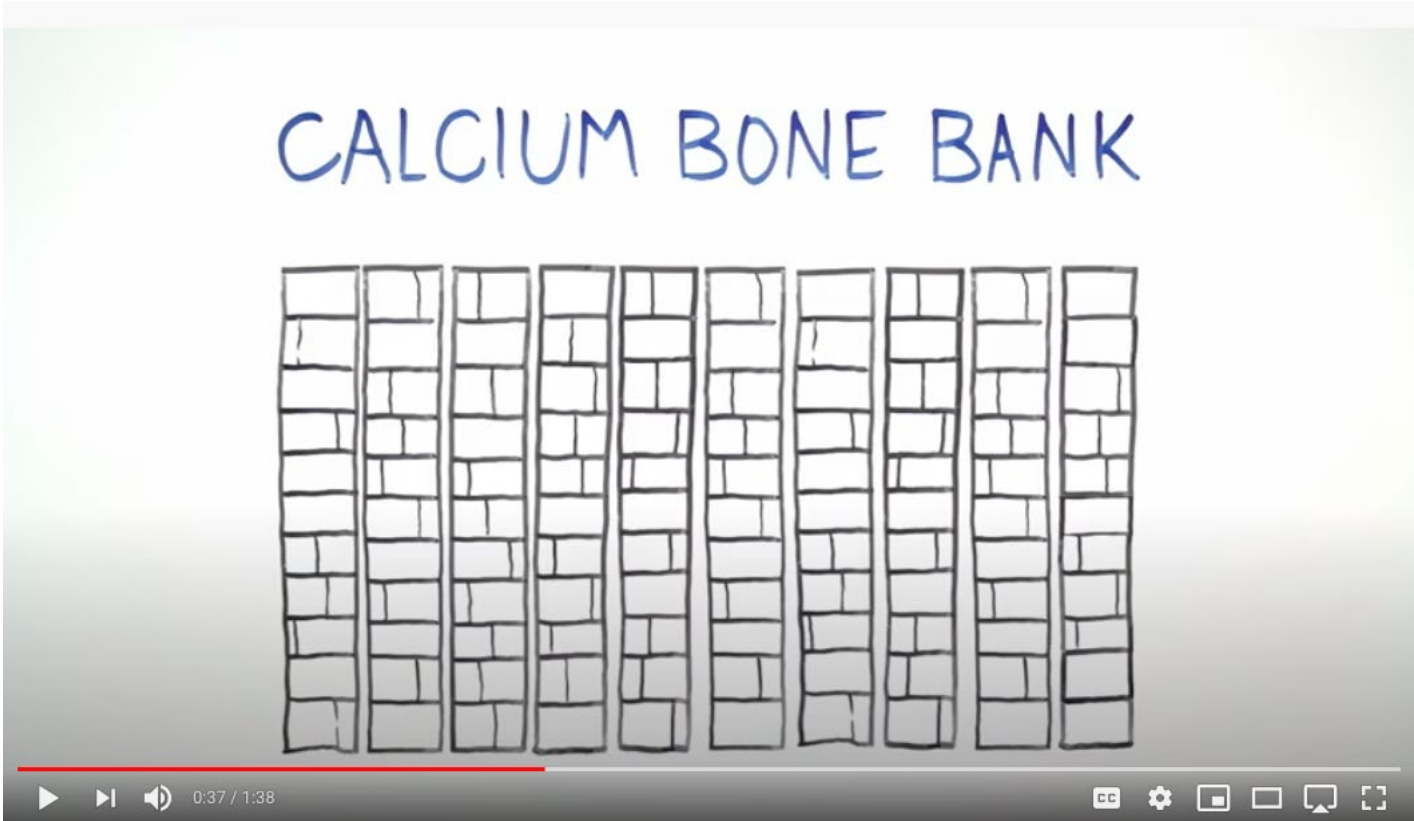
Vitamin D is important for calcium and phosphorus regulation, as well as other mechanisms related to bone health.

It is highly likely that athletes who are deficient in Vitamin D will be at a greater risk of low bone mass and bone injuries, such as stress fractures:

- Vitamin D is best obtained from the sun, if possible
- The RDA for adults is 600 IU/d.
- It is best to monitor blood values of Vitamin D status



SUMMARY VIDEO



[Link to bone summary video](#)



CONNECTIVE TISSUE

LIGAMENTS & TENDONS

Tendons and ligaments are complex and dynamic tissues that are poorly understood, in part because of the difficulty in working with them in human models.

Recently, engineered ligaments have been developed from human anterior cruciate ligaments or hamstring tendons. These tissues are functionally similar to embryonic tendons and ligaments and can be used to understand how different stimuli affect function.

Historically it was thought that the connective tissues was unresponsive to exercise stimuli and nutrition, but it is now known not to be the case.



Dr, Keith Baar at UC Davis developed the engineered ligament model

Tendon – attaches a muscle to bone
Ligament – attaches two bones together

SSE#187



NUTRITION & CONNECTIVE TISSUE

The study of nutritional impact on connective tissue function is in early stages.

One study has shown leucine-rich whey protein to benefit not only muscle but also tendon hypertrophy with strength training. But it's unclear if the effect was directly on the tendon or an indirect effect of muscle hypertrophy.

Hydrolyzed collagen and gelatin, rich in the amino acid proline, lysine, hydroxylysine and hydroxyproline, have been shown to positively effect collagen synthesis in ligaments when combined with Vitamin C.

Why Vitamin C?

Vitamin C is an essential cofactor for the synthesis and crosslinking of collagen

KEY RESEARCH FINDINGS

Clark et al. (2008): hydrolyzed collagen decreased knee pain in athletes.

McAlindon et al. (2011): 10 g/d collagen hydrolysate resulted in increased knee cartilage.

Shaw et al. (2017): 15 g gelatin + vitamin C 1 hour prior to activity increased collagen synthesis.

KEY RESEARCH FINDINGS

Vitamin C + Amino Acids = ↑ collagen synthesis
(proline, lysine, hydroxyproline, hydroxylysine)



48 mg

Gelatin (15 g)

1 hour prior to 6 min rope skipping

Shaw et al.




How to Deliver Gelatin: Gummie Recipe from Dr. Baar



Keith Baar
@MuscleScience


Here is the recipe that I use to get a high concentration in a gummie



FMBLab
Nutrition

Building Blox Recipe

Ingredients	Directions
<p>8 Servings</p> <p>80g (½ cup) of Knox® Gelatin</p> <p>80g (½ cup) of Great Lakes Hydrolyzed Collagen</p> <p>1½ Cup Vit C enriched juice (Ribena)</p> <p>1 Cup water</p> <p>500 mg of vitamin C if not using Vit C enriched</p> <p>* use a type of juice that is a favorite of the house. Most are sweet enough to not need any sugar. Nutrition calculated using Ribena®.</p>	<ol style="list-style-type: none">1. Bring 1½ cups of Ribena® to a boil.2. Meanwhile, mix gelatin and collagen into the cup of water.3. Add the hot juice to the gelatin and stir until dissolved4. Pour gelatin into molds or a flat tray or use ice cube/candy molds5. Place in the fridge to set.6. Cut into 8-10 pieces7. Eat one piece 30-60min before training




Gel Blox Nutrition	
Amount	1/8 recipe
Calories	168kcal
FAT (g)	0
CHO (g)	31.9
PRO (g)	10

This is a dairy, nut and gluten free food.

For Further Information Contact:

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Follow us on Twitter:
 @MuscleScience

Food for Thought

Including gelatin in a rehab program or consuming gelatin 30-60 minutes before training is thought to improve collagen synthesis (make ligaments, bones and tendons stronger), prevent injury, and accelerate return to play after injury to bone, tendon, ligament, and cartilage.

KEY TAKEAWAYS

- ✓ The role of nutrition to build and maintain bone is well established.
- ✓ For athletes, energy availability, protein intake, calcium and vitamin D intake are important considerations.
- ✓ The role of nutrition to support connective tissue health and function is emerging.
- ✓ There appears to be a benefit to consuming gelatin and vitamin C.



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