

EOTRH and Organic Selenium The Missing Link?

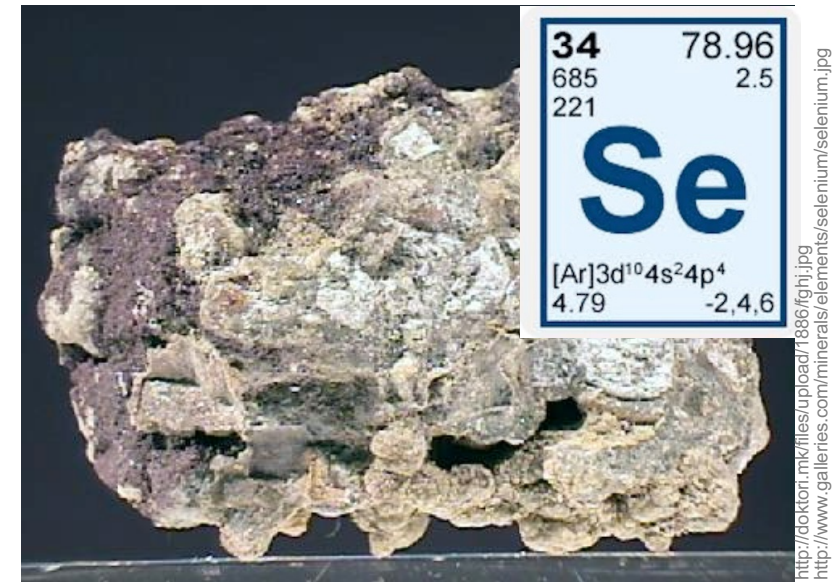
Dr. rer. nat. Christina Fritz



Midjourney

Selenium – A Common Trace Element

- Selenium is a **trace element found throughout the world**
 - The **body requires it in small amounts** for various metabolic processes
 - In larger amounts, it becomes **toxic very quickly!**
(>1-2 mg/kg of feed dry matter)
 - **Until the 1980s**, selenium was **supposed to be a toxic mineral for horses** due to experiences with Blind Staggers / Alkali Disease from pasture in the Great Planes (USA)
 - Carnivores naturally ingest large amounts of selenium through their diet and have developed a certain tolerance
 - **Plants generally contain very little to no selenium**
- **As a herbivore, the horse is adapted to a very low selenium intake!**





Selenium Deficiency – A Modern Equine „Pandemic“

Selenium Deficiency – A Common Diagnosis in Equine Practice

- **Almost every horse today is diagnosed with “selenium deficiency” based on a blood test – regardless of clinical symptoms!**
- Even otherwise healthy horses often show low selenium levels in their bloodwork:

Trace Elements

Copper	75	mcg/dl		50 - 150
Zinc	1140	mcg/l		500 - 1300
Selenium	59	mcg/l	-	100 - 200

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- **But: “deficiency” much depends on the lab you use*:**

Lab:	Vet.-Med.-Lab	Biocontrol	Tierlab	Laboklin	US-Labs
Selenium	80-150	28-133	140-250	100-200	60-300
Zinc	600-1600	600-1600	550-630	600-1300	650-2700
Copper	500-1500	1200-1330	1210-1330	1200-1330	850-2000

*Source: Dr. Stefan Brosig 2005

Selenium Reference Ranges and Requirements Remain Uncertain to This Day

Selenium Levels in Studies Show Strong Variation:

Author	Reference Range
Ullrey (1987)	80 - 120µg/l
Meyer (1990)	60 - 120µg/l
Meyer (1990)	40 - 80µg/l
Heikens (1992)	53 - 140µg/l
Puls (1994)	53 - 250µg/l
Meyer & Coenen (2002)	100 - 250µg/l
Meyer & Coenen (2002)	70 - 90µg/l
Dietz & Huskamp (2006)	28 - 133µg/l


Key Fact:

Recent Studies show that plasma selenium levels have no correlation with selenium levels in tissues!

Selenium Metabolism and Blood Levels

- Selenium is primarily absorbed through the diet.
- In the bloodstream, selenium is transported bound to albumins or globulins.
- **It accumulates mainly in the following tissues:**
 - Muscle
 - Liver
 - Kidneys
 - Endocrine glands (pancreas, thyroid, adrenal glands, gonads, pituitary gland, etc.)
- When selenium is required, **plasma levels drop first** as selenium is transported into the cells.
- With selenium supplementation, **tissue levels increase first**, and only later do plasma levels begin to rise.
- In cases of **zinc deficiency, selenium levels in blood often decrease before zinc** levels do.
- A **“true” selenium deficiency** ($<40\mu\text{g/l}$ or $0.508\ \mu\text{mol/l}$) in bloodwork is frequently a **secondary indicator** for **increased zinc loss**, such as in Kryptopyrroluria (KPU).
- Importantly, **blood selenium levels do not reflect the availability of selenium for the cellular processes.**

➤ **Then why is everybody talking about selenium deficiency?**

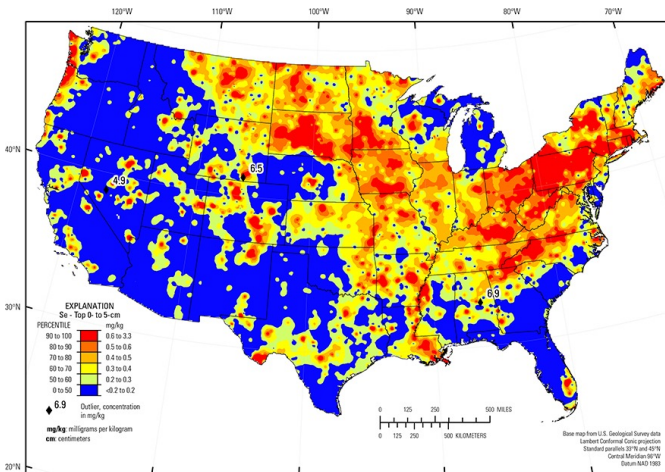
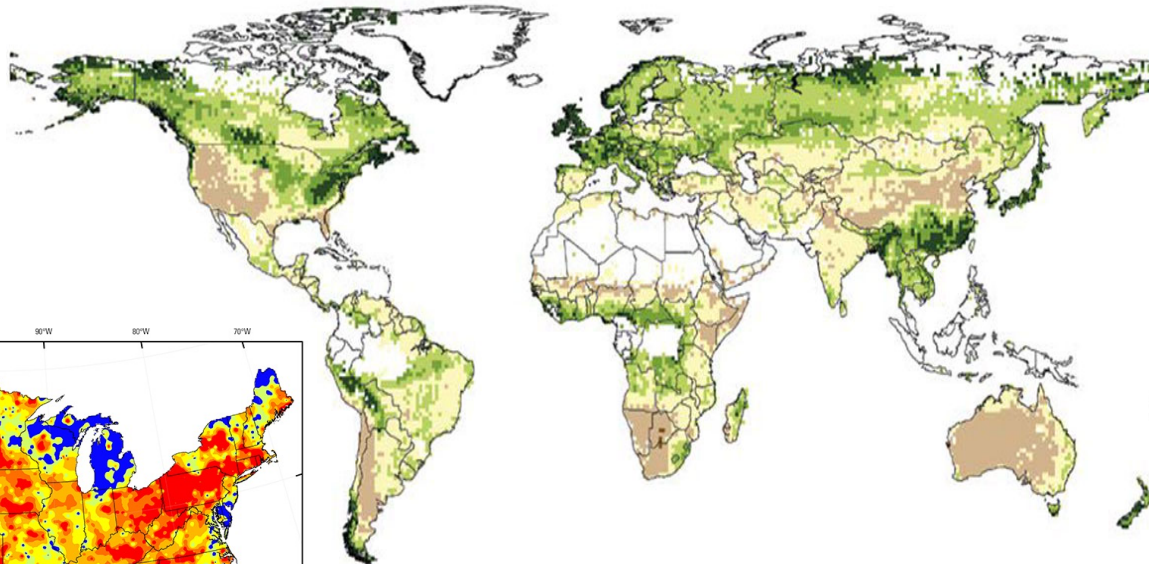


Selenium Deficiency is the Leading Cause for Widespread White Muscle Disease in Calves



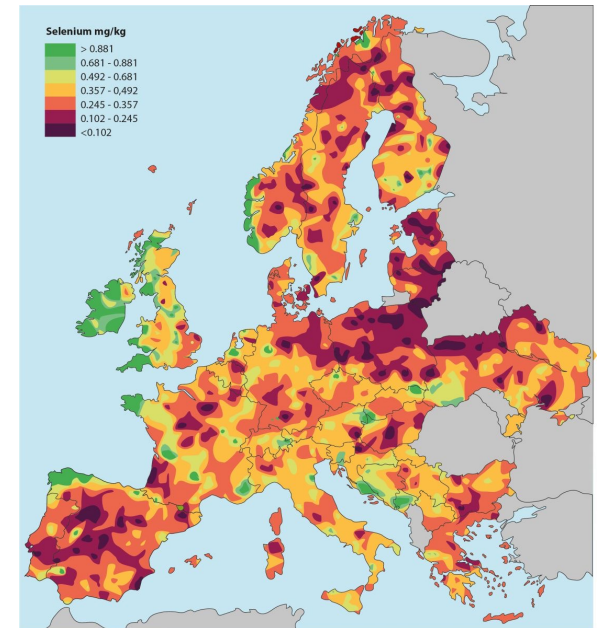
= It Must Be Selenium-Deficient Soils!

Selenium is Very Common in Dark Soils, Only Rare in Dry Regions



https://pubs.usgs.gov/sir/2017/5118/elements/Selenium/Top5_Se_m.png

<https://www.horizonte-magazin.ch/wp-content/uploads/2017/04/horizonte-112-weltkarte-eines-spurenelements-1170x780.jpg>



<https://www.pharmanord.com/static/CKFinderJava/userfiles/images/pharmanord/US/seleniumbook/usfarmland.jpg>

“Selenium Deficient” Soils = Deficiency in Feed?



- **Soil selenium levels do not reflect availability in forage**
 - Many plants do not absorb any Selenium from soil, while others are Selenium-accumulators
 - **Selenium levels in forage can be estimated based on cow's milk values*:**
 - Finland: 6 µg/l
 - Germany: 10–20 µg/l
 - Northeast Poland (near Trakehnen): 5.5 µg/l
 - According to this logic, Trakehnen's legendarily tough horses all suffered from severe selenium deficiency which makes one wonder how they managed to survive the brutal trek westward at the end of WWII...
 - **Since 2003, adding selenium to fertilizers** has been recommended to counteract the "selenium deficiency" in dairy cows and horses – which now leads to **selenium poisoning in horses via hay and pasture.**
- **Horses are far more sensitive to selenium oversupply than cattle or pigs!**

*Source: Dr. Stefan Brosig 2005

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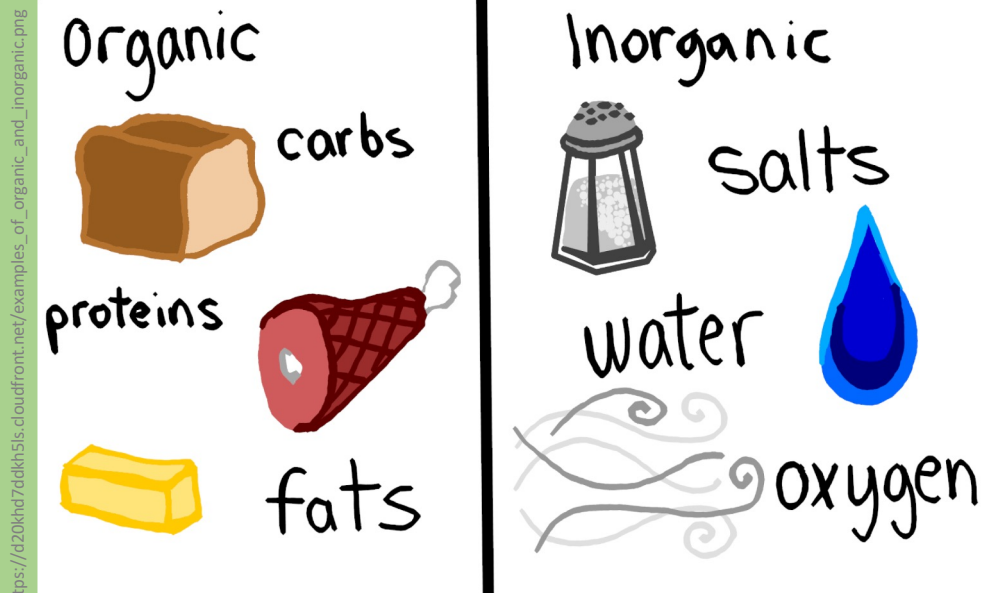


Current Selenium Intake Recommendations in Horses

- **Currently, it is recommended to feed horses 0.1–0.2 mg of selenium per kg of dry matter (Germany).**
- According to more than 300 grass samples from 7 federal states (Germany), the average selenium content in basic forage is only 0.011–0.123 mg/kg dry matter.
- For centuries, hardworking and healthy horses were bred and fed with this „selenium-poor“ forage.
- **So, is selenium supplementation truly necessary and useful?**
- After all, selenium as a trace element only became a topic in equine nutrition in the 1990s.
- **Since the mid-1990s, horse feeds—especially mineral and mixed feeds—have been supplemented with selenium and still selenium deficiency in horses bloodworks is „common“.**



We feed it. We test for it. But do we actually understand what's going on with selenium in the horse's body?



„Organic“
vs.
„Inorganic“
and
„Bioavailability“

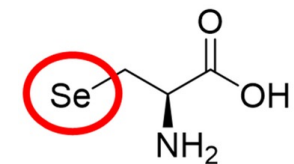
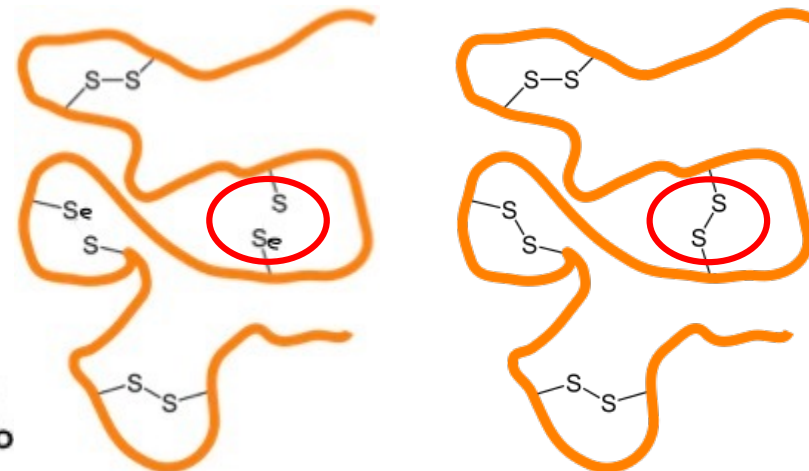
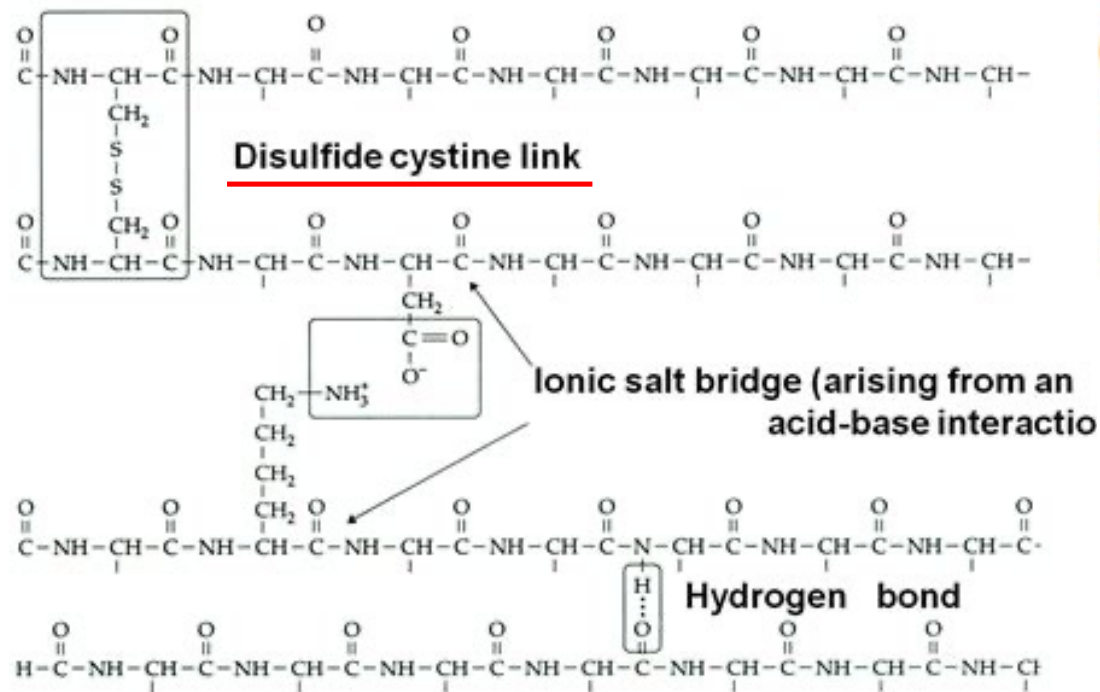


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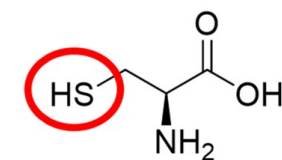


Organic Selenium: Potential Effects on Equine Dental Health

Organic Selenium is Incorporated In Place of Cysteine Into Proteins



Selenocysteine



Cysteine

Disulfide Bonds Provide Structural Integrity...

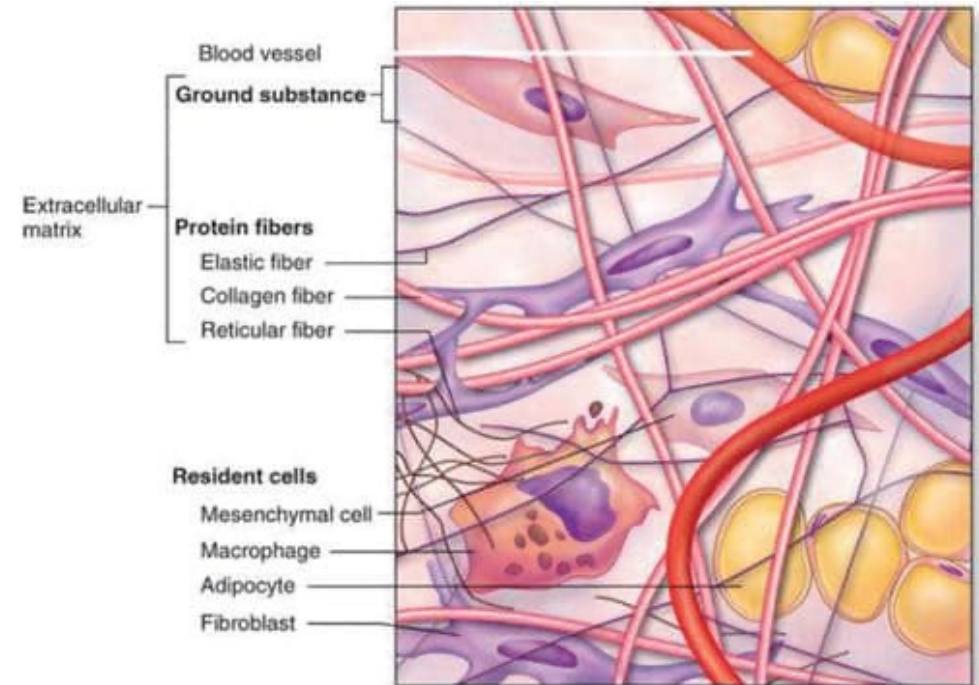
...for all connective tissues (collagen fibers):

Matrix proteins are essential for tendon and ligament function because they **organize and stabilize the collagen network** — a process that depends on intact disulfide bonds.

➤ **Without disulfide bonds, matrix protein function is impaired, weakening the tissue's structural integrity.**

Matrix proteins in:

- Connective Tissue
- Fascia
- Tendons
- Ligaments
- Joint Capsules
- ...

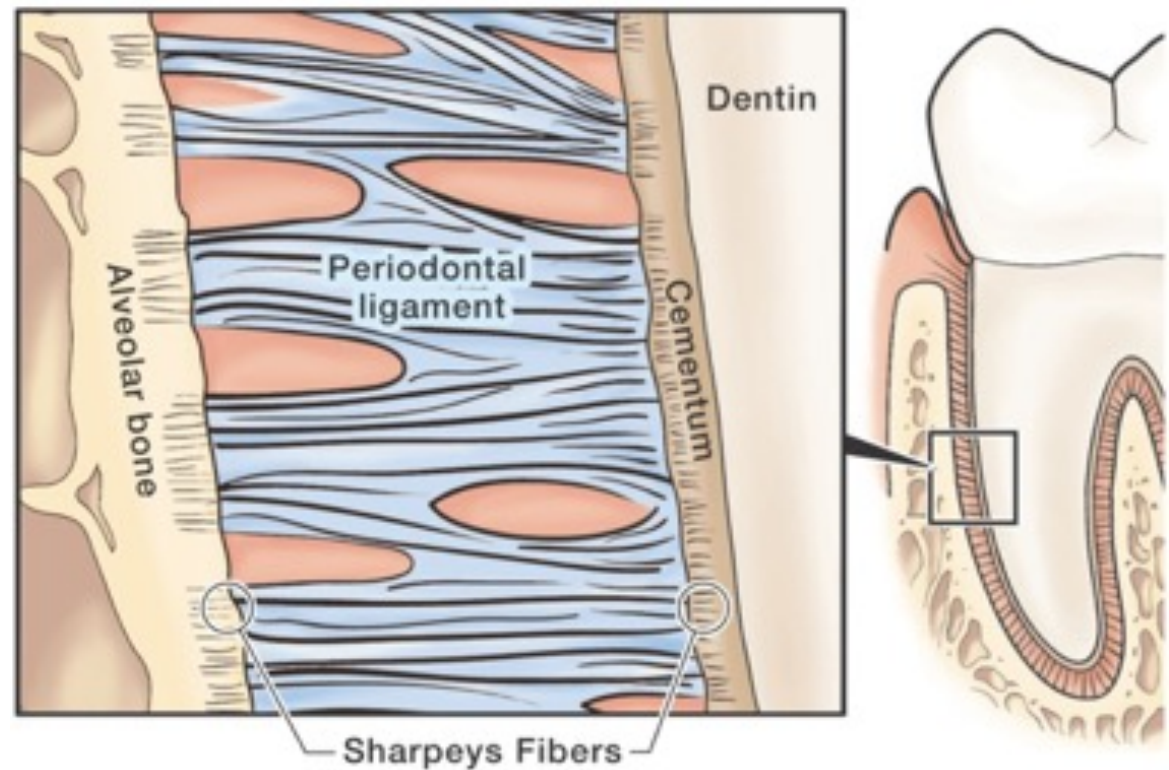


Disulfide Bonds Provide Structural Integrity...



... for tooth roots as well!

- The tooth is not just loosely placed in the alveolar socket — it is firmly **anchored by Sharpey's fibers**.
- These fibers connect the **periodontal ligament** to both the **cementum of the tooth** and the **alveolar bone**.
- **Sharpey's fibers and periodontal ligament** require **specific matrix proteins** to align properly and ensure **tensile strength**.
- This structure allows the tooth to **resist pressure and traction** during biting and grazing without the root moving within the socket.
- When the **integrity of Sharpey's fibers or periodontal ligament** is disrupted (e.g. by exposure to **organic selenium** interfering with matrix protein integrity),
→ **fibers rupture**,
→ the tooth root begins to **move within the socket** under mechanical load.



<https://quizlet.com/738375696/periodontium-part-2-flash-cards/>

Working Hypothesis Behind Organic Selenium and Acute EOTRH

1. Mechanical stress as the initial trigger

- Incisors that are **too long relative to molars** and disrupt natural occlusion.
- To bring molars into contact, the horse must **bite harder**, increasing pressure on the incisors.
- **Additional stressors:** tightly meshed haynets with coarse hay, short or grazed-down or overmature pastures.

2. Compromised Sharpey's fibers and periodontal ligament integrity

- **Sharpey's fibers and periodontal ligaments** anchor the incisor root within the alveolar socket and **absorb mechanical load**.
- Their structural integrity depends on **proper matrix protein synthesis**.
- **Organic selenium** can interfere with this process, leading to **weakened fiber alignment** and reduced tensile strength.

3. Fiber rupture and loss of stability

- Under excess mechanical load, **Sharpey's fibers and periodontal ligaments tear**.
- The tooth root becomes **mobile within the socket**, causing micro-movements with every bite and during powerstrokes.
- These movements result in **micro-fractures and bone resorption** around the root apex.

4. The body's compensatory response

- The damage triggers **inflammation** followed by **hypercementosis** – the body's attempt to stabilize the tooth within the socket.
- This **explains the characteristic lesions, inflammation and pain of acute EOTRH**.



Dental Work & Nutrition Are a Team

Understanding the pattern

- Acute EOTRH always involves **unphysiological pressure on the incisors**.
- But since older horses in earlier centuries often had extremely long incisors *without* acute EOTRH,
→ **mechanical pressure alone cannot be the cause.**



- Horse feed is supplemented with **sodium selenite since 1990s** and **organic selenium since 2003 (USA) / 2006 (EU)**
- **First publications about incisor EOTRH in horses 2006** (Gregory 2006, Barat 2007, Caldwell 2007, Kreutzer et al. 2007, Staszuk et al. 2008)
- „An aetiological hypothesis proposes **mechanical stress of the periodontal ligament** as the initiating factor.“
- (Staszuk et al. 2008)
- The condition emerges only when **excessive mechanical load** coincides with an additional factor
- We propose **biochemical weakening of Sharpey's fibers and periodontal ligaments through incorporation of selenocysteine into matrix proteins, inhibiting their function.**
- Seen in this light, **hypercementosis** is not the disease itself, but a **stabilizing emergency response** of the body to prevent further bone destruction.

Organic Selenium: Additional Side Effects on Equine Health



https://m.media-amazon.com/images//51k4lkiqpl_UF894,1000_QL80_.jpg

Organic Selenium Also Increases the Risk for

- Recurring tendon and/or ligament inflammation / ruptures
- Scarring and „pulling“ within the fascial system
- Laminitis
- White line disease
- Navicular disease
- Chronic airway issues (COPD, equine asthma)
- Gastric ulcers
- Colitis / hindgut inflammation and dysbiosis
- Fecal water / chronic diarrhoea
- Thyroid dysregulation
- Insulin dysregulation
- EMS / Pseudo-EMS
- Cushing's



➤ **Many horses with acute EOTRH suffer from one or more of these symptoms!**



What to Do With Selenium- Challenged Horses?

Selenium in Bloodworks

40-120 μ g/l or
0.508-1.524 μ mol/l
is „normal“

Selenium overload
(>120 μ g/l or 1.524 μ mol/l)
is more common.

Always check bloodworks
for **Insulin Dysregulation** in
these cases.



Selenium deficiency
(<40 μ g/l or 0.508 μ mol/l)
is almost always a hidden
zinc deficiency.

Always check bloodworks
for **Kryptopyrroluria (KPU)**
in these cases.



<https://preview.free3d.com/img/2015/11/2269113951356716278/gdwzn2qd.jpg>

Therapeutic Approach

- **Shorten incisors**
- **Check all feed labels for organic selenium** (seleniumyeast, selenocysteine, selenomethionine) and avoid products accordingly
- **Optimize feeding** (24/7 low sugar <6% hay, 2-3kg / 100kg body weight)
- Eliminate all extra and hidden sugars, no (processed) grains, ideally no concentrates at all
- Provide **balanced inorganic mineral feed** or ration balancer with sodium selenite (inorganic selenium) instead of organic versions
- Administer **MSM** (Methylsulfonylmethane) during coat changes (enhanced protein turnover)
- **Treat other side effects** of organic selenium accordingly (e.g. insulin dysregulation, KPU etc.) to restore overall health.
- **Adjust training schedule** (muscles expend selenium!).
- Administer Schuessler Salt No. 26 „Selenium“ to re-balance selenium metabolism (=homeopathic remedy).
- **Never supplement organic selenium!**



A herd of five horses is galloping across a field of dry grass at sunset. The horses are in various stages of their stride, with dust kicked up behind them. The background is a soft, hazy orange and yellow sky. The overall mood is dynamic and energetic.

Want to know more?
www.sanoanimal.com

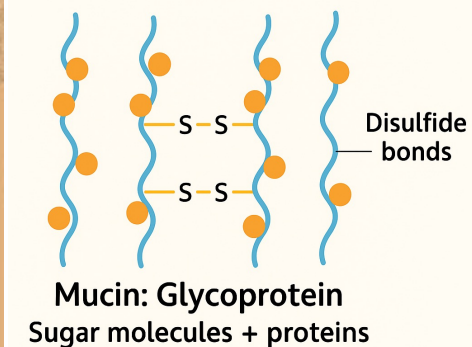
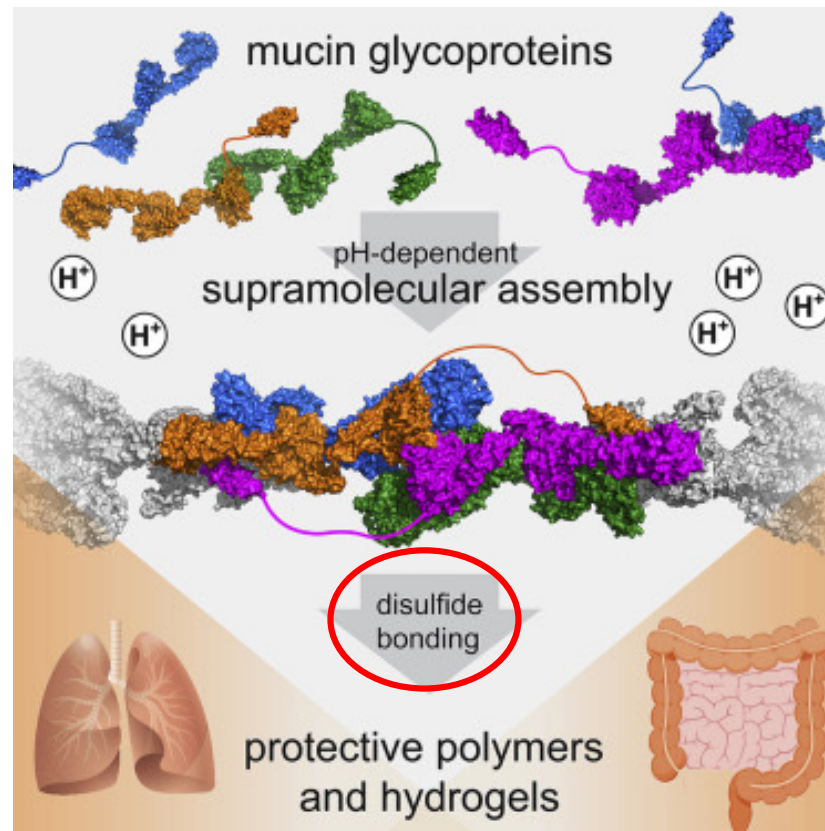
The logo for Sanoanimal features a stylized, abstract shape in a vibrant orange color. This shape is composed of several curved lines that sweep upwards and outwards, resembling a horse's head in profile or a stylized flame. Below this graphic, the word "Sanoanimal" is written in a teal, sans-serif font.

Sanoanimal

Viscosity of Mucus is Dependend on Disulfide Bonds

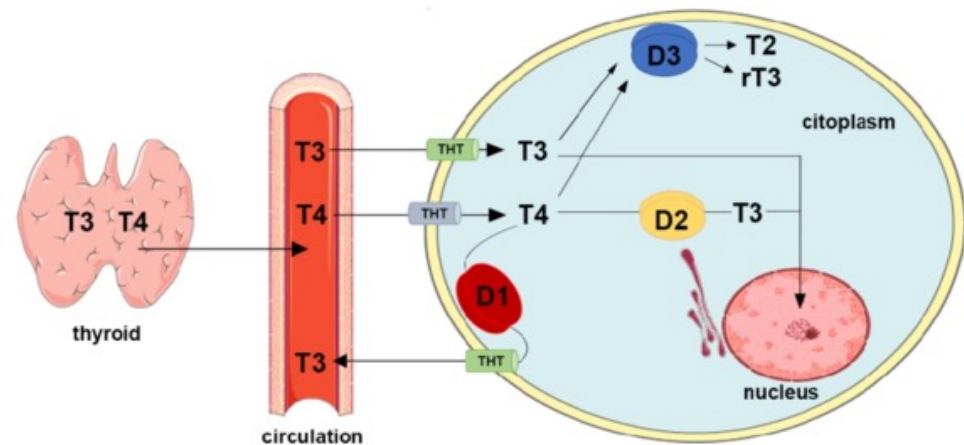
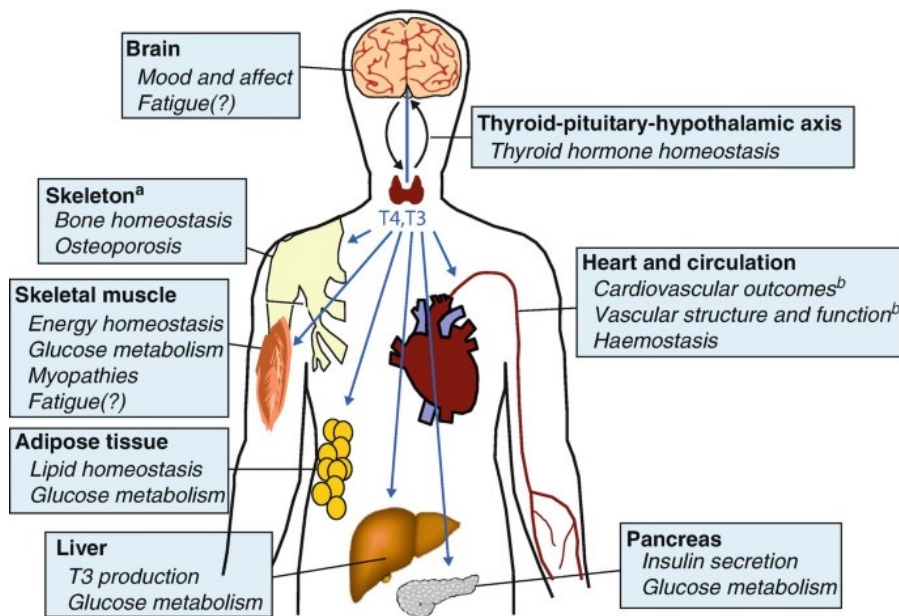
Results of insufficient mucus protection:

- Gastric ulcers
- Colitis / hindgut inflammation
- Fecal water, diarrhoea
- Chronic airway issues:
 - Coughing
 - Equine asthma
 - Airway allergies



<https://ars.els-cdn.com/content/image/1-s2.0-S0092867420311624-fx1.jpg>

Thyroid Hormones Play a Critical Role in Energy Metabolism – And are Regulated by Selenium!



The Three Types of Deiodinases – and the Role of Selenium

Deiodinases are **selenium-dependent enzymes** that regulate thyroid hormone activity in the body. All three types contain **selenocysteine** as an essential part of their **active site**, making **adequate selenium availability critical for proper thyroid function**.

✓ DIO1 (Type 1 Deiodinase):

Location: Liver, kidney, thyroid gland.

Function: Converts **T4 (thyroxine) into T3 (triiodothyronine)**, the active form, and also **reverse T3 (rT3) into T2** (inactive).

Systemic role: Ensures sufficient levels of T3 in the bloodstream.

✓ DIO2 (Type 2 Deiodinase):

Location: Brain, pituitary, adipose tissue, skeletal muscle, thyroid gland.

Function: Also converts **T4 into T3**, but does so **within the cells** to meet **local metabolic needs**.

Importance: Especially critical for maintaining T3 availability in tissues like the brain and muscles, independent of blood levels.

✓ DIO3 (Type 3 Deiodinase):

Location: Placenta, fetal tissues, brain, skin.

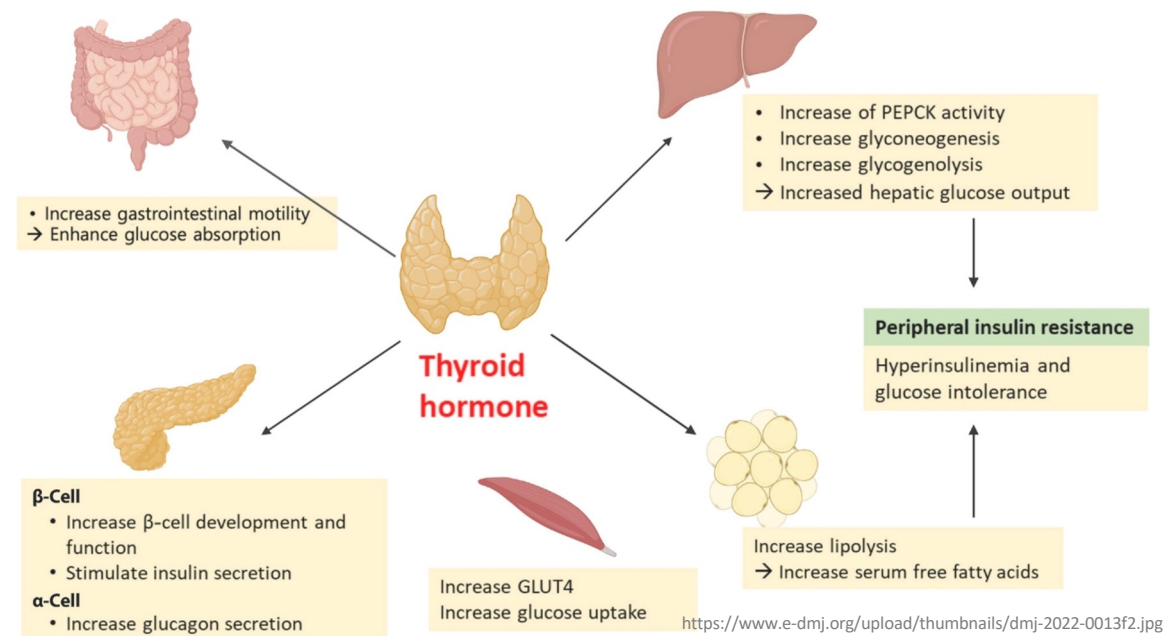
Function: **Inactivates** thyroid hormones by converting **T4 into reverse T3 (rT3)** and **T3 into T2**.

Protective role: Prevents excessive thyroid hormone activity, particularly in sensitive tissues (e.g., during fetal development or periods of physiological stress).

All three deiodinases incorporate selenocysteine into their structure!

Selenocystein + Thyroid = Too little is as bad as too much!

- Supplementation with **selenocysteine** can **disrupt the thyroid hormone balance** in horses due to accumulation in endocrine glands.
- If selenium accumulates in tissues like the thyroid gland, it may **alter enzyme activity**, misregulate local T3 production, or shift the balance toward inactivation pathways.
- This can impact **energy metabolism, muscle function, and hormonal feedback loops**.



Possible Thyroid Hormone Dysregulation Caused By Organic Selenium

Symptoms of Hyperthyreodism = Cushings' Symptoms

- Weight loss
- Progressive muscle wasting
- Fragile tendons / ligaments
- Hirsutism
- Poor hoof horn quality, laminitis
- Increased susceptibility to infections, weak immune system
- Insulin Dysregulation

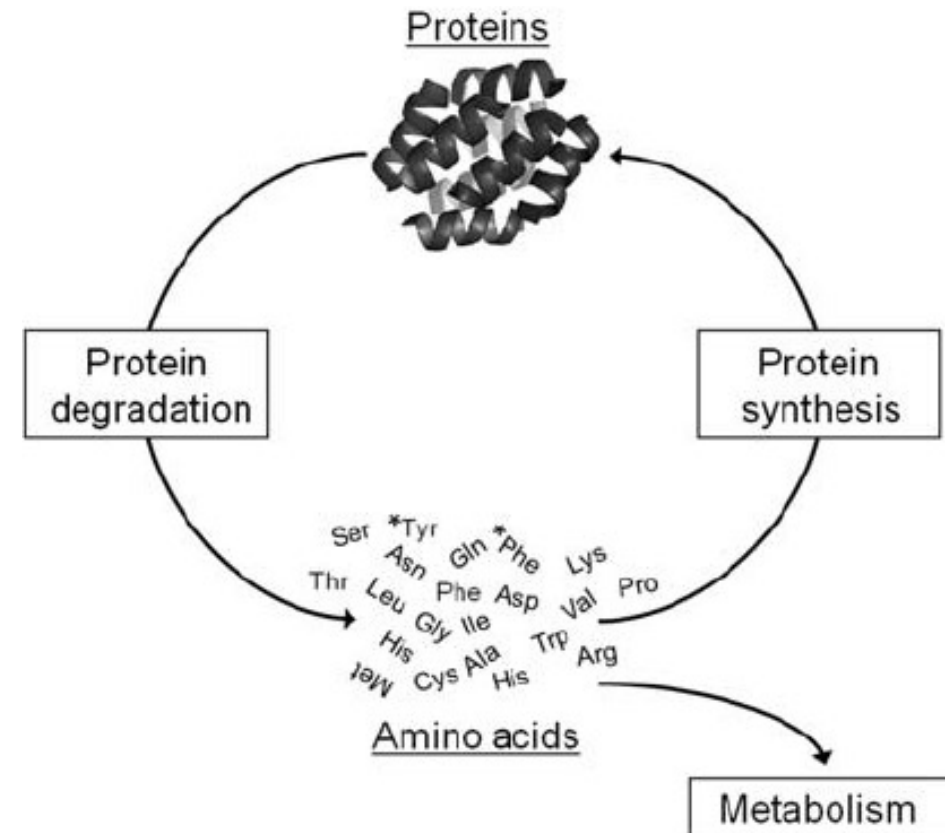


Symptoms of Hypothyreodism = (Pseudo)EMS Symptoms

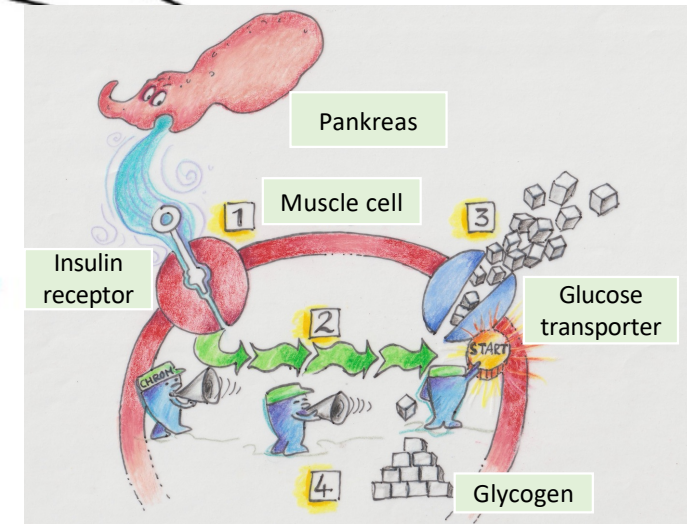
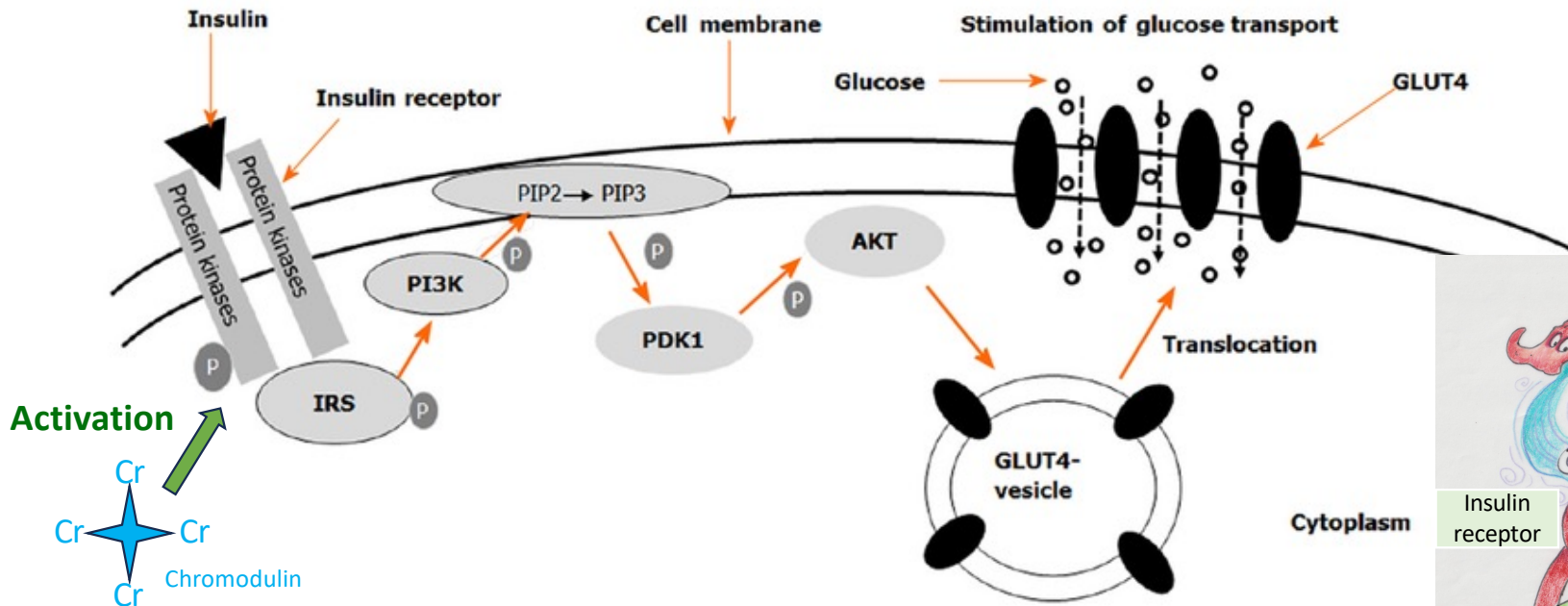
- Fat accumulation
- Edema formation ("fluid retention")
- Laminitis
- Renal insufficiency
- Reduced cardiac output
- Lack of performance
- Insulin Dysregulation

Release of „Stored“ Organic Selenium

- **Protein turnover takes 1 to 3 years**, during which selenium is released from broken-down proteins and amino acids.
- **Blood selenium levels rise months or years after feeding** organic selenium!
- **High selenium levels in the blood** trigger redistribution into tissues:
 - **Muscles**
 - **Liver**
 - **Kidneys**
 - **Endocrine glands**
- in order to **lower blood concentration and prevent toxicity**.

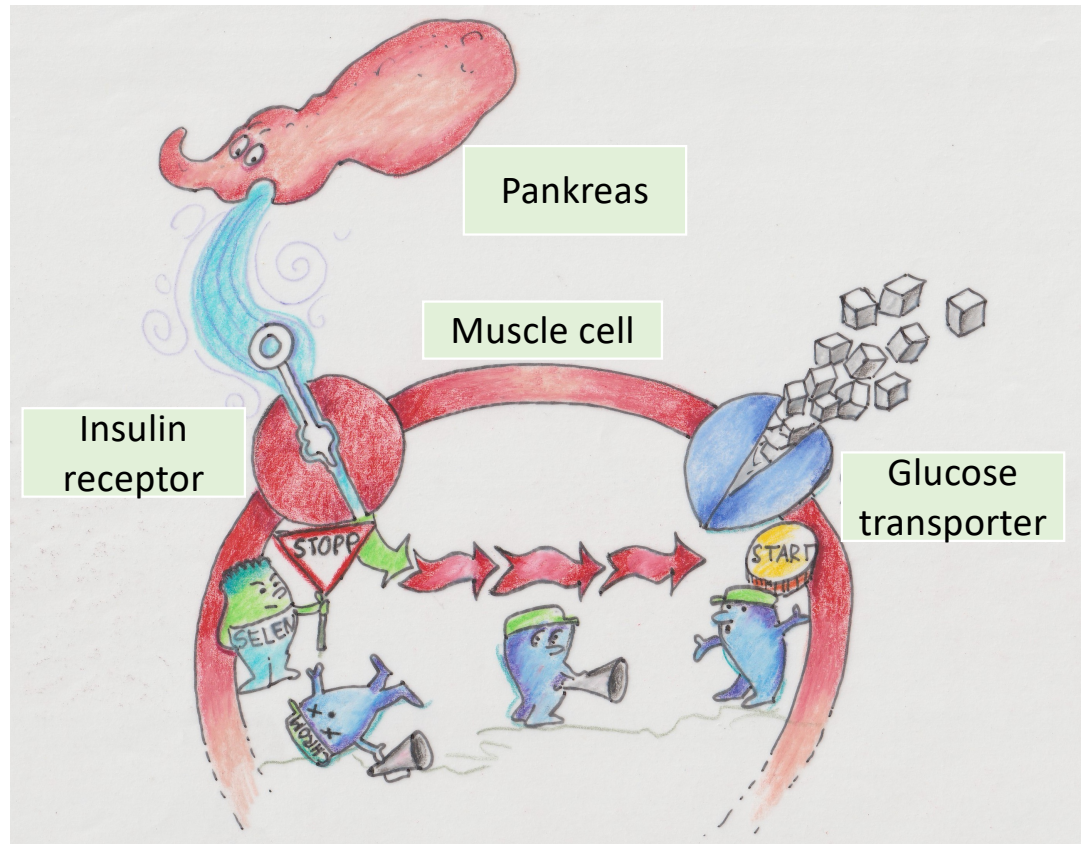


Muscle Cells Are The Primary Storage System For Excess Blood Glucose



Picture courtesy of: Angela Mayr, Zusammenhänge endlich richtig verstehen, um Hufrehe dauerhaft zu vermeiden, 2025

Selenium Accumulation in Muscles Can Trigger Insulin Dysregulation!



Picture courtesy of: Angela Mayr, Zusammenhänge endlich richtig verstehen, um Hufrehe dauerhaft zu vermeiden, 2025

Often misdiagnosed as:

- PSSM2 / MIM
- EMS
- Laminitis
- Cushings'