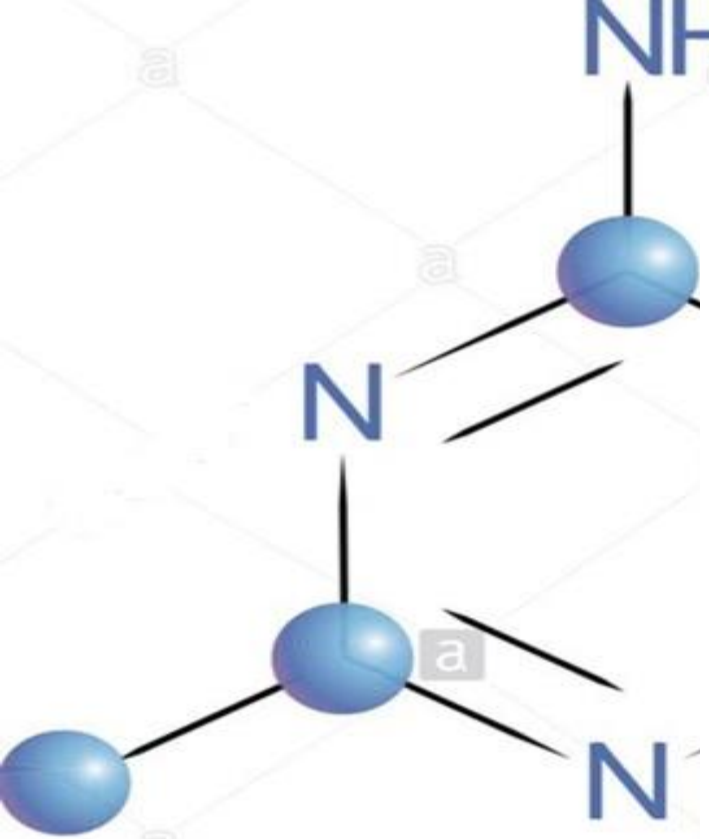
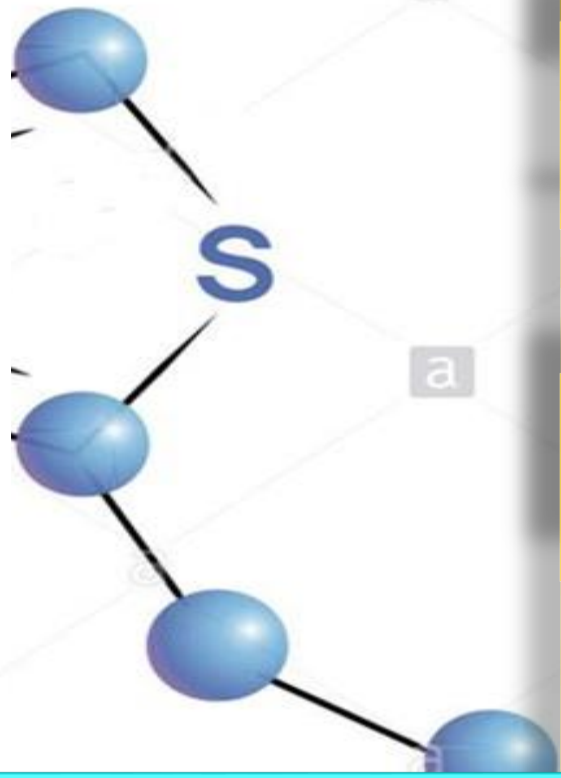

بسم الله الرحمن الرحيم

سرآغاز هر کار نام خداست همان کو گشایشگر کارهاست

خداوند دانای راز نهان ستایشگرش، جملگی جسم و جان

لیلا لطفی



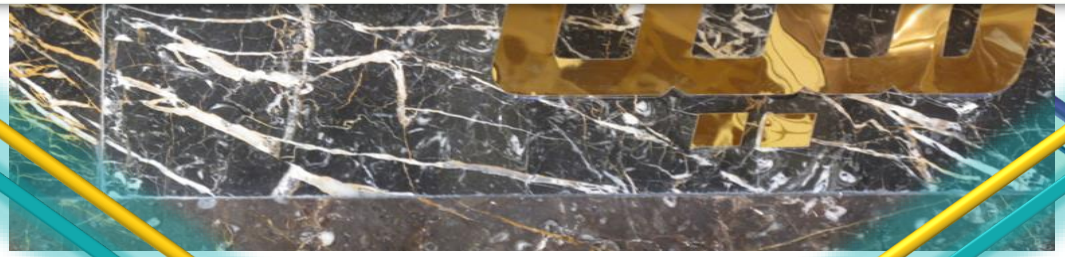


مینا طیور

تولید کننده مکمل، پریمیکس، کنسانتره و خوراک طیور

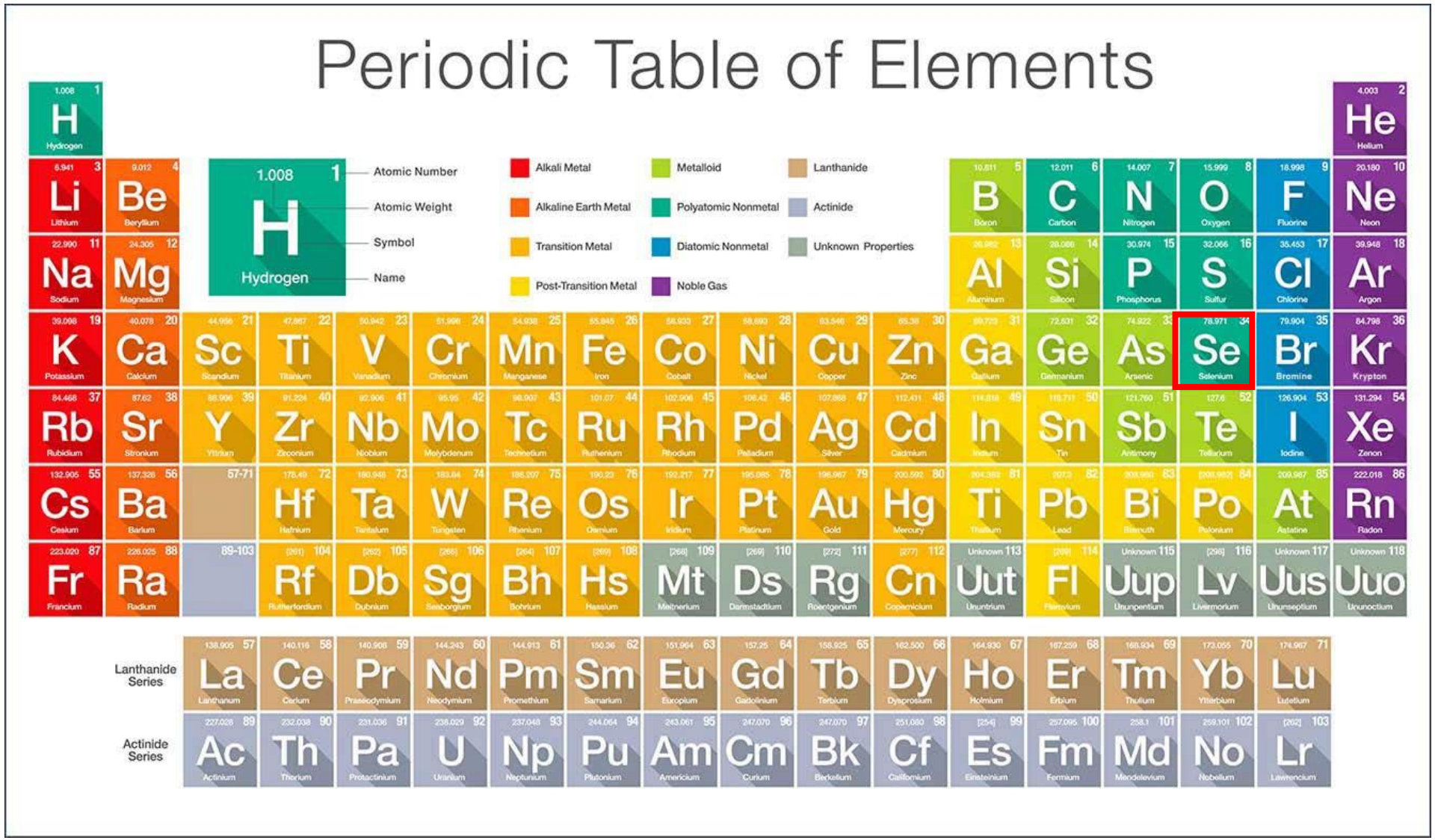
Since 1994

نقش سلنیوم در تغذیه و سلامت طیور



Jun 15, 2021

مقدمه
Introduction

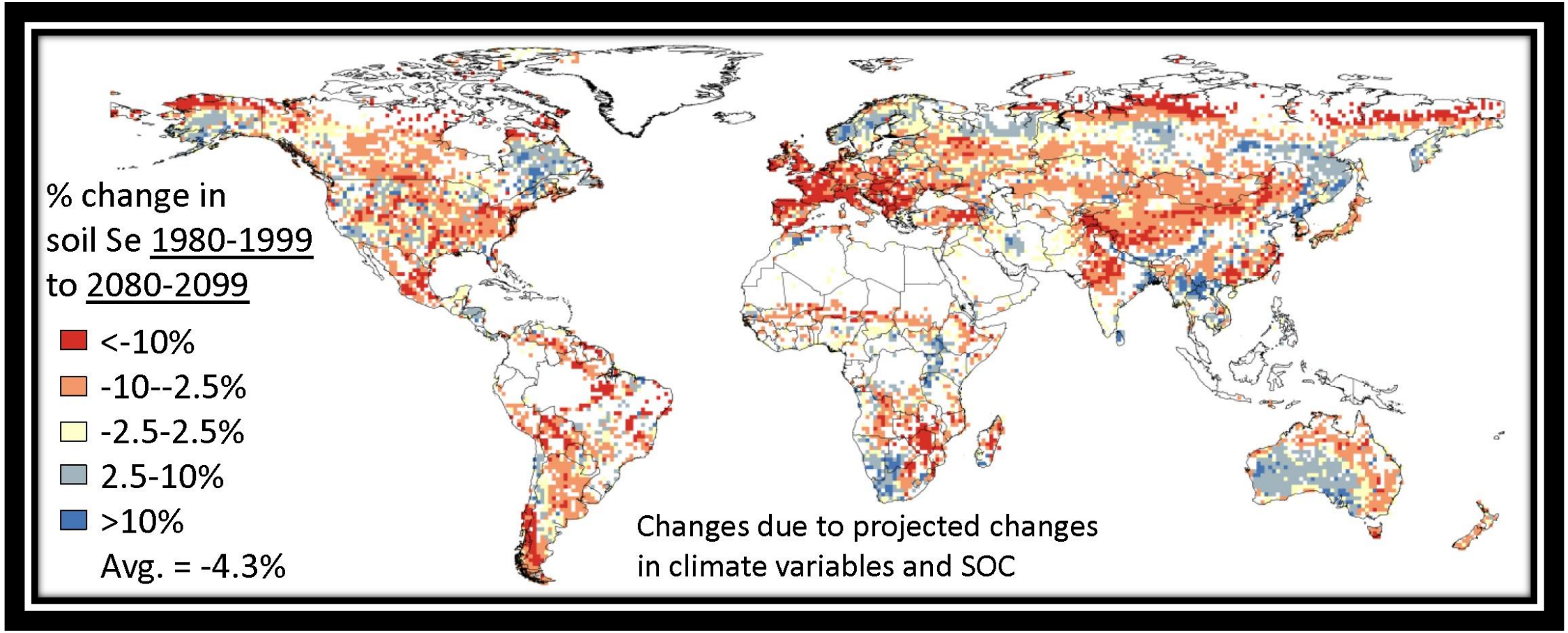

Periodic Table of Elements
1.008 1 H Hydrogen
Atomic Number
Atomic Weight
Symbol
Name
Alkali Metal
Alkaline Earth Metal
Transition Metal
Post-Transition Metal
Metalloid
Polyatomic Nonmetal
Diatomic Nonmetal
Noble Gas
Lanthanide
Actinide
Unknown Properties
Lanthanide Series
Actinide Series


34
Se
Selenium
78.96

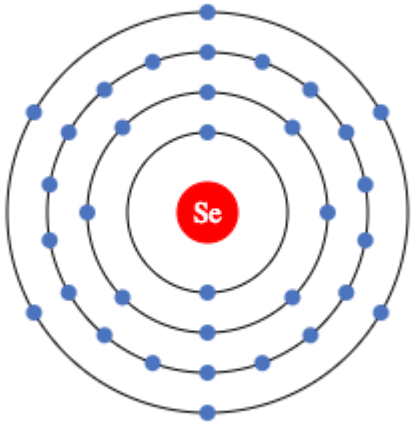
Jöns Jacob Berzelius (1779–1848)

Born	20 August 1779 Väversunda, Östergötland, Sweden
Died	7 August 1848 (aged 68) Stockholm, Sweden
Nationality	Sweden
Alma mater	Uppsala University
Known for	Atomic weights Chemical notation catalysis Silicon Selenium Thorium Cerium
Awards	Copley medal (1836)
Scientific career	
Fields	Chemistry
Institutions	Karolinska Institute
Doctoral advisor	Johann Afzelius
Doctoral students	James Finlay Weir Johnston Heinrich Rose


BERZELIUS

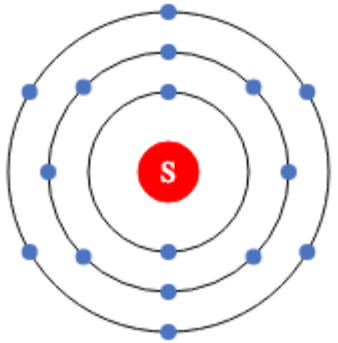

% change in
soil Se 1980-1999
to 2080-2099
<-10%
-10--2.5%
-2.5-2.5%
2.5-10%
>10%
Avg. = -4.3%
Changes due to projected changes
in climate variables and SOC

34: Selenium



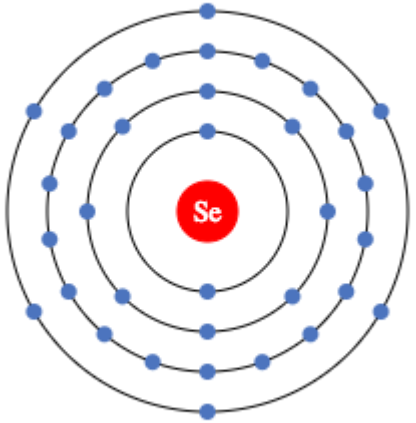
[Ar] 3d10 4s2 4p4 [2, 8, 18, 6]

16: Sulfur



[Ne] 3s2 3p4 [2, 8, 6]

34: Selenium



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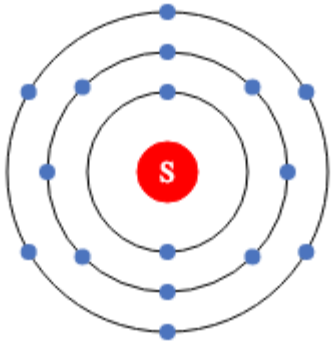
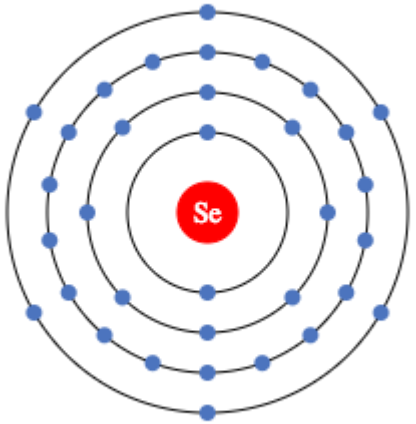
16: Sulfur



[Ne] 3s2 3p4 [2, 8, 6]

34: Selenium



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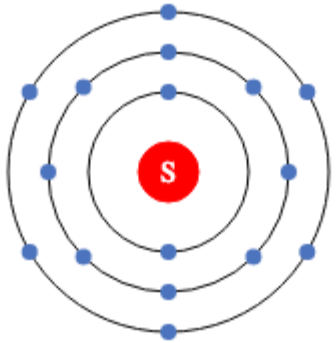
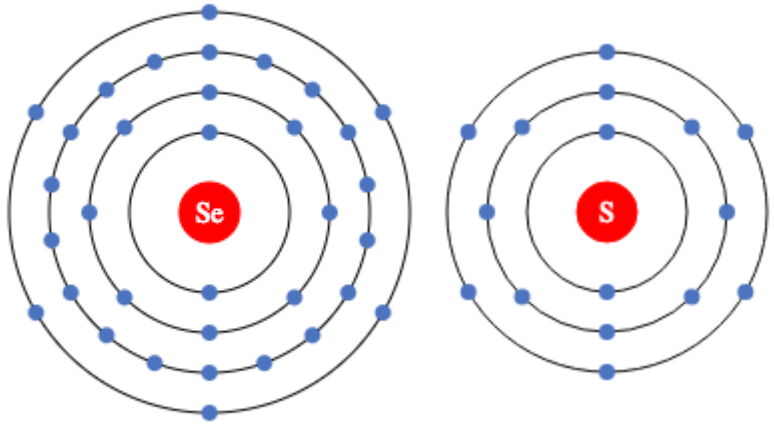
16: Sulfur



[Ne] 3s2 3p4 [2, 8, 6]

34: Selenium

16: Sulfur

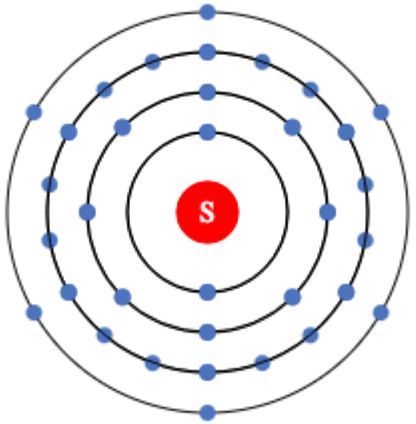


[Ar] 3d10 4s2 4p4 [2, 8, 18, 6]

[Ne] 3s2 3p4 [2, 8, 6]

34: Selenium

16: Sulfur



[Ne] 3s2 3p4 [2, 8, 6]

[Ar] 3d10 4s2 4p4 [2, 8, 18, 6]

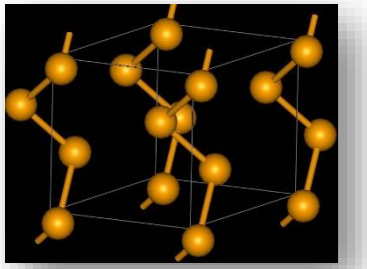
- The discovery of Se essentiality in early 1960s.
- The discovery in 1973 that glutathione peroxidase is a selenoprotein.
- Characterisation of main selenoproteins in nutrition and health in 2003.

New insight

The role of free radicals as signalling molecules, understanding the role of nutrients in gene expression and maternal programming, tremendous progress in human and animal genome.

- Elemental selenium

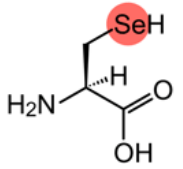
Se^0



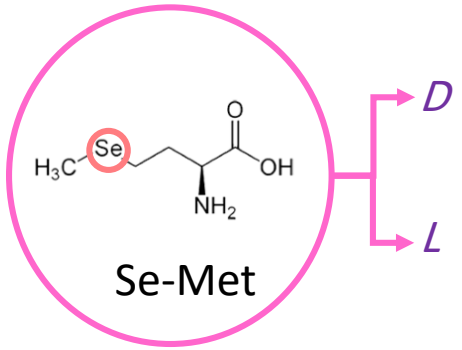
- Inorganic selenium compounds

Selenite (SeO_3^{--}), Selenate (SeO_4^{--}), Selenide (Se^{--})

- Organic selenium compounds

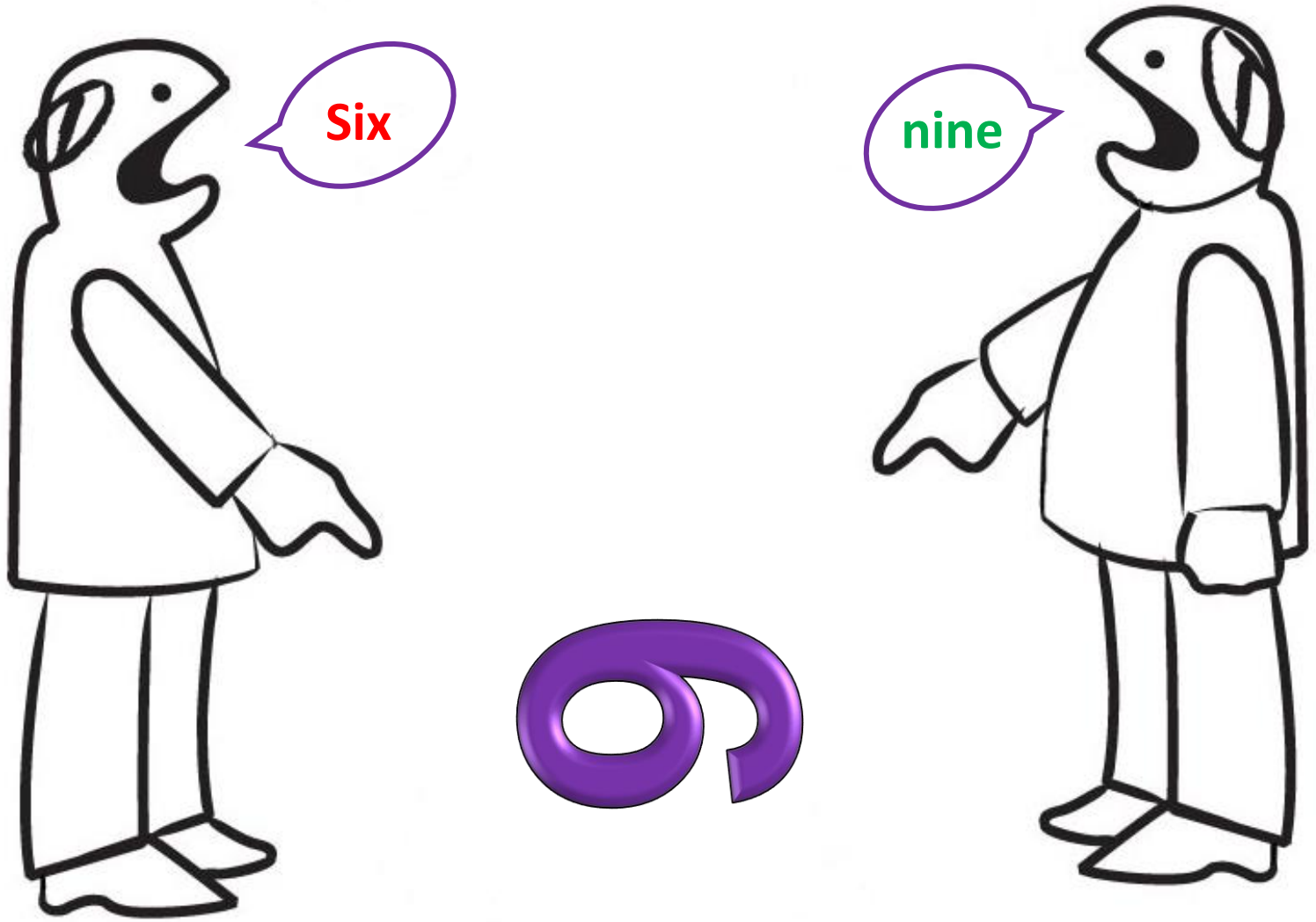


Se-Cys

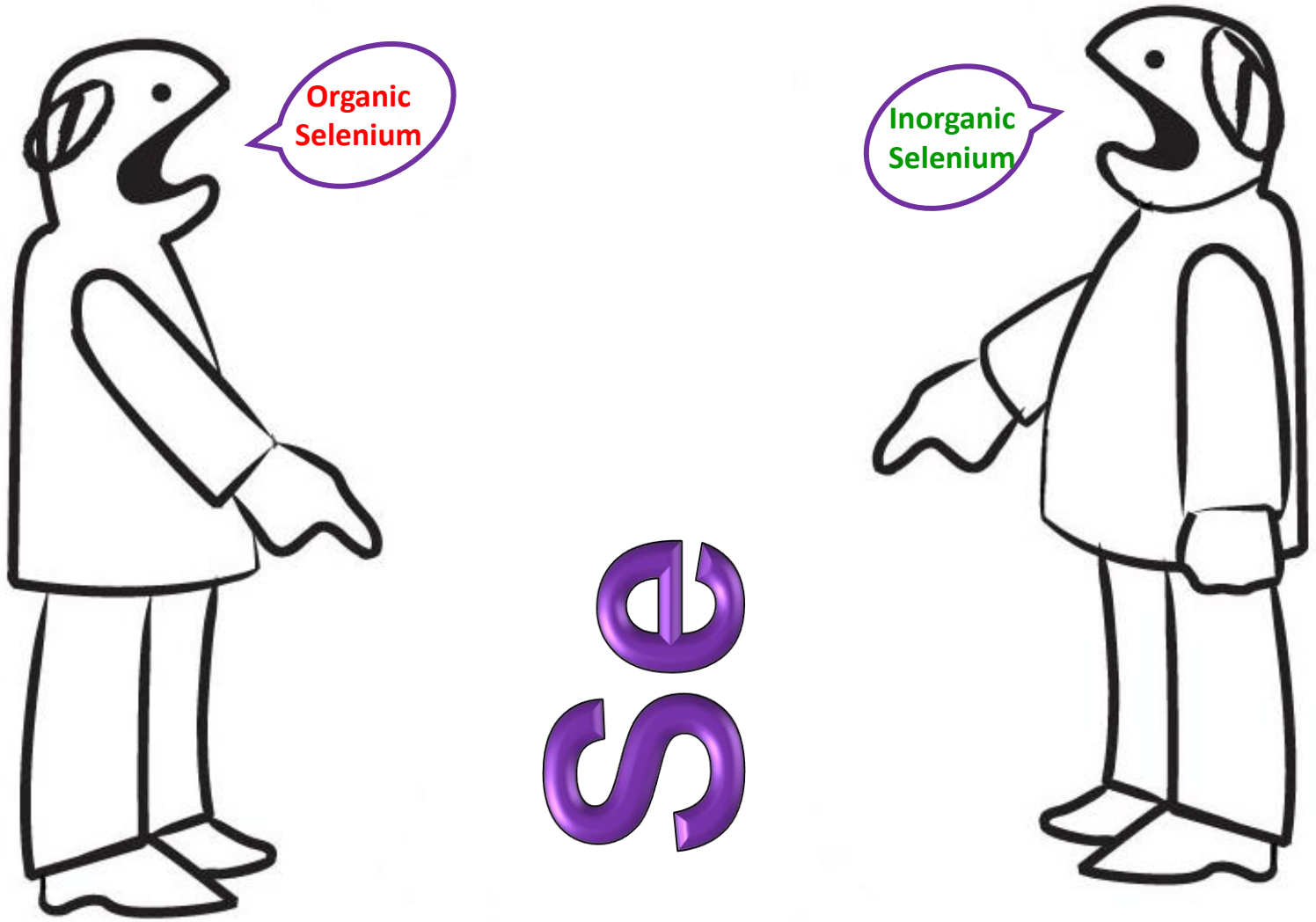


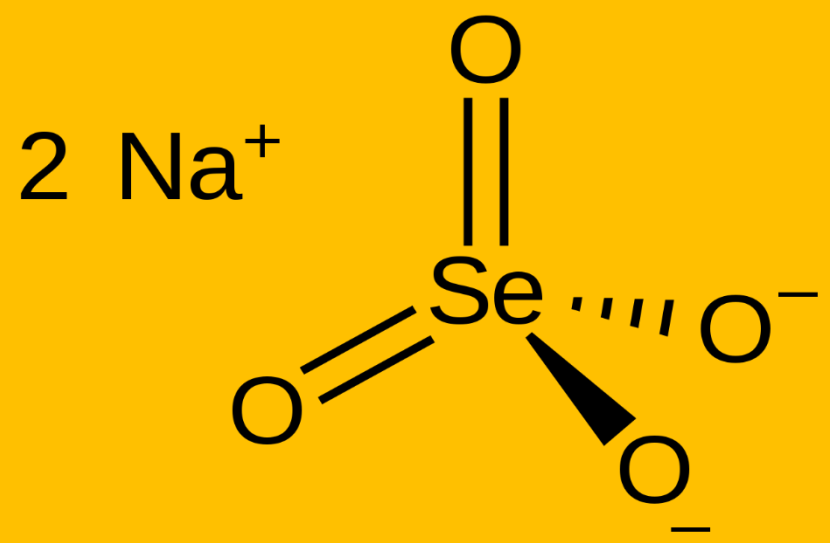
Se-Met

What is this?

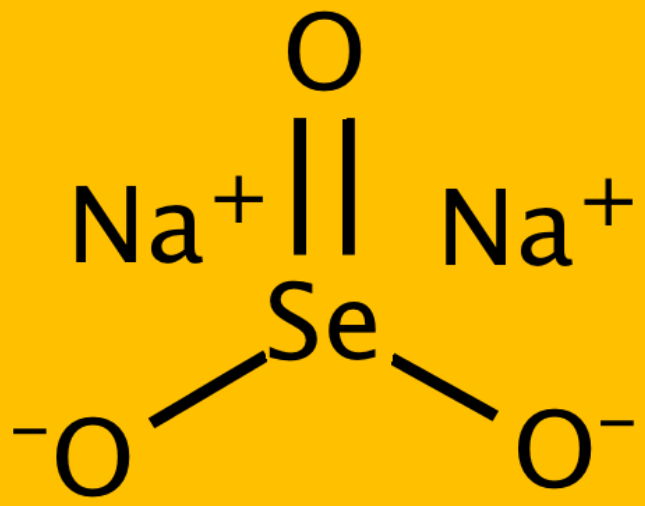


What is this?

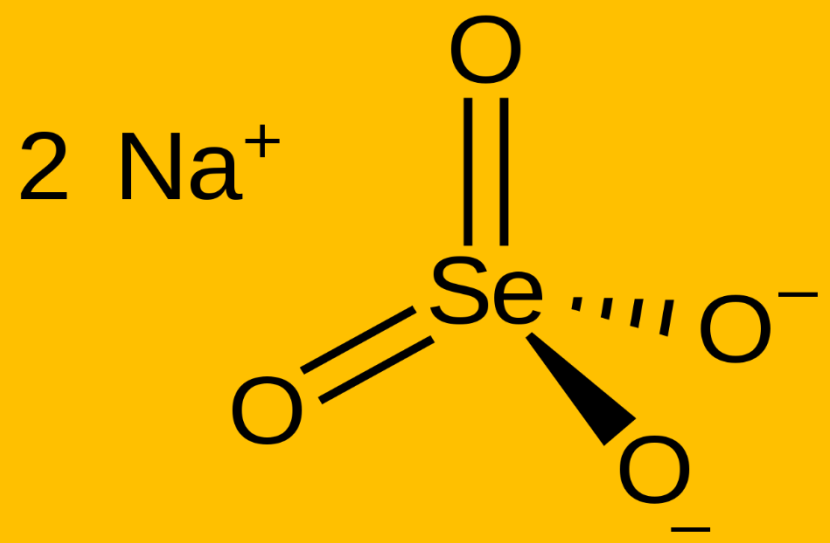




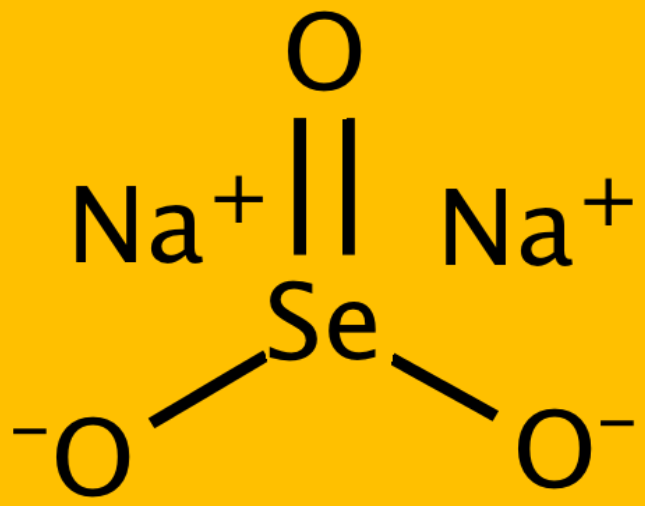
Sodium Selenate



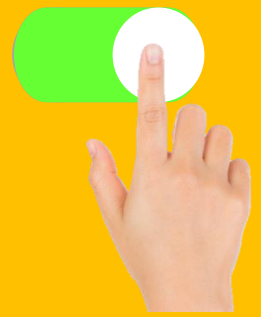
Sodium Selenite

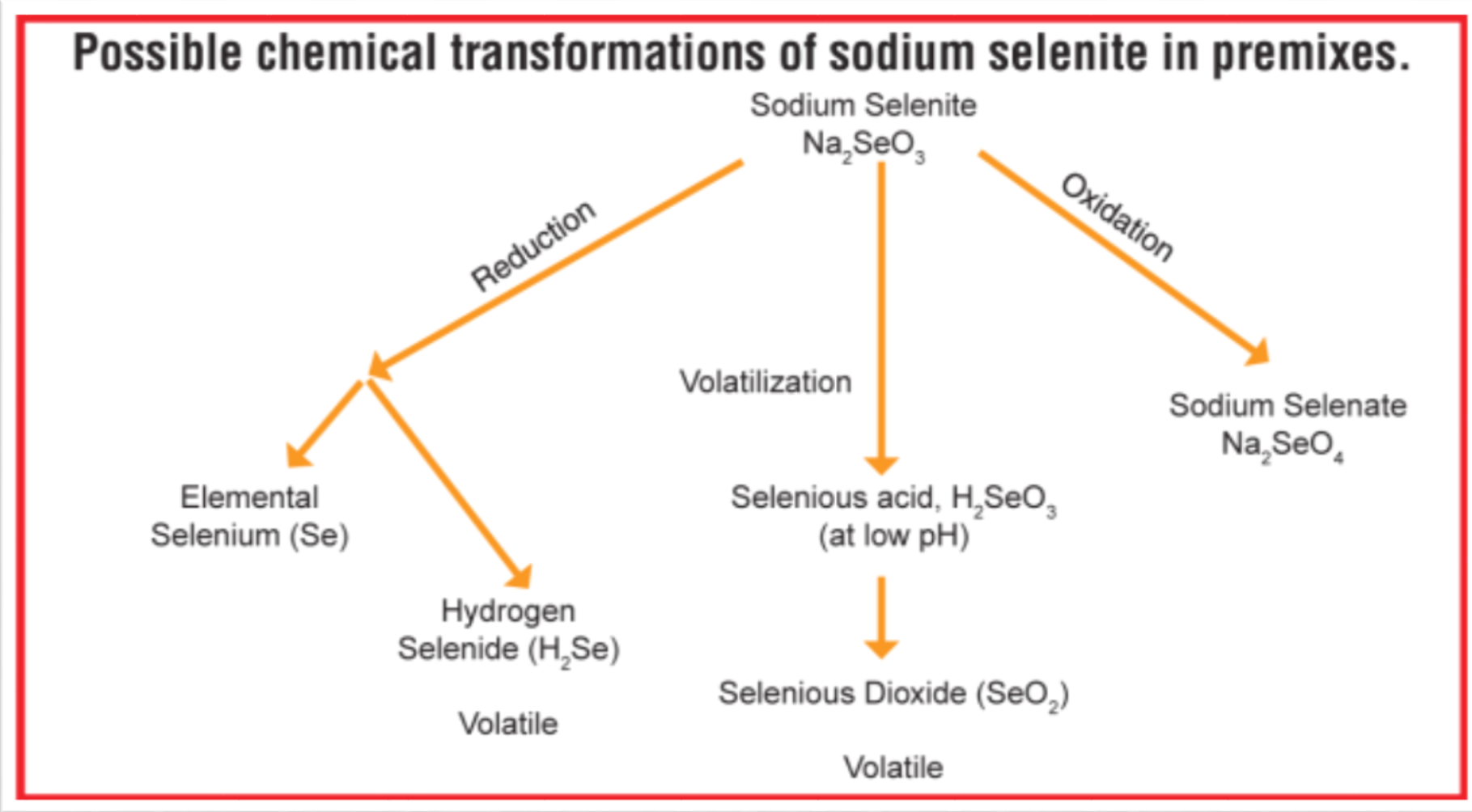


Sodium Selenate



Sodium Selenite



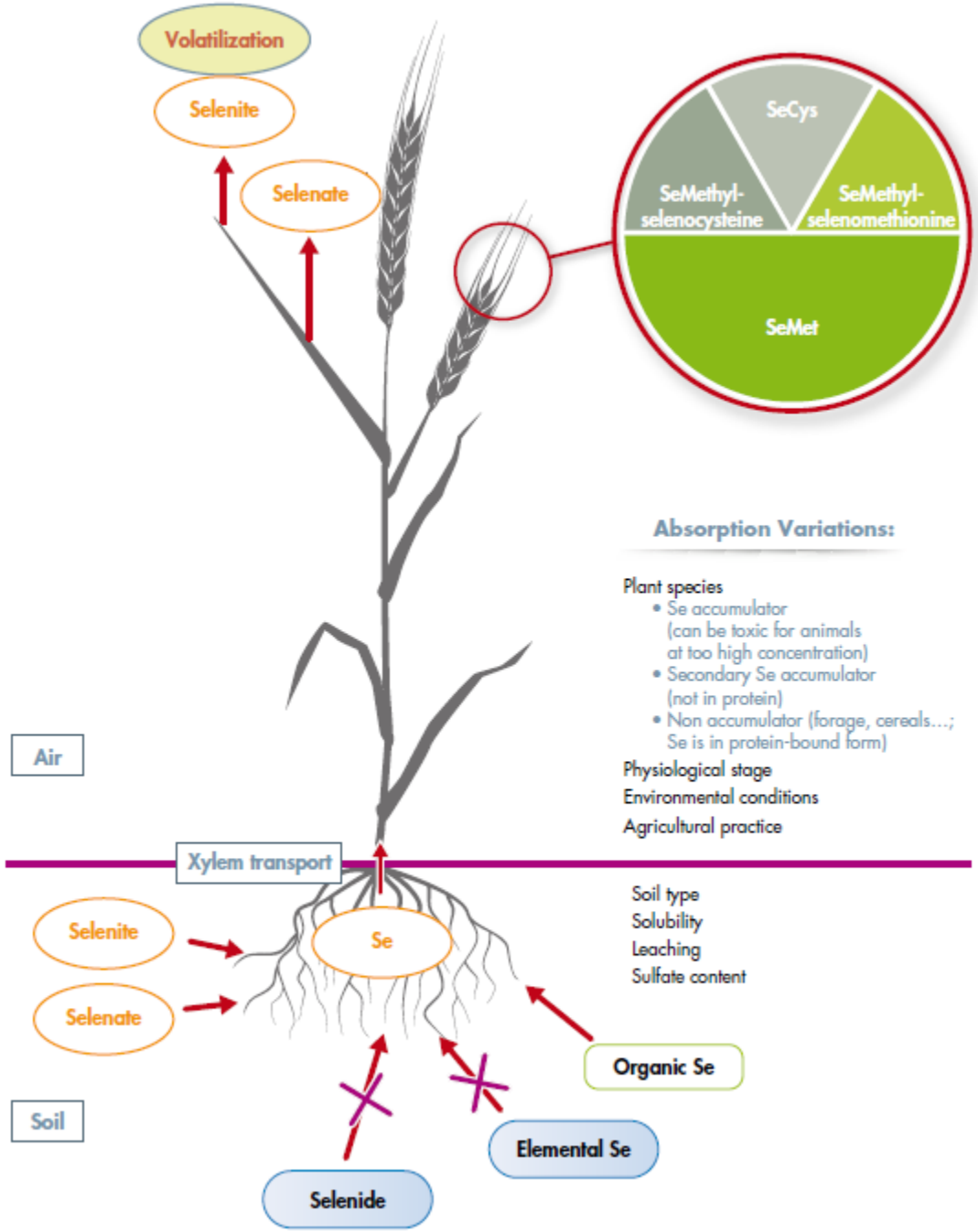

Possible chemical transformations of sodium selenite in premixes.
Sodium Selenite
Na_2SeO_3
Reduction
Volatilization
Oxidation
Elemental
Selenium (Se)
Hydrogen
Selenide (H_2Se)
Volatile
Selenious acid, H_2SeO_3
(at low pH)
Selenious Dioxide (SeO_2)
Volatile
Sodium Selenate
Na_2SeO_4

	Organic selenium	Selenite
Absorption	similar to methionine with active transport in the gut	similar to other mineral with passive transport in the gut
Accumulation	building Se reserves by non-specific incorporation of SeMet into the proteins	not accumulated in the body
Toxicity	at least 3 times less toxic than selenite	highly toxic, can penetrate via skin causing problems
Bioavailability	higher bioavailability in comparison to selenite to animals/poultry	lower bioavailability in comparison to SeMet
Antioxidant activity	possesses antioxidant properties per se and could scavenge NO and other radicals	possesses prooxidant properties and could stimulate free radical production when reacting with GSH
Effect on DNA	stimulate DNA-repair enzymes	causes DNA damage
Transfer to eggs and muscles	transferred to egg and muscles giving an opportunity to produce Se-eggs and Se-meat	poorly transferred to eggs and muscles
Reactions with other elements	neutral, ascorbic acid promotes SeMet assimilation from the diet	highly reactive, reduced to metallic, unavailable selenium by ascorbic acid
Protective effect in stress conditions	provide additional protection due to Se reserves in the body	cannot provide additional protection due to absence Se reserves in the body
Effect on drip loss	decrease drip loss	does not affect drip loss
Environmental issues	better retention in tissues, less released with faeces and urine	low retention in tissues and high release with faeces and urine
Stability	stable	stable
Classification based on the mode of action	feed additive	drug

Major differences

	سلنیوم آلی	سلنیت
جذب	مشابه متیونین با انتقال فعال در دستگاه گوارش	مشابه سایر عناصر معدنی با انتقال غیرفعال در دستگاه گوارش
تجمع	ساخت ذخایر سلنیوم با ورود غیر اختصاصی سلنومتیونین به ساختار پروتئین	عدم تجمع در بدن
سمیت	سمیت دست کم یک سوم سلنیت	بسیار سمی، می‌تواند از طریق پوست نفوذ کند و باعث ایجاد مشکل شود
زیست فراهمی	زیست فراهمی بالاتر در مقایسه با سلنیت برای دام و طیور	زیست فراهمی پایین‌تر در مقایسه با سلنومتیونین
فعالیت پاداُکسندگی	دارا بودن خواص پاداُکسندگی به صورت خود به خود و توانایی از بین بردن اُکسید نیتریک و سایر رادیکال‌ها	دارای خواص اکسندگی و می‌تواند تولید رادیکال‌های آزاد را وقتی با گلوتاتیون پراُکسیداز واکنش می‌دهد، تحریک کند
اثر بر دی اُکسی ریبو نوکلوئیک اسید	تحریک آنزیم‌های ترمیم کننده دی اُکسی ریبو نوکلوئیک اسید	باعث تخریب دی اُکسی ریبو نوکلوئیک اسید می‌شود
انتقال به تخم مرغ و ماهیچه‌ها	انتقال به تخم‌مرغ و ماهیچه‌ها و ایجاد فرصت برای تولید گوشت و تخم مرغ حاوی سلنیوم	انتقال ضعیف به تخم مرغ و ماهیچه‌ها
واکنش با سایر عناصر	اسید آسکوربیک خنثی، جذب سلنومتیونین را از جیره، بهبود می‌بخشد	بسیار واکنش پذیر، توسط اسید آسکوربیک به سلنیوم فلزی و غیرقابل دسترس تبدیل می‌شود
اثر محافظتی در شرایط تنش	فراهم آوردن محافظت اضافی به دلیل ذخایر سلنیوم در بدن	به دلیل عدم وجود ذخایر سلنیوم در بدن، نمی‌تواند محافظت زیادی ایجاد کند
اثر بر از دست دادن مایعات	کاهش خروج مایعات	بر خروج مایعات اثر نمی‌گذارد
سازگاری با محیط زیست	ابقای بیشتر در بافت‌ها، کاهش دفع در مدفوع و ادرار	ابقای کم در بافت‌ها و دفع بالا در مدفوع و ادرار
پایداری	پایدار	پایدار
طبقه بندی براساس روش عمل	افزودنی خوراکی	دارو

pH↓ absorption↓



Plants differ markedly in their ability to incorporate selenium from soil into tissues; and based on this ability, plants are divided into three major categories:

1. **Selenium accumulators**
   Astragalus, Stanleya, Morinda, Neptunia, Oonopsis,and Xylorhiza
2. **Secondary Se accumulators**
   Aster, Astragalus, Atriplex, Castilleja, Comandra, Grayia, Grindelia, Gutierrezia, Machaeranthera and Brassica
3. **Non-accumulator plants**
   forage, cereal, oilmeal and crop plants

Bioavailability of Se in feedstuffs (adapted from Cantor, 1997).

Feedstuff	Biological availability, %
Dehydrated alfalfa meal	210
Brewer's yeast	89
Cottonseed meal	86
Corn	86
Brewer's grains	80
Wheat	71
Distiller's dried grains and solubles	65
Soybean meal	60
Herring meal	25
Tuna meal	22
Poultry by-product meal	18
Menhaden fish meal	16
Meat and bone meal	15
Fish solubles	9

SeMet in grains.

	Grains	SeMet proportion, % total Se	References
Wheat	wheat grain	56-83	Whanger, 2002
	wheat	50.4-81.4	Yang *et al.*, 1997
	wheat grain	72-85	Cubadda *et al.*, 2010
	spring wheat grains, Australia	90	Stadlober *et al.*, 2001
	spring wheat grain, India	66	Cubadda *et al.*, 2010
	durum wheat, Austria	62	Stadlober *et al.*, 2001
	winter wheat grain, India	58	Cubadda *et al.*, 2010
	wheat flour, Belgium	52	Moreno *et al.*, 2004
Barley	summer barley grains, Austria	77	Stadlober *et al.*, 2001
Maize	maize	61-64	Whanger, 2002
	maize	45.5-82.0	Yang *et al.*, 1997
Soybeans	soybeans	>80	Whanger, 2002
	soybeans	62.9-71.8	Yang *et al.*, 1997
Rice	rice	68-81	Whanger, 2002
	rice	54.9-86.5	Yang *et al.*, 1997
	basmati rice, India	93	Mar *et al.*, 2009
	jasmine rice, Thailand	96	Mar *et al.*, 2009
	white rice, USA	94	Mar *et al.*, 2009

Toxicity

- Acute
- Sub-acute
- Chronic poisoning (alkali disease)
  - Ataxia
  - Diarrhoea
  - Death
  - Garlic odour
  - Hair loss
  - Growth retardation

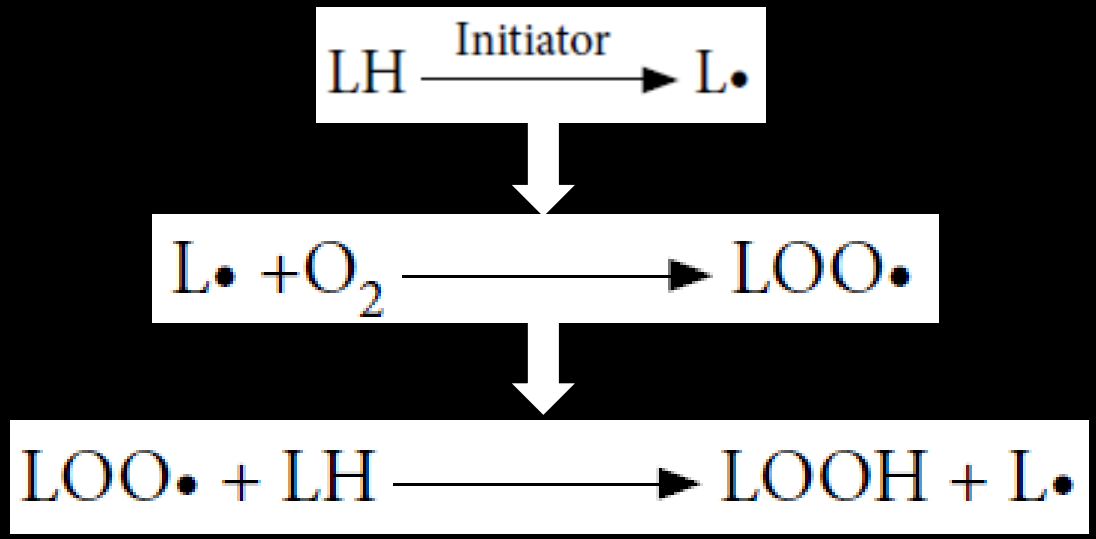
Selenium acid > selenite > selenate > selenocysteine > methylated selenium compounds

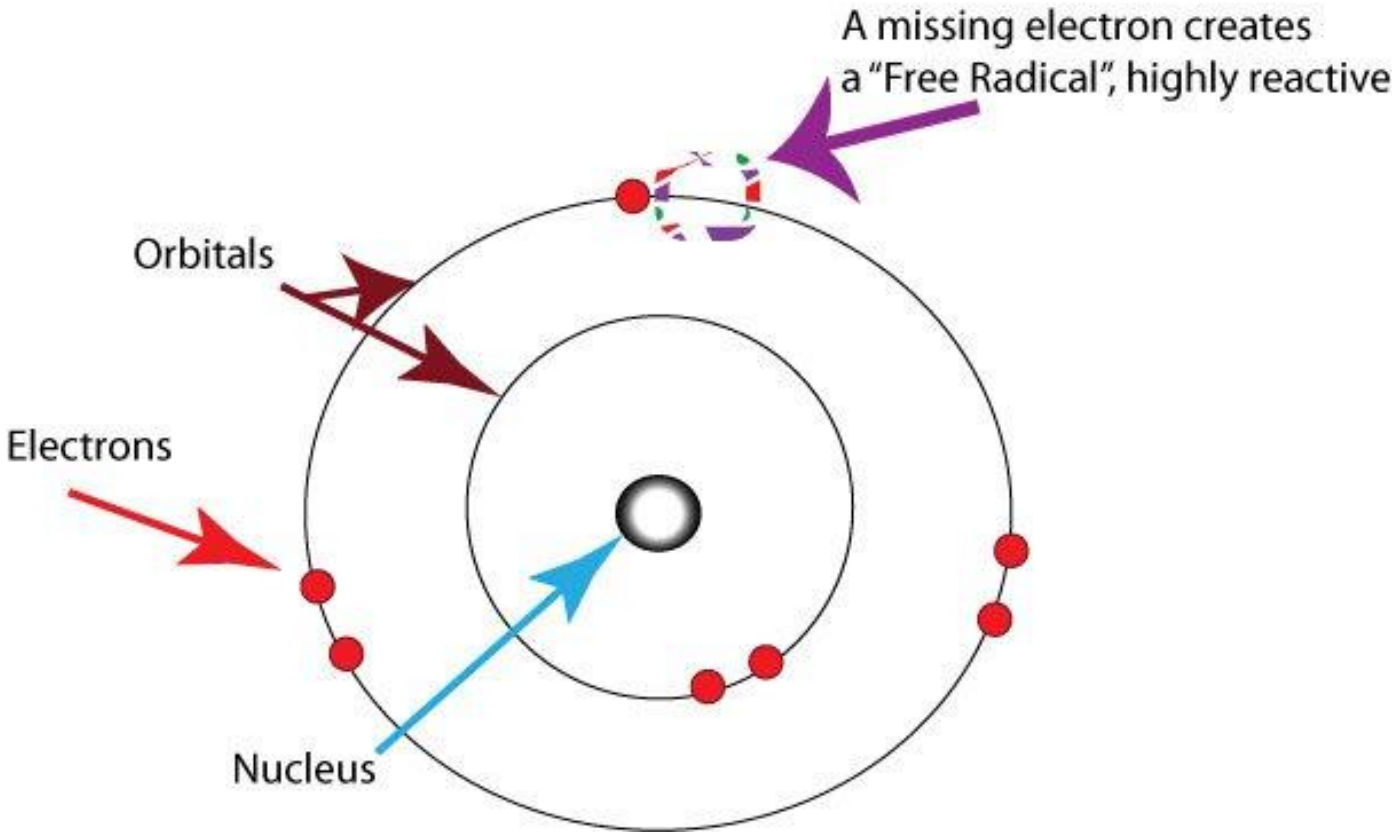
Se Functions

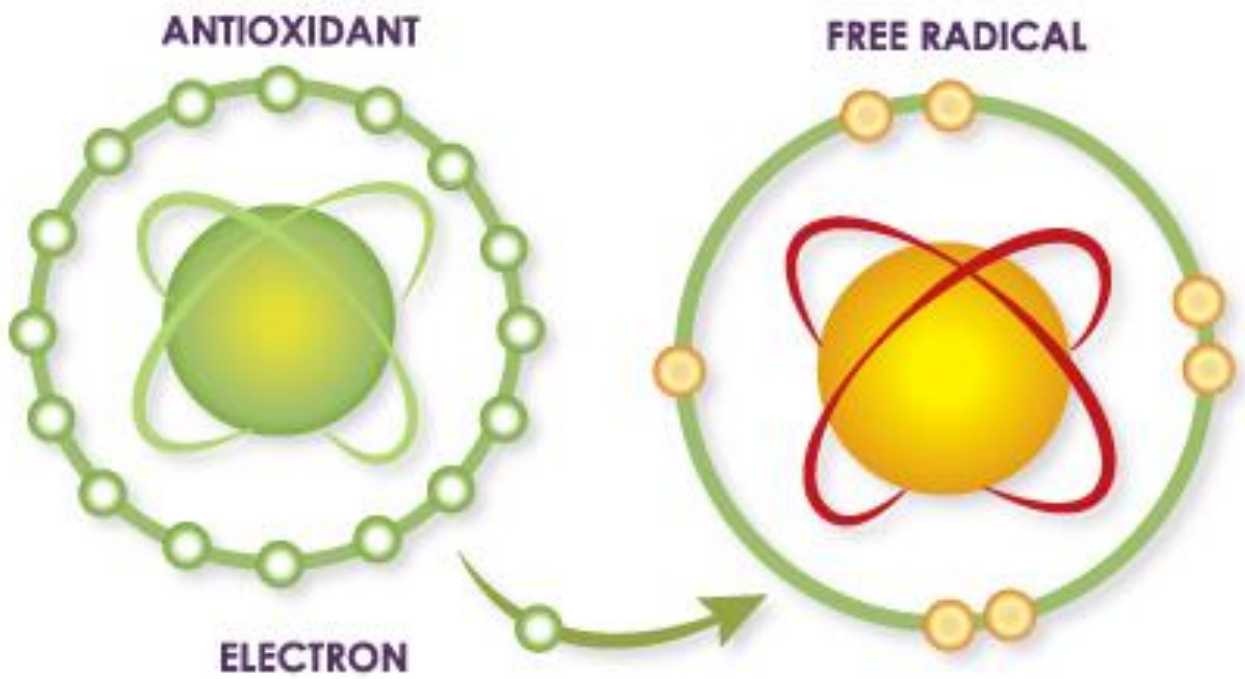
- Selenium dependent enzymes
  - Glutathione peroxidase
  - Deiodinases
- Other functions
  - Immune response
  - Complex with heavy metals (Cd, Hg & Ag)

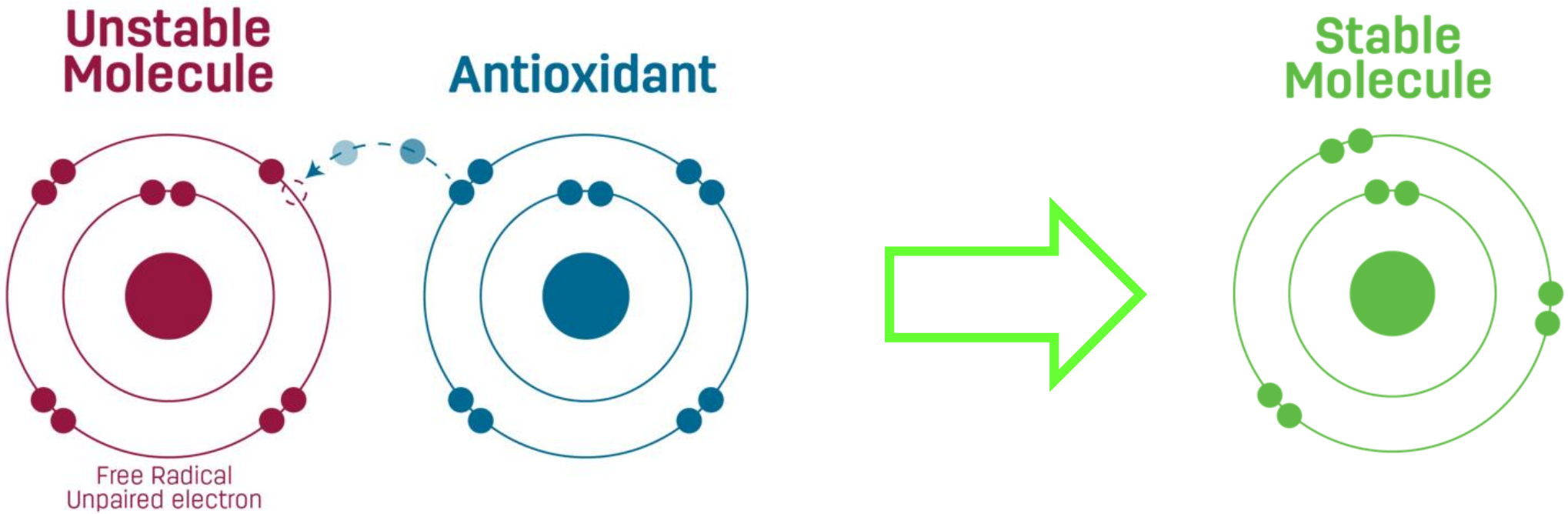
Functions

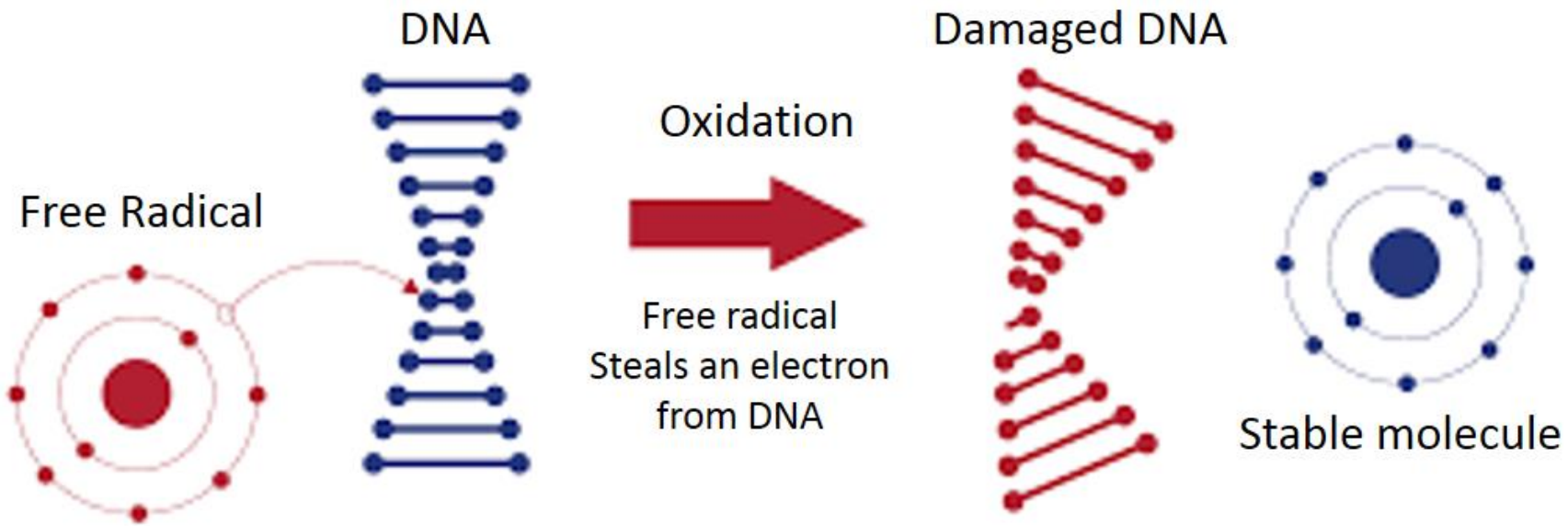
Self-preservation is the first law of nature

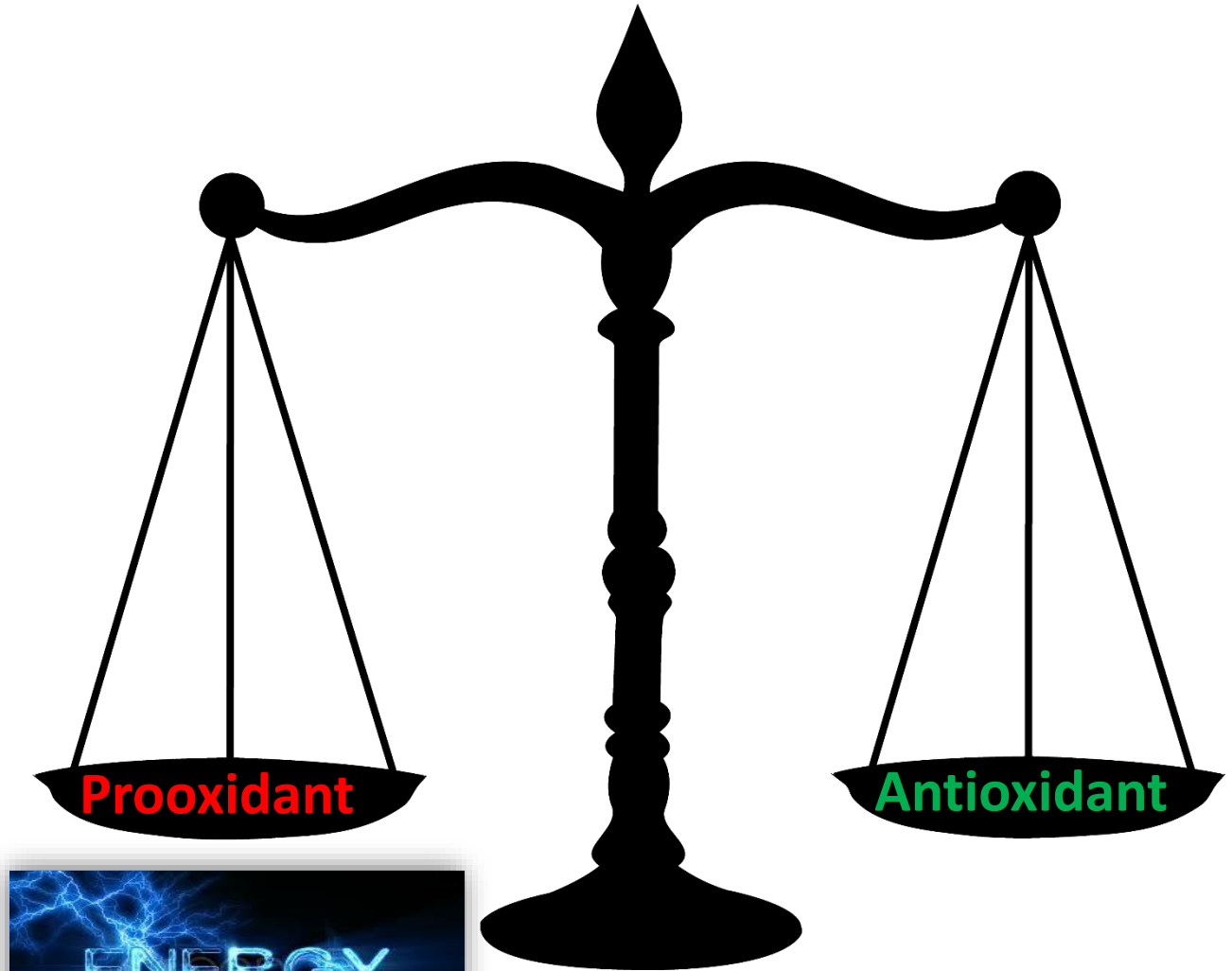


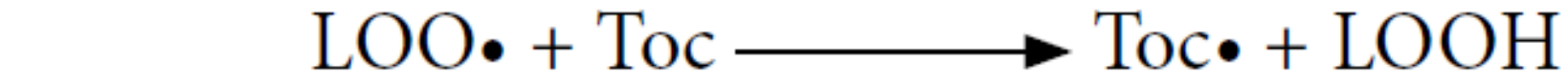

A missing electron creates
a "Free Radical", highly reactive
Orbitals
Electrons
Nucleus


ANTIOXIDANT
FREE RADICAL
ELECTRON

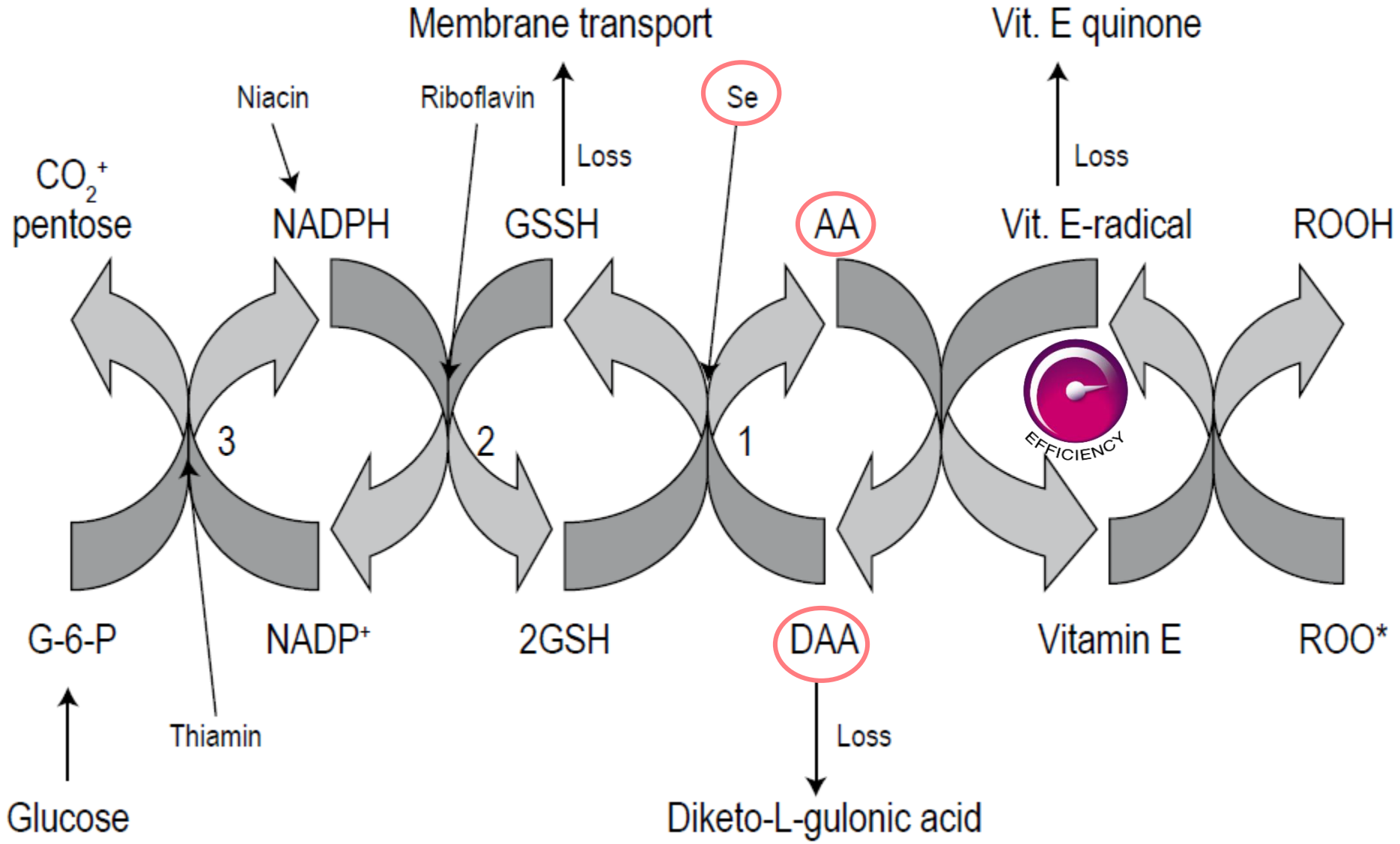

Unstable Molecule
Antioxidant
Stable Molecule
Free Radical
Unpaired electron


DNA
Damaged DNA
Oxidation
Free Radical
Free radical
Steals an electron
from DNA
Stable molecule

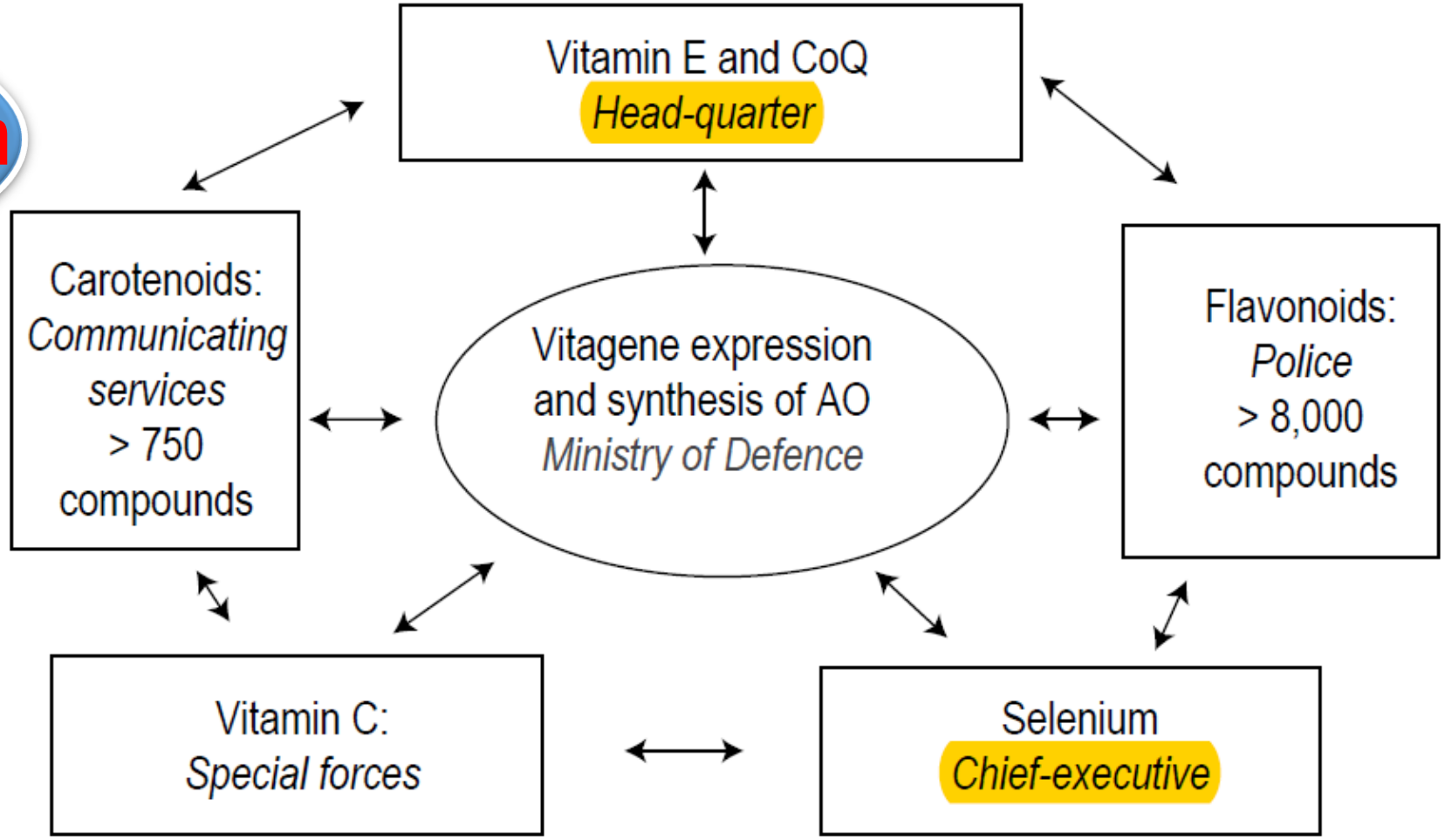

Prooxidant
Antioxidant
ENERGY


LOO• + Toc
Toc• + LOOH


ROOH + 2GSH
GSH-Px
ROH (non-toxic) + H2O + GSSG


Membrane transport
Vit. E quinone
Niacin
Riboflavin
Loss
Se
Loss
CO_2^+
pentose
NADPH
GSSH
AA
Vit. E-radical
ROOH
3
2
1
EFFICIENCY
G-6-P
NADP+
2GSH
DAA
Vitamin E
ROO*
Thiamin
Loss
Glucose
Diketo-L-gulonic acid

Antioxidant system



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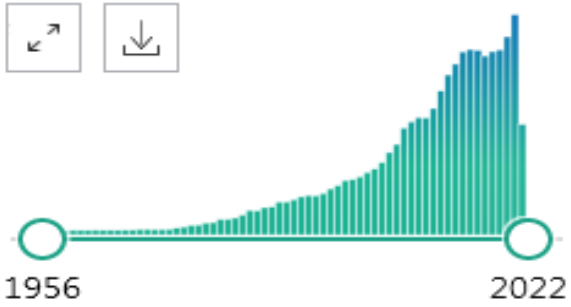
41,252 results

RESULTS BY YEAR



TEXT AVAILABILITY

- [ ] Abstract
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1 Cite Share

Glutathione peroxidase family - an evolutionary overview.

Margis R, Dunand C, Teixeira FK, Margis-Pinheiro M.

FEBS J. 2008 Aug;275(15):3959-70. doi: 10.1111/j.1742-4658.2008.06542.x. Epub 2008 Jul 4.

PMID: 18616466 Free article. Review.

Some **glutathione peroxidase** isozymes have a selenium-dependent **glutathione peroxidase** activity and present a selenocysteine encoded by the opal TGA codon. In the present study, insights into the evolution of the whole **glutathione peroxidase** ...

2 Cite Share

Glutathione peroxidase 4: a new player in neurodegeneration?

Cardoso BR, Hare DJ, Bush AI, Roberts BR.

Mol Psychiatry. 2017 Mar;22(3):328-335. doi: 10.1038/mp.2016.196. Epub 2016 Oct 25.

PMID: 27777421 Review.

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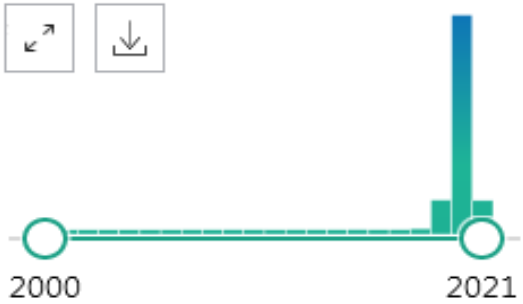
2,846 results

RESULTS BY YEAR



TEXT AVAILABILITY

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1

Cite

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Inactivation of the **glutathione peroxidase** GPx4 by the ferroptosis-inducing molecule RSL3 requires the adaptor protein 14-3-3epsilon.

Vučković AM, Bosello Travain V, Bordin L, Cozza G, Miotto G, Rossetto M, Toppo S, Venerando R, Zaccarin M, Maiorino M, Ursini F, Roveri A.

FEBS Lett. 2020 Feb;594(4):611-624. doi: 10.1002/1873-3468.13631. Epub 2019 Oct 20.

PMID: 31581313 Free article.

Ras-selective lethal small molecule 3 (RSL3), a drug candidate prototype for cancer chemotherapy, triggers ferroptosis by inactivating the **glutathione peroxidase glutathione peroxidase** 4 (GPx4). Here, we report the purification of the protein indispens ...

2

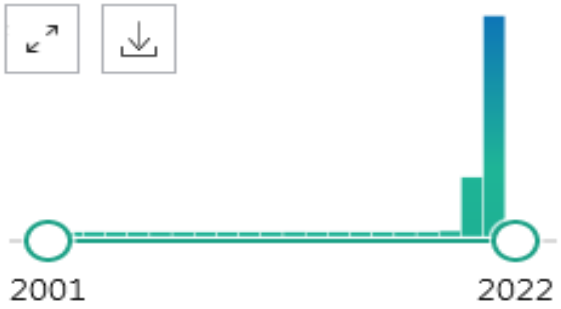
Dietary lipids fuel GPX4-restricted enteritis resembling Crohn's disease.

Mayr L, Grabherr F, Schwärzler J, Reitmeier I, Sommer F, Gehmacher T, Niederreiter L, He GW, Ruder B,

MY NCBI FILTERS

1,376 results

RESULTS BY YEAR



TEXT AVAILABILITY

- [ ] Abstract
- [ ] Free full text

1. **Glutathione peroxidase**-1 and neuromodulation: Novel potentials of an old enzyme.

Cite Share

Sharma G, Shin EJ, Sharma N, Nah SY, Mai HN, Nguyen BT, Jeong JH, Lei XG, Kim HC.

Food Chem Toxicol. 2021 Feb;148:111945. doi: 10.1016/j.fct.2020.111945. Epub 2020 Dec 29.

PMID: 33359022 Review.

Glutathione peroxidase (GPx) acts in co-ordination with other signaling molecules to exert its own antioxidant role. ...

2. Selenium Deficiency.

Cite

Shreenath AP, Ameer MA, Dooley J.

2021 Feb 11. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2021 Jan–.

289 Free Books & Documents. Review.

Microsoft Edge

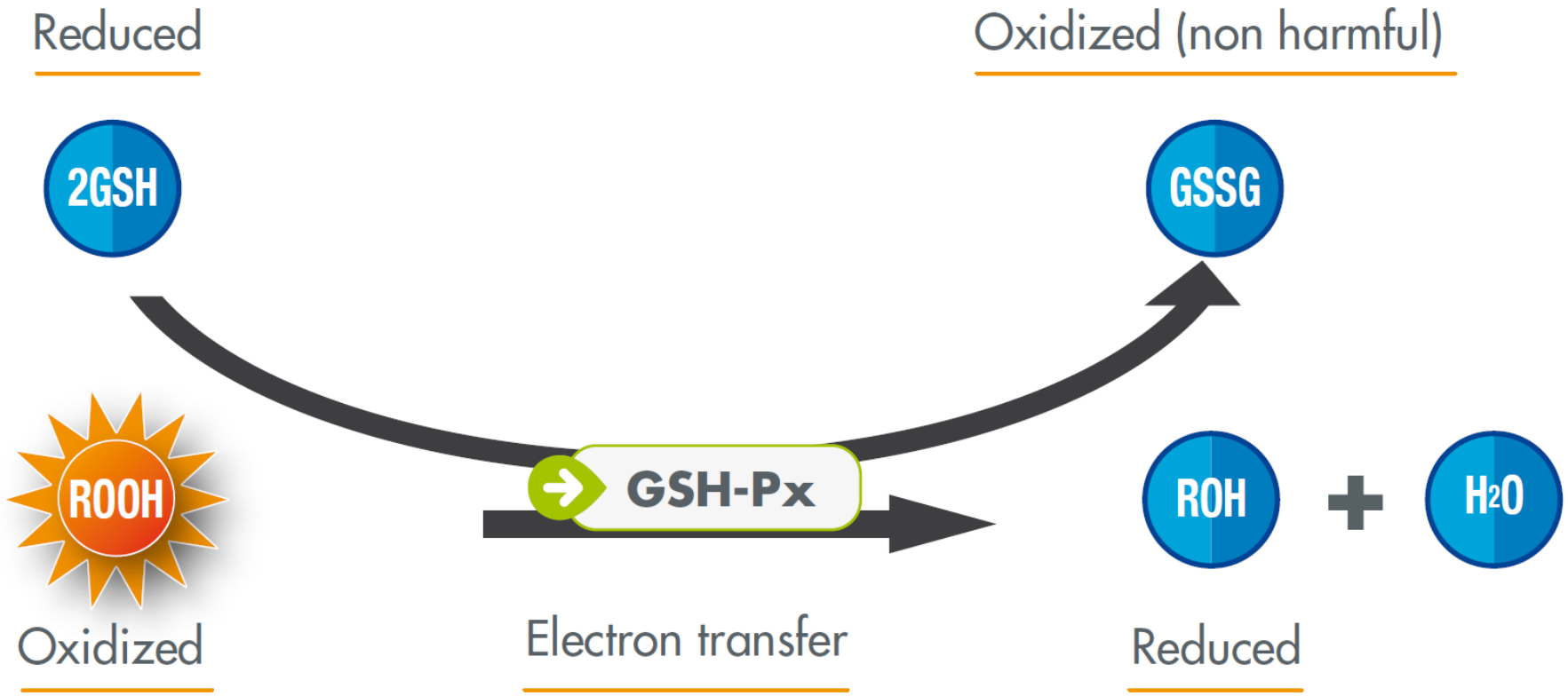
Se-dependent glutathione peroxidase characteristics

Glutathione peroxidase	Nomenclature	Localisation	Subunit size (kDa)	Substrates	Electron donors	Other characteristics
Cytosolic GSH-Px	GSH-Px1	intracellular, cytosolic, partly mitochondria	21.9	H_2O_2, t-BHP	GSH	Erythrocytes, kidney and liver
Gastrointestinal GSH-Px	GSH-Px2	intracellular, cytosolic	21.9	H_2O_2, t-BHP	GSH	mucosal epithelial cells in GIT
Extracellular (plasma) GSH-Px	GSH-Px3	plasma	25.5	H_2O_2, t-BHP, phospholipid hydroperoxides	GSH, thioredoxin, gluta-redoxin	expressed in kidney
Phospholipid hydroperoxide GSH-Px	GSH-Px4	intracellular, partly cytosolic, mitochondrial, membrane-bound	22.1	H_2O_2, phospholipid hydroperoxides	GSH, DTT, 2-ME, L-cys	renal epithelial cells and testes

[1] t-BHP = tret-butylhydroperoxide; DTT = 1,4-ditiothreitol; 2-ME = 2-mercaptoethanol; L-cys = L-cysteine.; GIT = gastrointestinal tract; GSH = glutathione.

Total glutathione peroxidase (GSH-Px) activity in the liver of various animals, U/mg protein

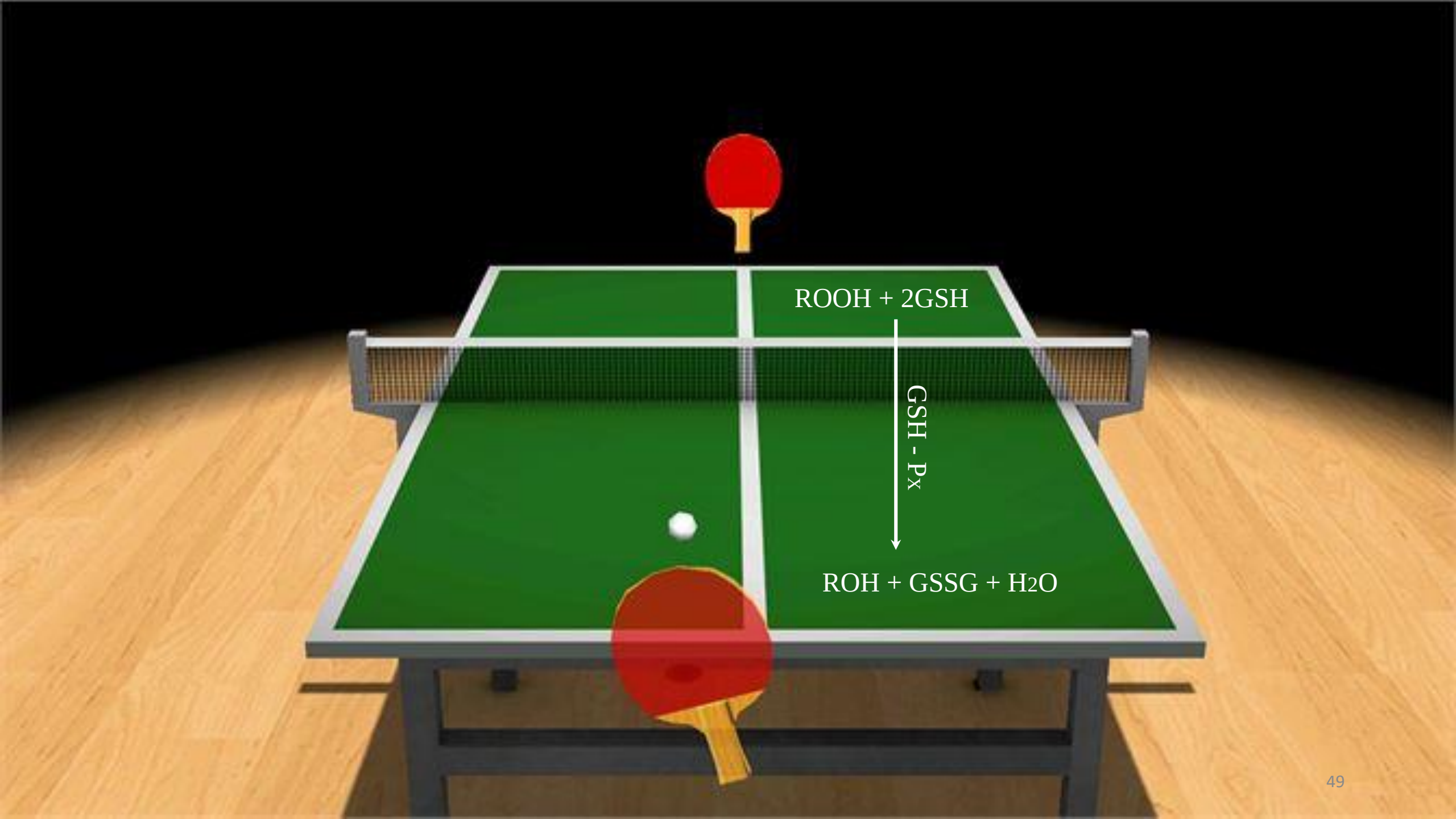
Animal	GSH-Px activity	Animal	GSH-Px activity
Chicken	33	White mouse	468
Cattle	70	Ground squirrel	49
Sheep	64	Cat	67
Rat	245	Dog	20
Mouse	476	Rainbow trout	0.9
Guinea pig	12	Blue gill sunfish	3.4
Hamster	920	Carp	143
Rabbit	496	Fence lizard	22
Gerbil	683	American toad	2
Wild house mice	446	Western newt	1.5

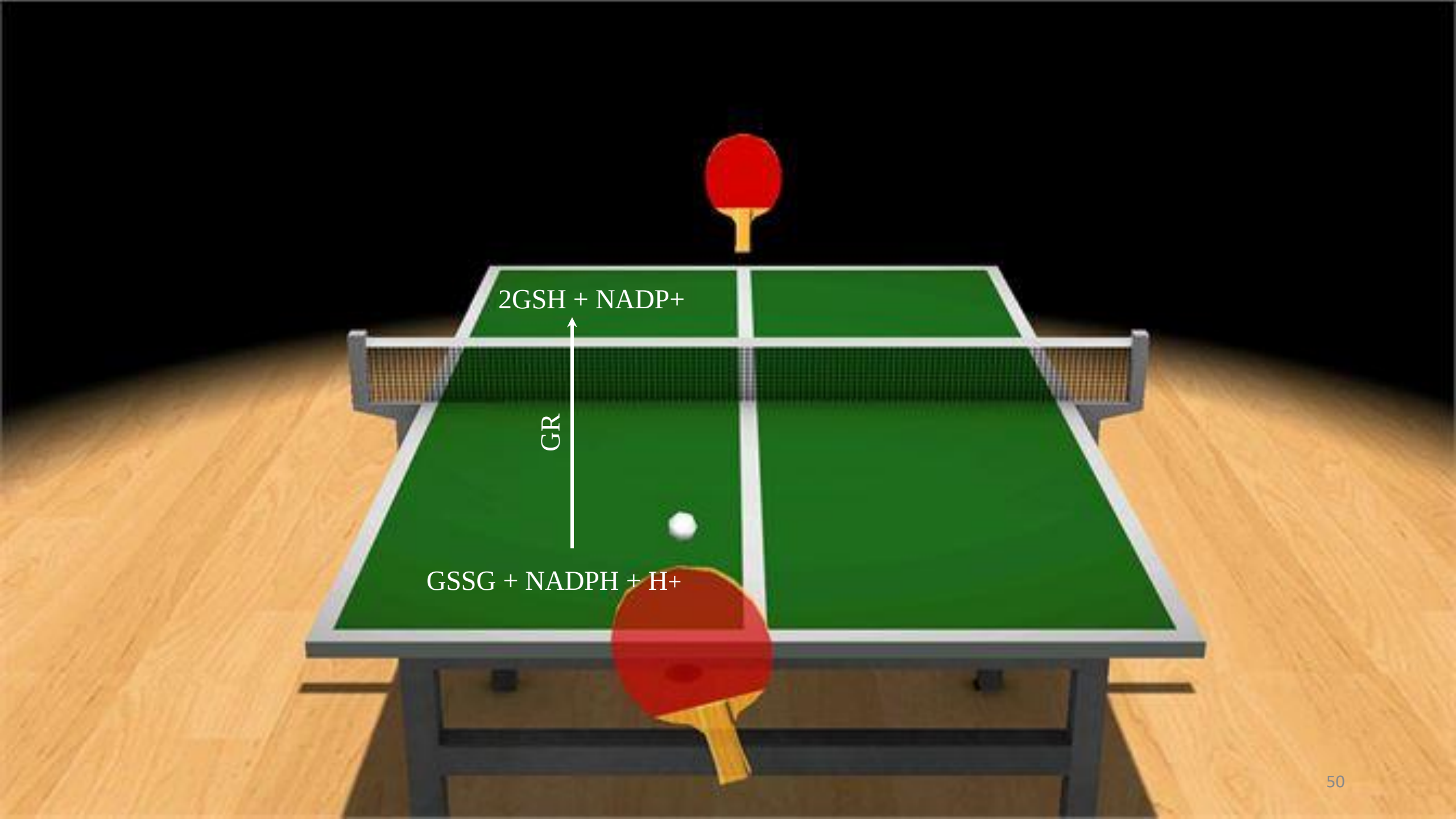

Reduced
Oxidized (non harmful)
2GSH
GSSG
ROOH
GSH-Px
ROH
+
H2O
Oxidized
Electron transfer
Reduced

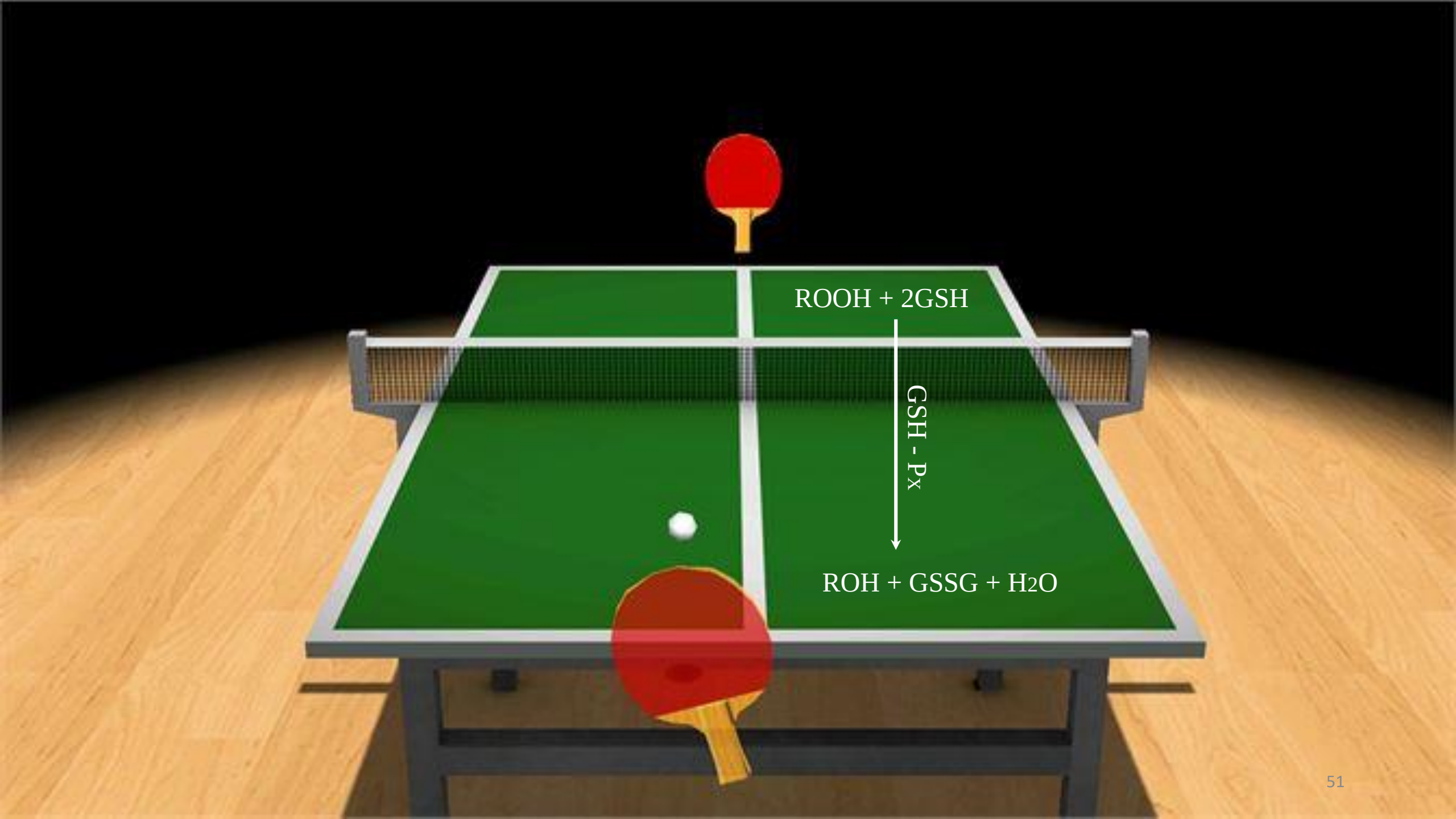
- 4 different GSH-Px in avian species
- Selenium feed supplementation ↗ GSH-Px activity

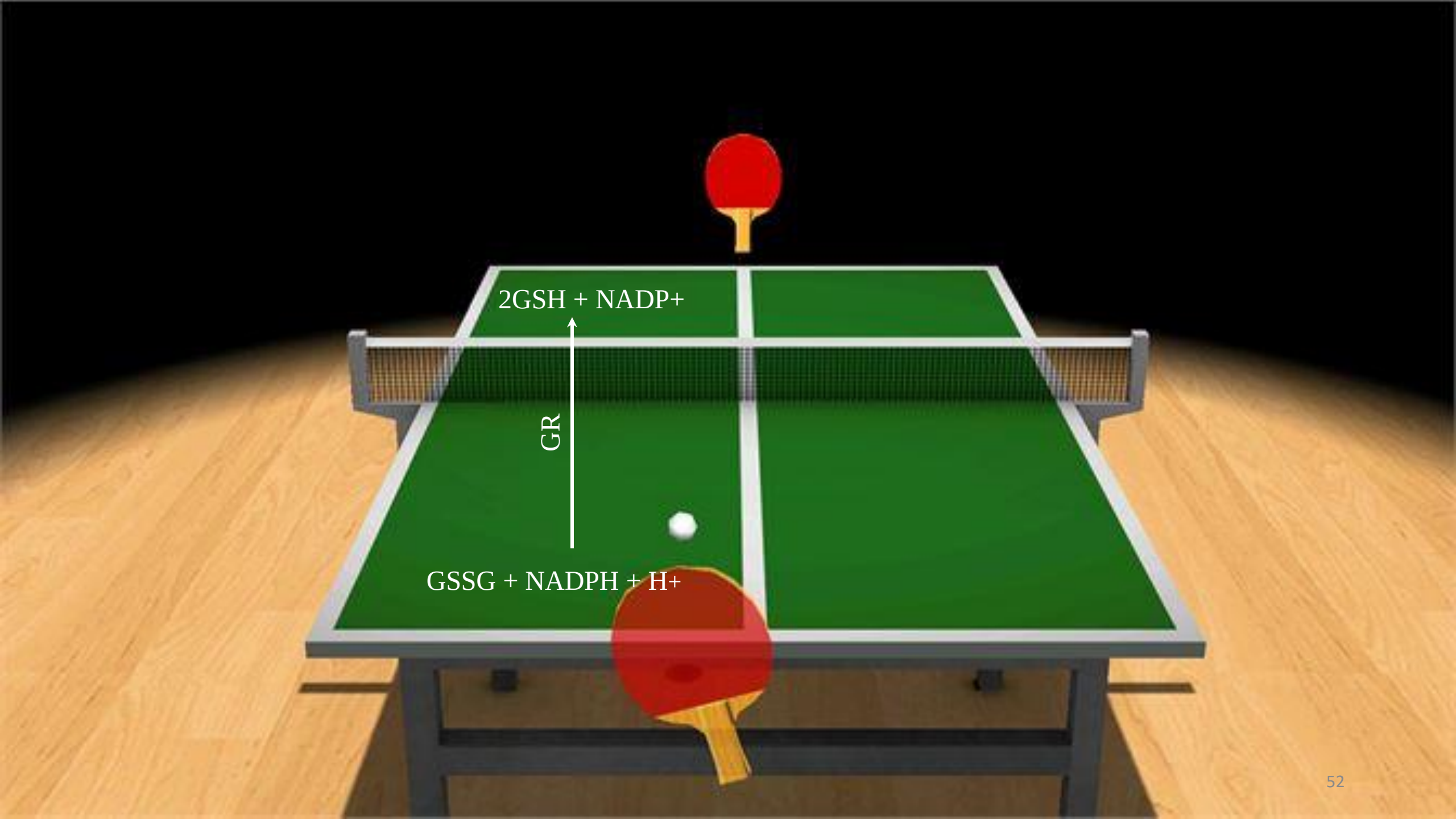
Different biological roles:

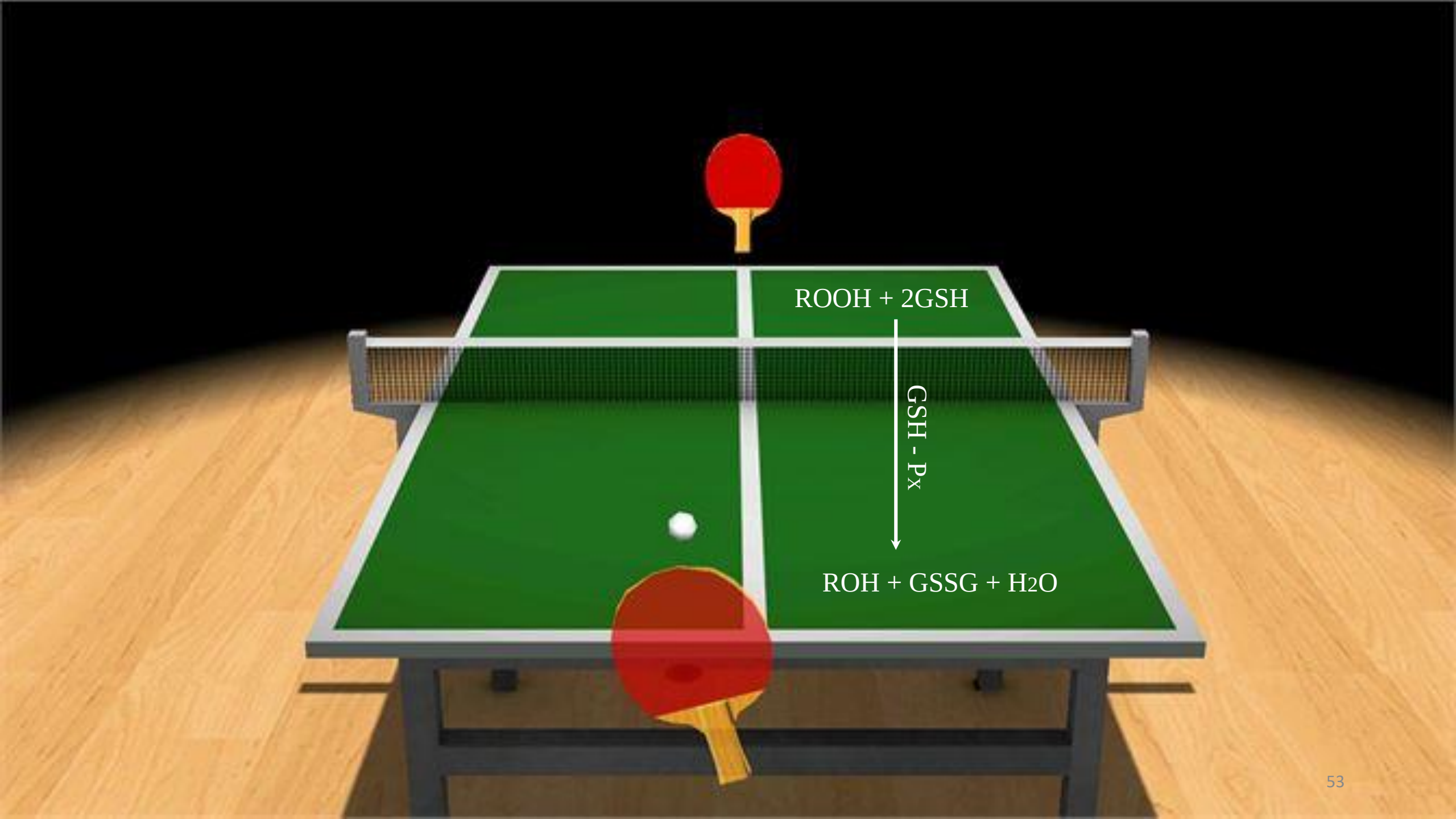
- Prevention of lipid peroxidation
- ROS detoxification
- Specific role of GSH-Px 4 in male fertility

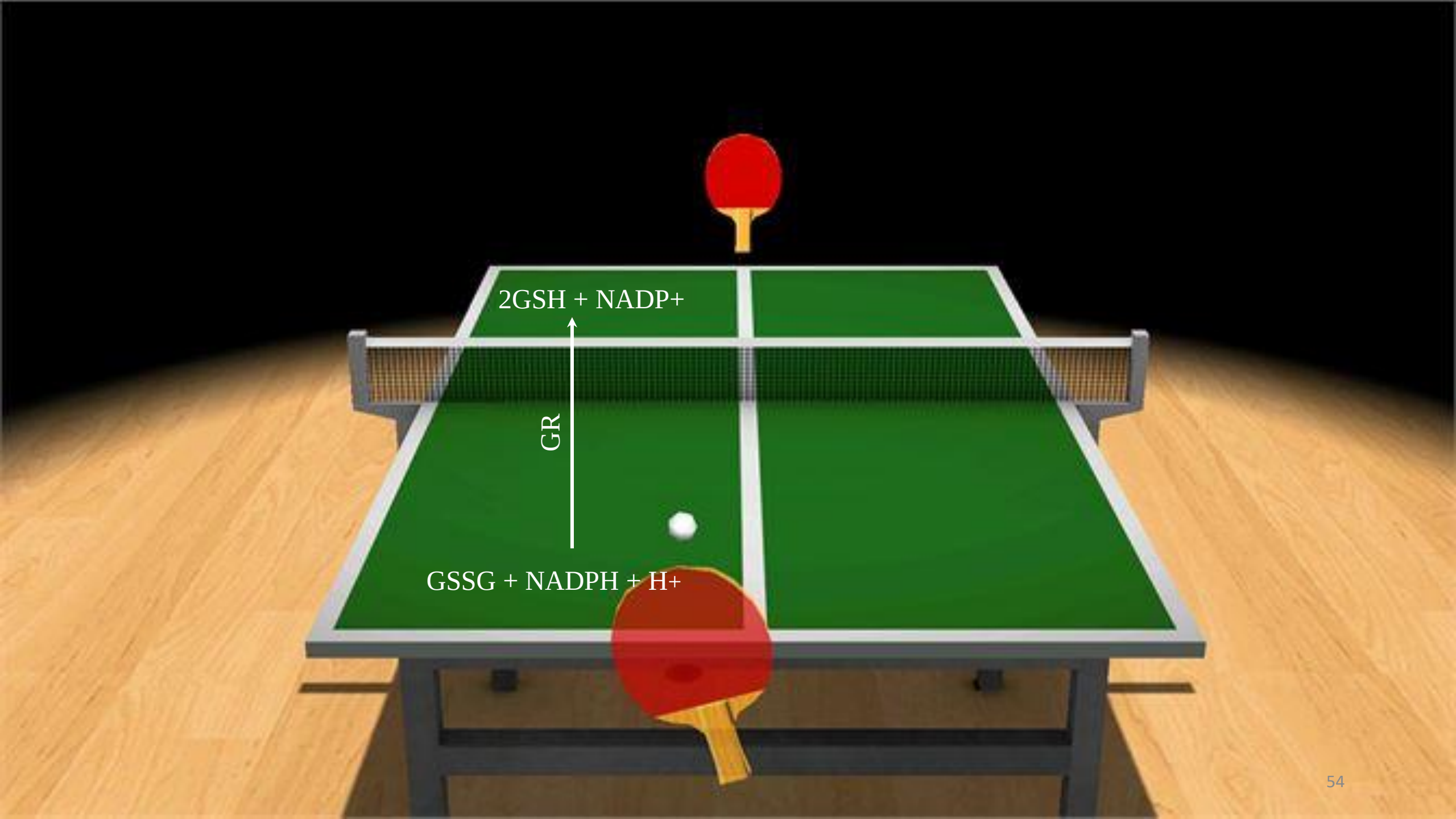

ROOH + 2GSH
GSH - Px
ROH + GSSG + H2O

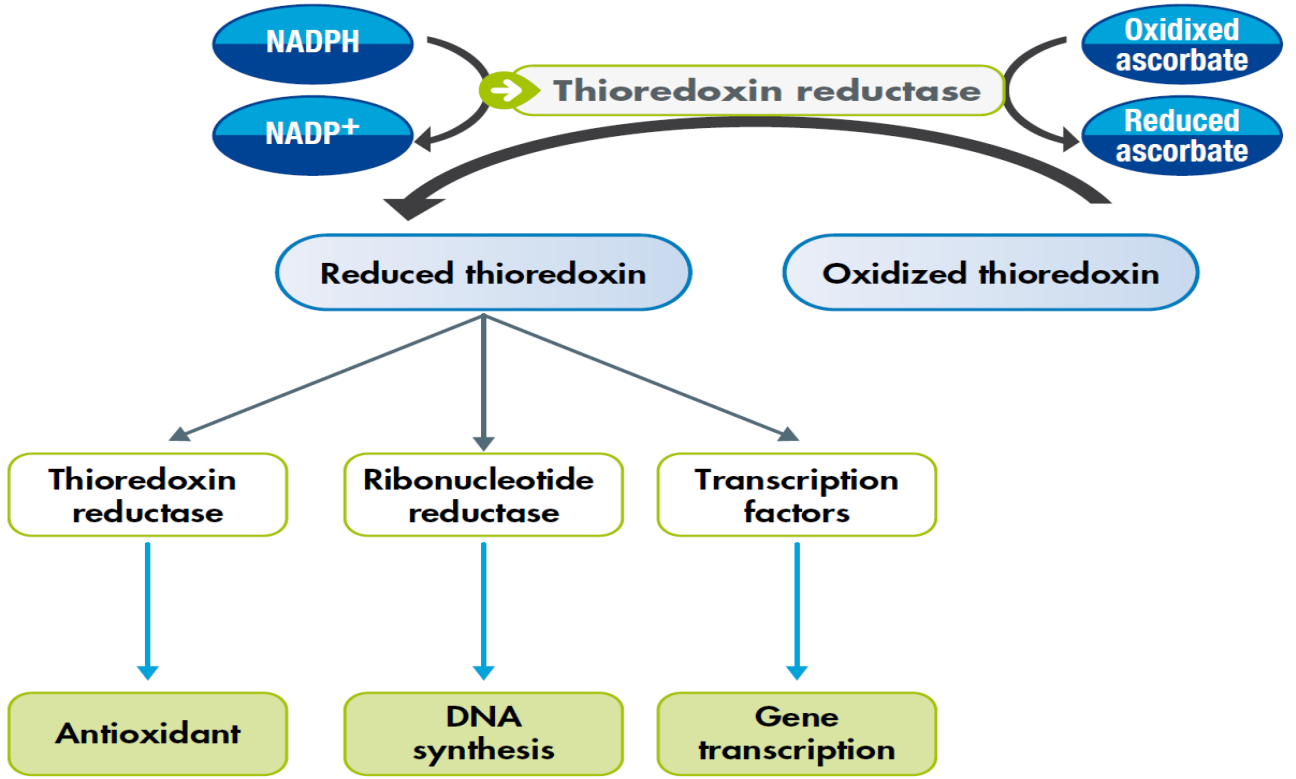

2GSH + NADP+
GR
GSSG + NADPH + H+


ROOH + 2GSH
GSH - Px
ROH + GSSG + H2O


2GSH + NADP+
GR
GSSG + NADPH + H+


ROOH + 2GSH
GSH - Px
ROH + GSSG + H2O


2GSH + NADP+
GR
GSSG + NADPH + H+



TrxR plays a role in:

- Cell growth
- Inhibition of apoptosis
- Cellular sensitivity to glucocorticoids
- Immunomodulation
- Pregnancy and birth
- Neuronal survival

Thioredoxin,
(Peroxidase, Reductase)

Glutathione,
(Peroxidase, Reductase)

Supply electrons for:

- Deoxyribonucleotide formation
- Antioxidant defence
- Protein and DNA synthesis and repair
- Redox regulation of signal transduction
- Transcription
- Cell growth, differentiation and apoptosis

Other selenoproteins

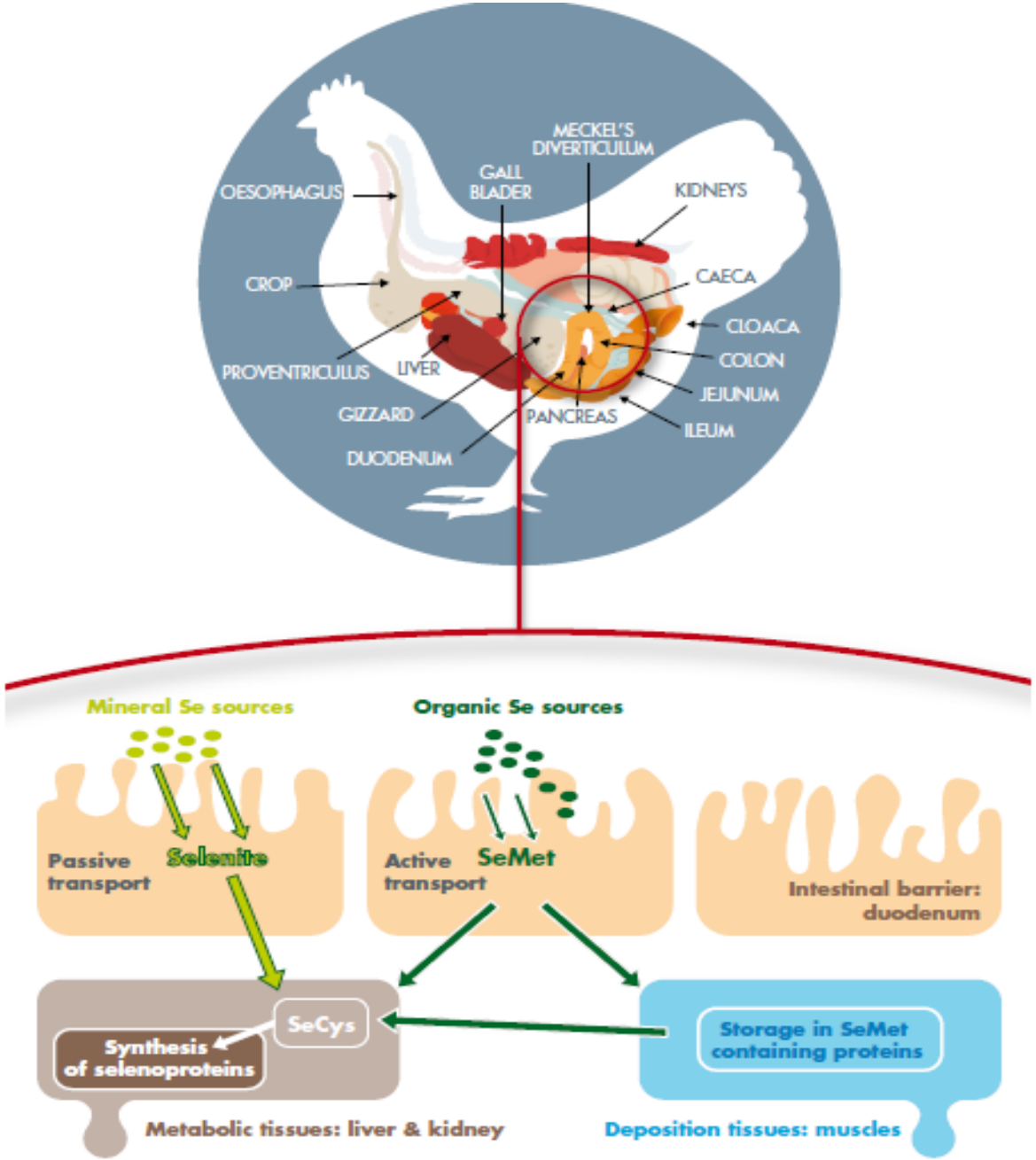
I. Iodothyronine deiodinases
II. Selenophosphate synthetase-2
III. 15-kDa selenoprotein
IV. Selenoprotein H
V. Selenoprotein I
VI. Selenoprotein K
VII. Selenoprotein M
VIII. Selenoprotein N
IX. Selenoprotein O
X. Selenoprotein P
XI. Selenoprotein Pb
XII. Selenoprotein R
XIII. Selenoprotein S
XIV. Selenoprotein T
XV. Selenoprotein U
XVI. Selenoprotein W

Selenoprotein location in chicken

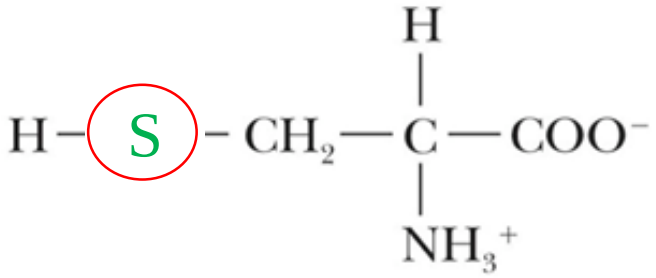
Location/feature	Selenoproteins
Inside the cell	GSH-Px1, GSH-Px2, GSH-Px4, DIO1, DIO2, DIO3, TrxR1, TrxR2, TrxR3, Sep15, SelH, SelI, SelK, SelM, SelN, SelO, SelT, SelU, SelW, MsrB1, SPS2
Outside the cell/secreted	SelPa, SelPb and GSH-Px3
Endoplasmic reticulum	DIO1, DIO2, DIO3, Sep15, SelI, SelK, SelM, SelN SelS and SelT
Mitochondria	GSH-Px1, GSH-Px2, GSH-Px4, TrxR1, TrxR2, TrxR3, SelM, SelO and SelU
Cytoplasm	GSH-Px1, GSH-Px2, GSH-Px4, TrxR1, TrxR2, TrxR3 and SelW
Nucleus	GSH-Px4, MsrB1 and SelH
Golgi apparatus	SelT
Membrane	SelI
Membrane-bound	SelI, SelK, SelS, SelT, DIO1 and DIO3
Zn-containing	Sep15, MsrB1, SelW and SelM
POP-containing	GSH-Px1, GSH-Px2, GSH-Px3 and GSH-Px4
Thioredoxin-like fold-containing	GSH-Px1, GSH-Px2, GSH-Px3, GSH-Px4, DIO1, DIO2, DIO3, TrxR3, SelT, SelH, SelW, Sep15, SelM, SelU and SelO
Flavin adenine dinucleotide-interacting	TrxR1, TrxR2 and TrxR

Selenium absorption and metabolism

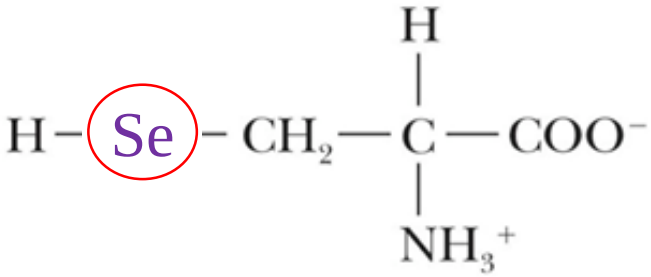
- ✓ Chemical form of Se
- ✓ Other dietary components
- ✓ Selenium status
- ✓ Physiological status
- ✓ Species


MECKEL'S DIVERTICULUM
GALL BLADER
OESOPHAGUS
KIDNEYS
CROP
CAECA
CLOACA
COLON
PROVENTRICULUS
LIVER
JEJUNUM
GIZZARD
PANCREAS
ILEUM
DUODENUM
Mineral Se sources
Organic Se sources
Passive transport
Selenite
Active transport
SeMet
Intestinal barrier: duodenum
SeCys
Synthesis of selenoproteins
Storage in SeMet containing proteins
Metabolic tissues: liver & kidney
Deposition tissues: muscles

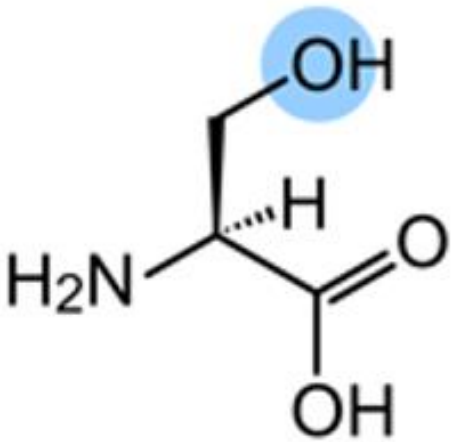
Synthesis Mechanism of 21st Amino Acid Selenocysteine



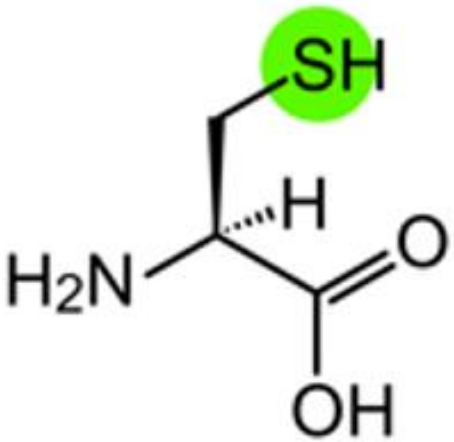
Cysteine



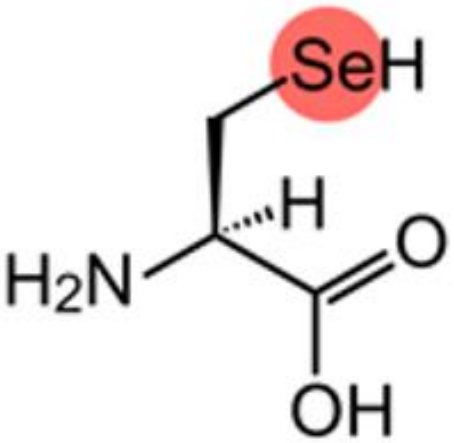
Selenocysteine



Serine (Ser)

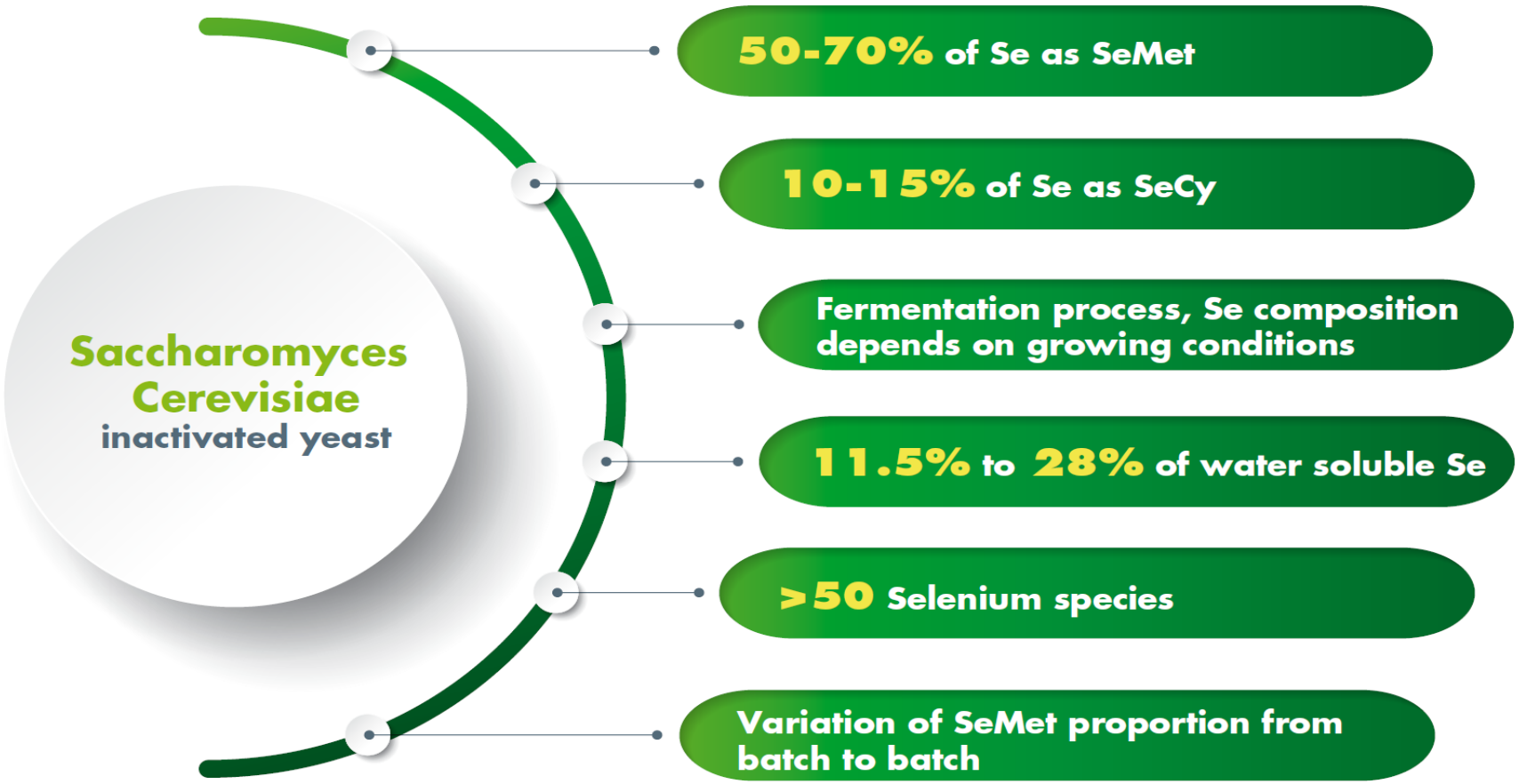


Cysteine (Cys)



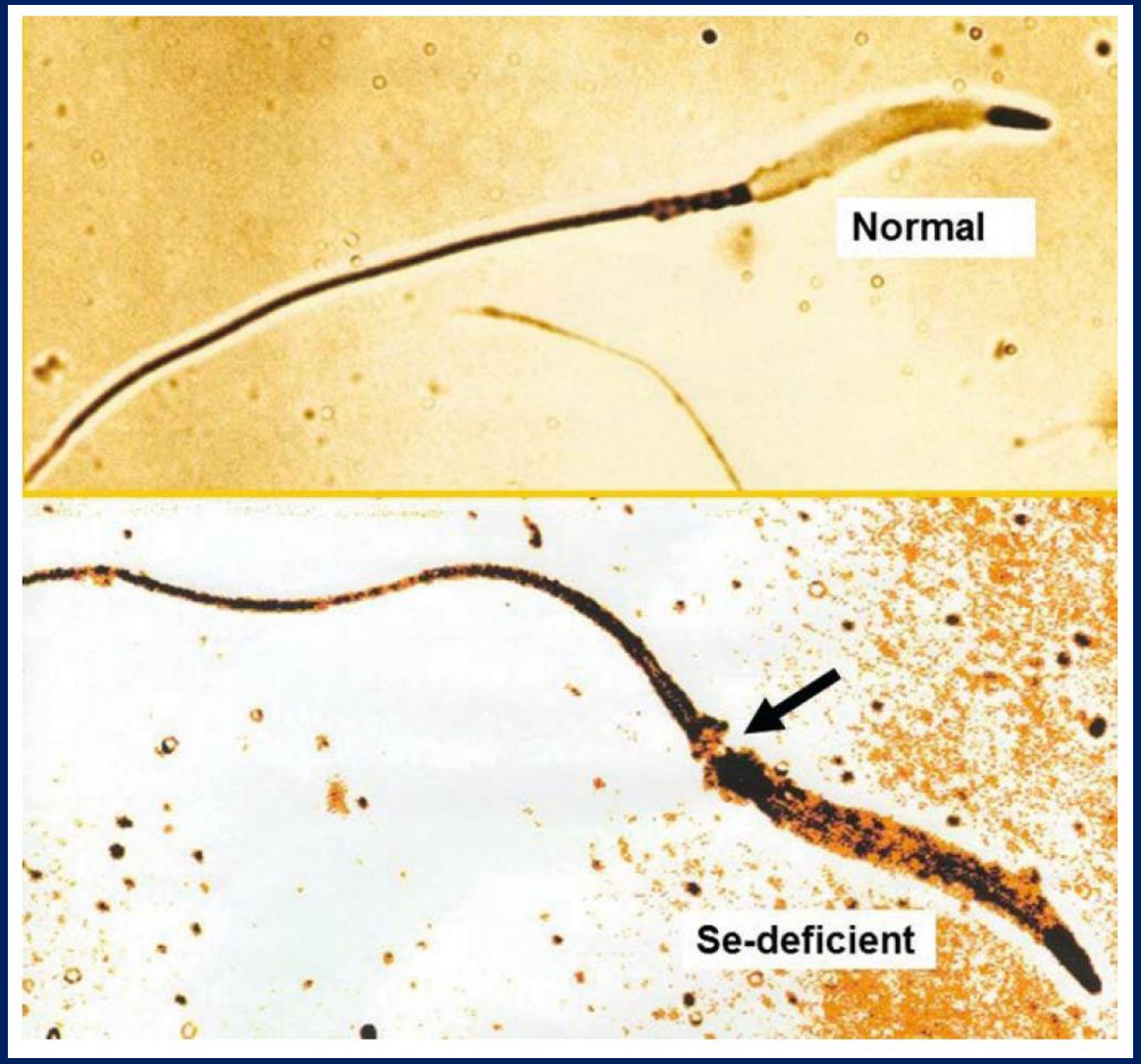
Selenocysteine (Sec)

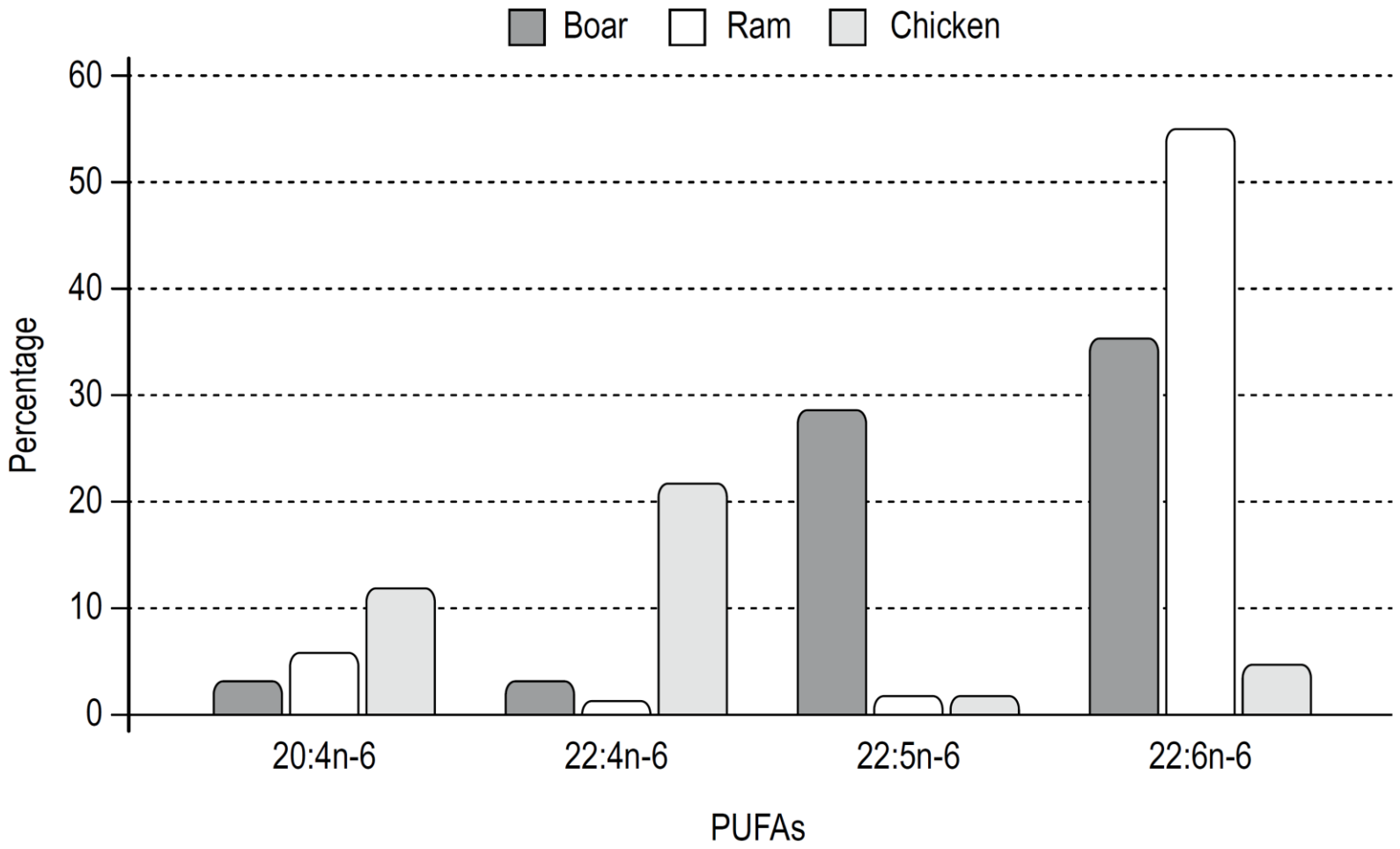
Selenium-enriched yeast



The legal definition of Se-yeast is as follows:

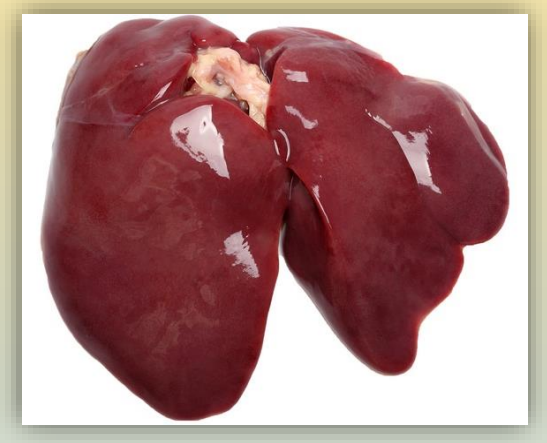
Selenium yeast is a dried, non-viable yeast (*Saccharomyce erevisiae*) tivated in a fed-batch fermentation which provides incremental amounts of cane olasse nd selenium salts in a manner which minimises the detrimental effects of selenium salts ne growth rate of the yeast and allows for optimal incorporation of inorganic selenium into cel ar organic material. Residual inorganic selenium is eliminated in a rigorous washing proce s and must not exceed 2% of the total selenium content in the final selenium yeast product (LII, 2015).


Normal
Se-deficient



Polyunsaturated fatty acids (PUFAs) in spermatozoa phospholipids, % (adapted from Surai, 2002).

20:4n-6 = arachidonic acid; 22:4n-6 = docosatetraenoic acid; 22:5n-6 = docosapentaenoic acid; 22:6n = 3 docosahexaenoic acid.



GSH-Px

GSH-Px

Theriogenology 126 (2019) 279–285

Contents lists available at ScienceDirect

Theriogenology

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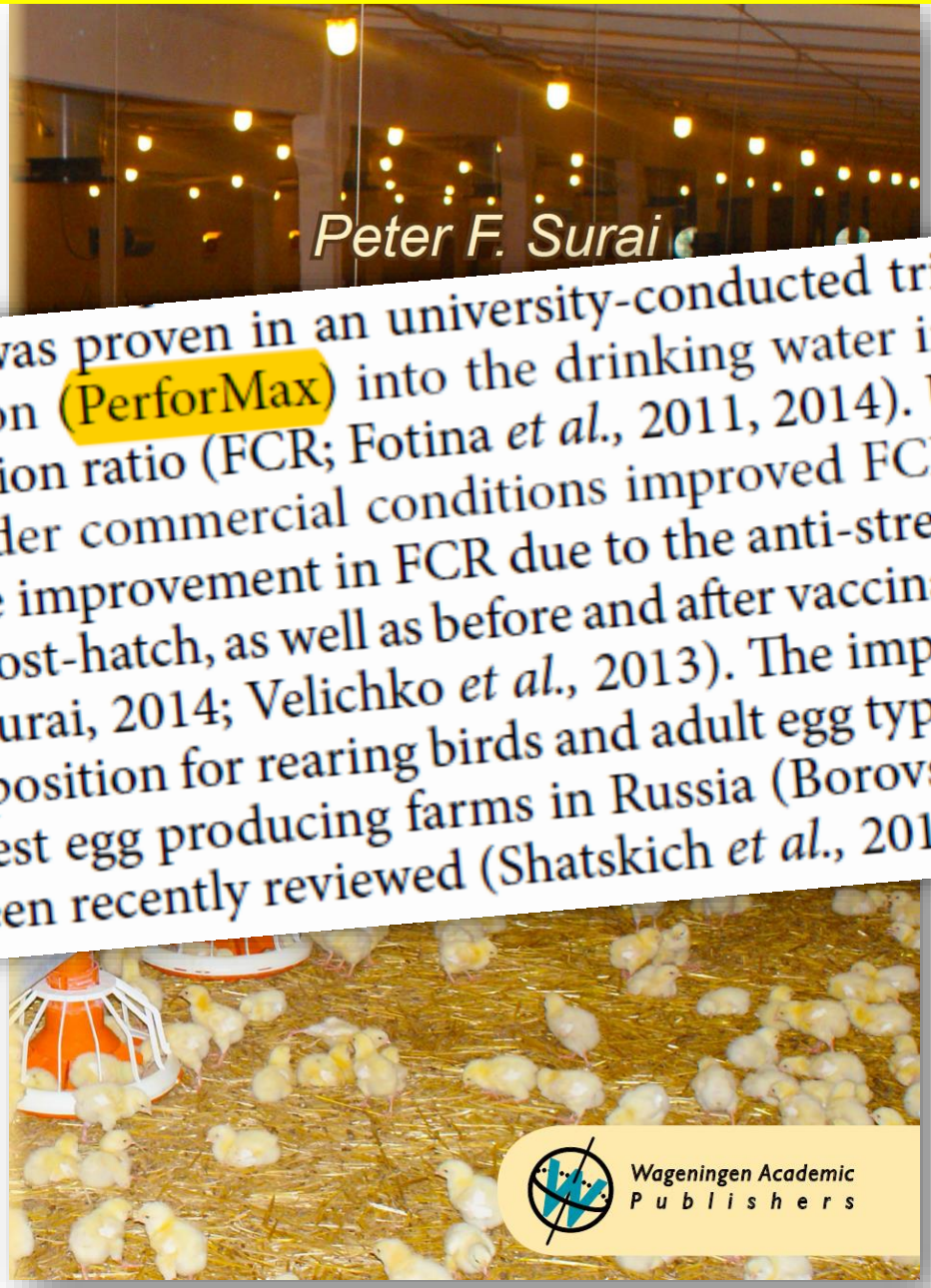
An improvement in productive and reproductive performance of aged broiler breeder hens by dietary supplementation of organic selenium

Mojtaba Emamverdi [a], Ahmad Zare-Shahneh [a, *], Mahdi Zhandi [a, **], Mojtaba Zaghari [a], Dariush Minai-Tehrani [b], Mahdi Khodaei-Motlagh [c]

[a] Department of Animal Science, College of Agriculture and Natural Resources, University of Tehran, Karaj, 31587-77871, Iran
[b] Faculty of Life Science and Biotechnology, Shahid Beheshti University, Tehran, 16589-53571, Iran
[c] Department of Animal Science, Faculty of Agricultural and Natural Science, University of Arak, Arak, 38156-88349, Iran



In particular, it was proven in an university-conducted trial that inclusion of anti-stress composition (PerforMax) into the drinking water improved chicken growth and feed conversion ratio (FCR; Fotina *et al.*, 2011, 2014). Using the same anti-stress composition under commercial conditions improved FCR during a 39 day broiler growth trial. The improvement in FCR due to the anti-stress composition during the first three days post-hatch, as well as before and after vaccination was highly significant (Velichko and Surai, 2014; Velichko *et al.*, 2013). The importance and efficacy of the anti-stress composition for rearing birds and adult egg type parent stock (Hy-Line) at one of the biggest egg producing farms in Russia (Borovskaya poultry farm, Tumen region) have been recently reviewed (Shatskich *et al.*, 2015).

نتیجه گیری
Conclusion


PARENT STOCK
ROSS 308
Nutrition Specifications
2021
ROSS
An Aviagen Brand

		Starter 1	Starter 2	Grower	Developer	Pre-Breeder	Breeder 1	Breeder 2	Breeder 3
Age Fed	**days**	**0-21 days**	**22-42 days**	**43-105 days**	**106 -140 days**	**141 days to 5% production**	**>5% production to 224 days**	**225-350 days**	**After 351 days**
Energy per kg*	**kcal**	**2800**	**2800**	**2800**	**2800**	**2800**	**2800**	**2800**	**2800**
	MJ	11.7	11.7	11.7	11.7	11.7	11.7	11.7	11.7
Energy per lb	**kcal**	**1271**	**1271**	**1271**	**1271**	**1271**	**1271**	**1271**	**1271**
DIGESTIBLE AMINO ACIDS									
Lysine (max)**	%	1.00	0.72	0.52	0.50	0.48	0.62	0.56	0.52
Methionine	%	0.46	0.37	0.36	0.34	0.34	0.38	0.35	0.34
Methionine & Cystine	%	0.84	0.68	0.62	0.60	0.58	0.62	0.57	0.55
Threonine	%	0.70	0.60	0.52	0.50	0.49	0.55	0.53	0.51
Valine	%	0.81	0.72	0.60	0.58	0.56	0.64	0.60	0.56
Tryptophan	%	0.18	0.18	0.15	0.15	0.15	0.15	0.14	0.13
Arginine	%	1.15	0.92	0.78	0.76	0.74	0.85	0.82	0.79
Leucine	%	1.20	1.03	0.82	0.80	0.78	0.95	0.90	0.86
Isoleucine	%	0.70	0.58	0.47	0.45	0.43	0.52	0.50	0.49
Histidine	%	0.43	0.32	0.26	0.23	0.20	0.30	0.28	0.26
Crude Protein (min)	**%**	**19.0**	**17.0**	**14.0**	**14.0**	**14.0**	**15.0**	**14.0**	**13.0**
MINERALS									
Calcium	%	1.05	0.94	0.90	0.90	1.50	3.00	3.20	3.40
Available Phosphorus	%	0.50	0.47	0.45	0.45	0.35	0.36	0.34	0.32
Sodium	%	0.18-0.23	0.18-0.23	0.18-0.23	0.18-0.23	0.18-0.23	0.18-0.23	0.18-0.23	0.18-0.23
Chloride	%	0.18-0.23	0.18-0.23	0.18-0.23	0.18-0.23	0.18-0.23	0.18-0.23	0.18-0.23	0.18-0.23
Potassium	%	0.60-0.90	0.60-0.90	0.60-0.90	0.60-0.90	0.60-0.90	0.70-0.90	0.65-0.90	0.60-0.90
ADDED TRACE MINERALS PER KG									
Copper	mg	16					16		
Iodine	mg	2					3		
Iron	mg	40					50		
Manganese	mg	120					120		
Selenium	mg	0.3					0.3		
Zinc	mg	120					120		

ای در سکوت چشمت، صد شیوه از ترانه
پیش آ که از تو دیدم در هر کجا نشانه

با مسجدی نشستم، می‌جست در کتابت
حاجی نشان کویت، می‌داد سوی خانه

آن می‌فروش میگفت، دیده است عکس رویت
در مستی مدام جام می مغانه

یک رهگذر به من گفت در پای آن سپیدار
بر روی قوس پیچک، هستی تو در میانه

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