Biogene Amine, Peptide und Proteine u.a.
Biogenic amines, peptides and proteins, and the like.

A. Aus der Thio(l)esterwelt, from the thio(l)ester world

http://www.xerlebnishaft.de/lebensstrukturenvergleich.pdf

Eiweiß hat Schwefel (Cystein, Methionin, Glutathion, Acetylcystein, Sulfonsäuren)
Protein has sulfur (cysteine, methionine, glutathione, acetylcysteine, sulfonacids)

Thioester-Gruppen (SH-Gruppen) spielen im Komplement-System http://xerlebnishaft.de/complement.pdf
eine zentrale Rolle als Vermittler zwischen Eiweiß- und Purin- Stoffwechsel.
Thioester groups (SH-groups) play in the complement system http://xerlebnishaft.de/complement.pdf
a central role as an intermediary between protein and purine metabolism.
DeDuve Chr (1994) Ursprung des Lebens. Präbiotische Evolution und die Entstehung der Zelle. Spektrum.
http://www.amazon.de/Der-Ursprung-Lebens-Pr%C3%A4biotische-Entstehung/dp/3860251872

Eiweiß hat im Gegensatz zu den Nukleinsäuren kein Phosphor
Protein, in contrast to the nucleic acids has no phosphorus

Thio(l)ester Thioester zur nucleophilen Acylierung in der Natur
http://www.chem.uzh.ch/robinson/lectures/AC_BII/Kap11/kap11.html#11.13
http://www.xerlebnishaft.de/lebensstrukturenvergleich.pdf

Spermidin http://www.xerlebnishaft.de/bildmethyl-arginin.pdf
Lida Mattman (2001) Cell Wall Deficient Forms. Stealth Pathogens. CRC Press, Seite , page 93
"Spermine levels might explain why some individuals have classical bacteria in infections and others only L-Phase organisms".
„Die Spermin Mengen könnten erklären warum manche Patienten klassische Bakterien ausbilden und andere nur intrazellulär persistierende bakterielle Dauerformen (L-Formen, Spheroplasten)".

L-Arginin http://www.xerlebnishaft.de/bildmethyl-arginin.pdf
Der **Harnstoffzyklus** (auch Arginin- oder Krebs-Henseleit-Zyklus) verwandelt bei Säugetieren die meist toxischen stickstoffhaltigen Abbauprodukte der Proteine, z.B. Ammonium, zu ungiftigem Harnstoff.
The **urea cycle** (also arginine or Krebs-Henseleit cycle) in mammals transforms usually toxic nitrogenous decomposition products of proteins, for example Ammonium, into non-toxic urea.
Hirsch JG. (1958) **Bactericidal action of histone.** J Exp Med 108, 925–44
"The arginine-rich fraction of calf thymus histone (histone B) exerts bactericidal activity on various coliform bacilli and micrococci under certain conditions *in vitro*".
„Die arginin-reiche Fraktion von Kalbsthymus Histon (Histon-B) wirkt *in vitro* an verschiedenen coliformen Bazillen und Mikrokokken unter bestimmten Bedingungen bakterizid".

L-Prolin

N-Acetylcystein und Glutathion
ist ein Glutathion Prodrug. Die **SH-Gruppe** im N-Acetylcystein-Molekül kann leicht oxidiert werden. Dabei verbinden sich zwei Moleküle über eine Disulfid-Brücke und reaktive sauerstoffhaltige Radikale, z.B. werden Wasserstoffperoxid (H_2O_2) und Hydroxylradikale (OH•) zu unschädlichen Molekülen reduziert. N-acetylcysteine is a Glutathione prodrug.
The **SH group** in the N-acetyl cysteine molecule may be easily oxidized. It combines two molecules via a disulfide bridge, and reactive oxygen-containing radicals, for example, Hydrogen peroxide (H2O2) and hydroxyl radicals (OH •) are reduced to harmless molecules.
Glutathion (**GSH**), auch γ-L-Glutamyl-L-cysteinylglycin, ist ein Tripeptid, das aus den drei Aminosäuren Glutaminsäure, Cystein und Glycin gebildet wird.
Glutathione (GSH) = γ-L-glutamyl-L-cysteinyl-glycine, is a tripeptide formed from the three amino acids glutamic acid, cysteine and glycine." http://de.wikipedia.org/wiki/Glutathion

➔ **Cytoskelett, cytoskeleton** http://www.xerlebnishaft.de/zytoskelett.pdf

Alliin, Cycloalliin, Sulfoxyde, Sulfonsäuren, Histone, Carnosin
Spezielle Peptide und Auto-Vaccine, Peptid Antibiotika, Peptid Hormone, das Proteom und Prione

B. Aus der Eiweißwelt, from the protein world

L-Tryptophan / Kynurenin http://de.wikipedia.org/wiki/Tryptophan http://en.wikipedia.org/wiki/Tryptophan http://www.ganzimmun.de/seiten/test.php?test_id=1435 http://lib.bioinfo.pl/paper:1531156

Protein- und Peptid- Hormone

Neuropeptid der Epiphyse: Melatonin
Neuropeptide des Hypothalamus: Freisetzungshormone für LH/FSH, TSH, ACTH, GH, Somatostatin, Agouti-ähnliches Peptid, Neuropeptid Y, Leptin, Ghrelin.
Glykoproteinhormone der Adenohypophyse: Follikelstimulierendes Hormon Follitropin (FSH), Luteinisierendes Hormon Luteotropin (LH), Schilddrüsenstimulierendes Hormon Thyreotropin (TSH), Adrenocorticotropin (ACTH).
Weitere adenihypophysäre Hormone: Wachstumshormon: GH, Prolaktin, Melanozytenstimulierendes Hormon (MSH), Galanin, Kisspeptin.
Neuropeptide der Neurohypophyse: Adiuretin (Vasopressin), Oxytocin.
Hormone der Schilddrüsen: Kalzitonin.
Hormone der Nebenschilddrüsen: Parathormon.
Hormone des Herzens: Atrial-Natriuretisches Peptid (ANP).
Hormone der pankreatischen Inselzellen: Insulin, Glucagon, Somatostatin, Pankreatisches Polypeptid.
Peptidhormone des Magen- und Darmtraktes: Cholecystokinin (CCK), Sekretin, Gastrin, Ghrelin, Vasoaktives intestinales Peptid (VIP), Gastroinhibitorisches Peptid (GIP), Peptid Tyrosyl-Tyrosin (PYY).
Peptidhormone der Leber: Insulin-like growth factor (IGF),
Proteohormone der Gonaden: Inhibin, Aktivin.

Protein and peptide hormones

Neuropeptide of the epiphysis: Melatonin
Neuropeptides of the hypothalamus: release hormones for LH / FSH, TSH, ACTH, GH, somatostatin, agouti-like peptide, neuropeptide Y, leptin, ghrelin.
Glycoprotein hormones of the anterior pituitary: follicle-stimulating hormone, follitropin (FSH), luteinizing hormone Luteotropin (LH), thyroid stimulating hormone thyrotropin (TSH), adrenocorticotropic hormone (ACTH).
More adenihypophysäre hormones: growth hormone: GH, prolactin, melanocyte stimulating hormone (MSH), galanin, Kisspeptin.
Neuropeptide the neurohypophysis: antidiuretic (vasopressin), oxytocin.
Of thyroid hormones: calcitonin.
Hormones of the parathyroid glands: parathyroid hormone.
Hormones of the heart: Atrial natriuretic peptide-(ANP).
Hormone of the pancreatic islet cell: insulin, glucagon, somatostatin, pancreatic polypeptide.
Peptide hormones of the gastro-intestinal tract: cholecystokinin (CCK), secretin, gastrin, ghrelin, vasoactive intestinal peptide (VIP), Gastroinhibitorisches peptide (GIP), peptide tyrosyl-tyrosine (PYY).
Peptide hormones of the liver: insulin-like growth factor (IGF),
Proteohormones of the gonads: inhibin, activin.
Quellen: http://de.wikipedia.org/wiki/Hormon u.a.

Rial NS et al. (2009) **Polyamines as mediators of APC-dependent intestinal carcinogenesis and cancer chemo prevention.** Essays Biochem. 46, 111–124

Soda K (2011) **The mechanisms by which polyamines accelerate tumor spread.** Journal of Experimental & Clinical Cancer Research 30, 59–104

Minois N et al. (2011) **Polyamines in aging and disease.** Aging 3, 1–17

Bishop BM, Juba ML, Russo PS et al. (2017) **Discovery of Novel Antimicrobial Peptides from Varanus komodoensis (Komodo Dragon) by Large-Scale Analyses and De-Novo-Assisted Sequencing Using Electron-Transfer Dissociation Mass Spectrometry.** J. Proteome Res., Article ASAP **DOI:** 10.1021/acs.jproteome.6b00857
http://pubs.acs.org/doi/abs/10.1021/acs.jproteome.6b00857

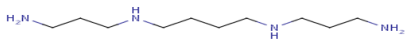
Blum K, Modestino EJ, Febo M et al. (2017) **Lyme and Dopaminergic Function: Hypothesizing Reduced Reward Deficiency Symptomatology by Regulating Dopamine Transmission.** J Syst Integr Neurosci. 3(3). doi: 10.15761/JSIN.1000163. Epub 2017 May 11.
https://www.ncbi.nlm.nih.gov/pubmed/28736624

Thio(l)ester

Pulka-Ziach K, Pavet V, Chekkat Net al (2014) Thioether Analogues of Disulfide-Bridged Cyclic Peptides Targeting Death Receptor 5: Conformational Analysis, Dimerisation and Consequences for Receptor Activation. Chembiochem doi: 10.1002/cbic.201402485.

Dubilier N, Mülders C, Ferdelman T et al. (2001) Endosymbiontic sulphate-reducing and sulphide-oxidizing bakteria in an oligochaete worm. Nature 411, 298-302
http://www.ncbi.nlm.nih.gov/pubmed/11357130

Spermidin, Spermin http://xerlebnishaft.de/bildmethyl-arginin.pdf



Spermidin (AI3-26636; 1,4-Diaminobutane, N-(3-aminopropyl)-; 1,4-Butanediamine, N-(3-aminopropyl)-; 1,5,10-Triazadecane; 4-Azaoctamethylenediamine; Spermidine; BRN 1698591; N-(3-Aminopropyl)-1,4-butane-diamine)**,**

Spermin (AI3-26633; 1,4-Bis(aminopropyl) butanediamine, Spermine*;* BRN 1750791; 4,9-Diaza-1,12-dodecanediamine; Diaminopropyltetramethylenediamine*)*

Erhöhte Spermidin Werte sind Entzündungsmarker bei regenerierenden Geweben.

Erniedrigte Spermidin Werte finden sich bei Vergiftungen, Vitaminmangel, Pyrollurie.

Diagnostik: z.B Labor Bayer aktuell
http://www.labor-bayer.de/newsletter/DrBayer-News-2013-09-web.pdf ,
zusätzlich Homocystein-Nachweis

Therapie: Soja, Grape fruit, Weizenkeime, Durian-Frucht

Synthetisiert zu erwerben: Fa. Sigma - Aldrich (2016) **Spermidine**
http://www.sigmaaldrich.com/catalog/product/sigma/s2626?lang=de&region=DE&gclid=CJXCmsPYwM4CFU46GwodEh4OIQ

Leeuwenhoek, A. van (1678) Observationes D. Anthonii Leeuwenhoek, de natis e semine genitali animalculis. Letter dated November 1677. Philos. Trans. Roy. Soc. London, 12, 1040-1043

Wrede F. (1925) Über die aus menschlichem Sperma isolierte Base **Spermin**. Dtsch. Med. Wochenschr.51, 24

Dudley H. W., Rosenheim O., Starling W. W. (1926) The chemical constitution of **spermine**. III. Structure and synthesis. Biochem. J. 20, 1082–1094

AMES BN, DUBIN DT, ROSENTHAL SM. (1958) **Presence of polyamines in certain bacterial viruses.** Science. 127(3302), 814–815. [PubMed]

AMES BN, DUBIN DT (1960) The role of polyamines in the neutralization of bacteriophage deoxyribonucleic acid. J Biol Chem. 235, 769–775. [PubMed]

Tabor WC. (1962) Stabilization of protoplasts and spheroplasts by **spermine and other polyamides**. J. Bacteriol. 83 1101-1111

Harold FM. (1964) Stabilization of Streptococcus faecalis protoplasts by **spermine**. 88, 1416-1420
Polyamines: Mysterious Functions Nature News and Views (1970) Nature 226, 317-318

Hirschman S, Leng M, Felsenfield G. (1967) **Interaction of spermine and DNA**. Biopolymers. 5(2), 227–233. [PubMed]

Lapinski EM. Flakas ED. (1970) Reversal of penicillin-induced L-phase growth of Haemophilus influenza by **spermine** and its effects on antibiotic susceptibility. Infect. Immun. 1 474-478

Gibson W, Roizman B (1971) **Compartmentalization of Spermine and Spermidine in the Herpes Simplex Virion.** Proc Natl Acad Sci U S A. 68(11), 2818–2821. PMCID: PMC389533
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC389533/

Raina A, Jänne J (1975) **Physiology of the natural polyamines putrescine, spermidine and spermine.** Medical biology 1975-6-1 PMID 169440
https://www.sigmaaldrich.com/catalog/papers/169440
« The biochemistry and biological function of the naturally occurring polyamines, putrescine, spermidine, and spermine, have been reviewed with special reference to animal organisms. These compounds are universally distributed in all living material. Their biosynthesis from ornithine and methionine is accurately controlled and may fluctuate according to the metabolic needs of the cell. Polyamines strongly and specifically interact with nucleic acids in vitro. It appears that under physiological conditions a substantial portion of cellular polyamines is noncovalently bound to nucleic acids and nucleic acid-containing structures such as ribosomes. Polyamines are able to stimulate protein and ribonucleic acid synthesis in vitro. In several systems characterized by rapid growth polyamines and ribonucleic acid accumulate in parrallel. Evidence that polyamines may have an essential role in protein and/or nucleic acid synthesis is substantiated by recent observations on polyamine-deficient bacterial mutants, although no specific function has been established with certainty as yet. Some clinical applications of polyamine research related to cancer are also discussed briefly. »

Cohen LF, Lundgren D, Farell PM (1976) **Distribution of Spermidine and Spermin in Blood From Cystic Fibrosis Patients and Control Subjects.**Blood 48(3) 469-475
http://www.bloodjournal.org/content/bloodjournal/48/3/469.full.pdf?sso-checked=true
« Comparison with controls revealed that the Sqd/Spm ratio in both whole blood and erythrocytes was significantly higher in the group of cystic fibrosis patients »

Uehara N, Shirakawa S, Uchino H, Y Saeki Y (1980) **Elevated contents of spermidine and spermine in the erythrocytes of cancer patients.** Cancer 1980-1-1 PMID 7350997
https://www.ncbi.nlm.nih.gov/pubmed/7350997
« Red blood cells (RBC) from 69 patients with advanced cancer and 37 healthy controls were subjected to polyamine determination by using high-performance liquid chromatography. The polyamine contents in normal human RBC were spermidine 15.04 +/- 3.63 nmol and spermine 8.82 +/- 3.12 nmol per 10(10) RBC. Spermidine and spermine levels in RBC were elevated in patients with cancer (p less than 0.005). Serial studies in seven patients with cancer indicated that both polyamines in RBC were reduced after successful surgery. Our data indicate that the determination of polyamine levels in RBC is clinically useful as a marker of disease activity in patients with cancer. »

US Patent Issued on November 24, 1998 http://www.patentstorm.us/patents/5840559/claims.html
Spermine, **Spermidine** and Putrescine: **General Biosynthesis** Physiology Literature
Lida Mattman (2001) Cell Wall Deficient Forms. Stealth Pathogens. CRC Press,

Frydman B, Westler WM, Valasinas A, Kramer DL, Porter CW (1999) Regioselective Binding of Spermine, N^1,N^{12}-Bismethylspermine, and N^1,N^{12}-Bisethylspermine to $tRNA^{Phe}$ as Revealed by 750 MHz ^{1}H-NMR and its Possible Correlation with Cell Cycling and Cytotoxicity. J. Braz. Chem. Soc. vol.10 no.4 São Paulo http://dx.doi.org/10.1590/S0103-50531999000400014
http://www.jbcs.sbq.org.br/imagebank/pdf/v10n4a14.pdf

Imai A, Matsuyama T, Hanzawa Y et al. (2004) Spermidine synthase genes are essential for survival of Arabidopsis. Plant Physiol. 2004 Jul;135(3):1565-73.http://www.ncbi.nlm.nih.gov/pubmed/15247389

Rhee HJ, Kim E-J, Lee JK (2007) Physiological polyamines: simple primordial stress molecules. J. Cell. Mol. Med. Vol 11(4), 685-703 http://onlinelibrary.wiley.com/doi/10.1111/j.1582-4934.2007.00077.x/pdf

Eisenberg T, Knauer H, Ischauer A. et al. (2009) Induction of autophagy by **spermidine** promotes longevity. Nature Cell Biology 11, 1305 – 1314 http://www.nature.com/ncb/journal/v11/n11/abs/ncb1975.html

Kaeberlein M. (2009) **Spermidine** surprise for a long life. Nature Cell Biology 11, 1277 - 1278 http://www.nature.com/ncb/journal/v11/n11/abs/ncb1109-1277.html

Rial N.S. et al. (2009) Polyamines as mediators of APC-dependent intestinal carcinogenesis and cancer chemo prevention. Essays Biochem. 46, 111– 124,

Igarashi K, Kashiwagi K (2010) Modulation of cellular function by polyamines. In: The International Journal of Biochemistry & Cell Biology. 42(1), 39-51, doi:10.1016/j.biocel.2009.07.009 http://www.sciencedirect.com/science/article/pii/S1357272509002015

Pegg AE, Michael AJ (2010) **Spermine synthase.** Cell Mol Life Sci. 67(1), 113. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2822986/http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2822986/

Büttner S, Eisenberg T, Kroemer G et al. (2010) **Spermidine**: a novel autophagy inducer and longevity elixir. Autophagy. 6, 1.

Morselli E, Galluzzi L, Kepp O et al. (2010) **Autophagy mediates pharmacological lifespan extension by spermidine and resveratrol.** Aging 2010-2-17 PMID 20157579 https://www.sigmaaldrich.com/catalog/papers/20157579
"Although autophagy has widely been conceived as a self-destructive mechanism that causes cell death, accumulating evidence suggests that autophagy usually mediates cytoprotection, thereby avoiding the apoptotic or necrotic demise of stressed cells. Recent evidence produced by our groups demonstrates that autophagy is also involved in pharmacological manipulations that increase longevity. Exogenous supply of the polyamine spermidine can prolong the lifespan of (while inducing autophagy in) yeast, nematodes and flies. Similarly, resveratrol can trigger autophagy in cells from different organisms, extend lifespan in nematodes, and ameliorate the fitness of human cells undergoing metabolic stress. These beneficial effects are lost when essential autophagy modulators are genetically or pharmacologically inactivated, indicating that autophagy is required for the cytoprotective and/or anti-aging effects of spermidine and resveratrol. Genetic and functional studies indicate that spermidine inhibits histone acetylases, while resveratrol activates the histone deacetylase Sirtuin 1 to confer cytoprotection/longevity. Although it remains elusive whether the same histones (or perhaps other nuclear or cytoplasmic proteins) act as the downstream targets of spermidine and resveratrol, these results point to an essential role of protein hypoacetylation in autophagy control and in the regulation of longevity. »

Morselli E, Guillermo M, Bennetzen MV et al. (2011) **Spermidine and resveratrol** induce autophagy by distinct pathways converging on the acetylproteome. The Journal of Cell Biology. 192, 4.

Minois N, Didac Carmona-Gutierrez D, Madeo F. (2011) Polyamines in aging and disease. Aging (Albany NY). 3(8), 716–732. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3184975/

Soda, K (2011) The mechanisms by which polyamines accelerate tumor spread. Journal of Experimental & Clinical Cancer Research 30, 59–104

Minois, N. et al. (2011) Polyamines in aging and disease. Aging 3, 1–17

Spermine, Spermidine and Putrescine (2012) General Biosynthesis Physiology Literature ; Orthomedis Speziallabor, Schweiz
http://www.google.de/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0CCEQFjAA&url=http%3A%2F%2Fhitaminintoleranz-info.npage.de%2Fget_file.php%3Fid%3D14019934%26vnr%3D143162&ei=mPOsVJyZCOTTygPa_oKIDg&usg=AFQjCNHVc7YUGP255vYrLVJpvu2xgh_zlQ&sig2=oNWVfjLKBuVHZGd8mVIM_w

Mandal S**,** Mandal A, Johansson HE ei al (2012) **Depletion of cellular polyamines, spermidine and spermine, causes a total arrest in translation and growth in mammalian cells**. Current tissue 110(6) 2169-2174 http://www.pnas.org/content/110/6/2169.full
"Our data provide strong evidence for a primary function of polyamines, spermidine and spermine, in translation in mammalian cells."

Perez-Leal O, Barrero CA, Clarkson AB, et al. (2012) Polyamine-regulated translation of spermidine / spermine-N1-acetyltransferase. Mol Cell Biol 32(8), 1453-67. http://www.ncbi.nlm.nih.gov/pubmed/22354986

Gupta VK, Scheunemann L, Eisenberg T, et al. (2013) **Restoring polyamines protects from age-induced memory impairment in an autophagy-dependent manner,** Nature Neuroscience, Advance Online Publication, doi:10.1038/nn.3512.
"Our findings indicate that autophagy is critical for suppression of memory impairments by spermidine and that polyamines, which are endogenously present, are candidates for pharmacological intervention".
http://www.fu-berlin.de/presse/informationen/fup/2013/fup_13_247/index.html
https://www.oximity.com/article/Administering_Natural_Substance_Spermidin_Stopped_Dementia_1#.UiQyjn9e1H4

Bauer MA, Carmona-Gutiérrez D, Ruckenstuhl Chr et al. (2013) Spermidine promotes mating and fertilization efficiency in model organisms. Cell Cycle 122, 346-352
http://www.ncbi.nlm.nih.gov/pubmed/23255134
https://books.google.de/books?id=wbL3Ca4aHXEC&pg=PA44&lpg=PA44&dq=Spermidine+promotes+mating+and+fertilization+efficiency+in+model+organisms&source=bl&ots=NIaI_N7dPh&sig=77U9Ys7YHiP3T6g3qiWHfLngoBs&hl=de&sa=X&ei=2HG2VL-7HcHRygP-xoKoDQ&ved=0CDoQ6AEwAg#v=onepage&q=Spermidine%20promotes%20mating%20and%20fertilization%20efficiency%20in%20model%20organisms&f=false

Sigrist SJ, Carmona-Gutierrez D, Gupta VK et al. (2014) **Spermidine-triggered autophagy ameliorates memory during aging**, Autophagy, 10,1, 178-179, DOI: 10.4161/auto.26918
http://dx.doi.org/10.4161/auto.26918

Pietrocola F, Lachkar S, Enor DP et al. (2014) **Spermidine induces autophagy** by inhibiting the acetyltransferase EP300. Cell Death Differentiation 1-8
http://www.nature.com/cdd/journal/vaop/ncurrent/full/cdd2014215a.html
http://www.bioportfolio.com/resources/pmarticle/1130498/Spermidine-induces-autophagy-by-inhibiting-the-acetyltransferase-EP300.html

Büttner S, Broeskamp F, Sommer C et al. (2014) **Spermidine protects** against alpha-synuclein neurotoxicity. Cell Cycle 13(24), 3903-3908
http://www.tandfonline.com/doi/full/10.4161/15384101.2014.973309#.VLZ6DXujBvo
http://www.ncbi.nlm.nih.gov/pubmed/25483063

Sigrist SJ, Carmona-Gutierrez D, Gupta VK et al. (2014) **Spermidine-triggered autophagy ameliorates memory during aging.** Autophagy. 10(1), 178-9. doi: 10.4161/auto.26918. Epub 2013 Nov 15. http://www.ncbi.nlm.nih.gov/pubmed/24262970 DOI: 10.4161/auto.26918
http://dx.doi.org/10.4161/auto.26918

Gupta VK, Pech U, Bhukel A (2016) **Spermidine Suppresses Age-Associated Memory Impairment by Preventing Adverse Increase of Presynaptic Active Zone Size and Release.** PLOS Biology
http://dx.doi.org/10.1371/journal.pbio.1002563
http://journals.plos.org/plosbiology/article?id=10.1371/journal.pbio.1002563

Eisenberg T, Abdellatif M, Schröder S et al. (2016) Cardioprotection and lifespan extension by the natural polyamine spermidine. Nature Medicine. 22(12) http://rdcu.be/mC0h DOI: 10.1038/nm.4222
https://www.ncbi.nlm.nih.gov/pubmed/27841876
"Here we show that oral supplementation of the natural polyamine spermidine extends the lifespan of mice and exerts cardioprotective effects, reducing cardiac hypertrophy and preserving diastolic function in old mice. Spermidine feeding enhanced cardiac autophagy, mitophagy and mitochondrial respiration, and it also improved the mechano-elastical properties of cardiomyocytes in vivo, coinciding with increased titin phosphorylation and suppressed subclinical inflammation. … Our results suggest a new and feasible strategy for protection against cardiovascular disease."

Eisenberg T, Abdellatif M, Zimmermann A et al. (2017) **Dietary spermidine for lowering high blood pressure.** Autophagy. 0. doi: 10.1080/15548627.2017.1280225. [Epub ahead of print]
https://www.ncbi.nlm.nih.gov/pubmed/28118075

http://www.tandfonline.com/action/journalInformation?journalCode=kaup20
„Altogether, spermidine represents a cardio- and vascular-protective autophagy inducer that can be readily integrated in common diets.“

Presse: http://www.google.de/search?q=spermidin+graz&hl=de&btnG=Google+Search

http://www.google.de/search?q=spermidin+graz&hl=de&btnG=Google+Search

L-Arginin

- ➔ **Bild Methyl-Arginin** http://www.xerlebnishaft.de/bildmethyl-arginin.pdf
- ➔ **L-Arginin** http://www.erlebnishaft.de/l-arginin.pdf

L-Prolin

L-Prolin ist eine **nichtessentielle**, sekundäre ***α*-Aminosäure**, d.h. L-Prolin hat eine endständige Carboxygruppe und in deren direkter Nachbarschaft die Aminogruppe.
L-Prolin wird im Stoffwechsel synthetisiert.
Der Ausgangsstoff von L-Prolin ist **L-Glutamat**. Die Synthese erfolgt unter Energieaufwand mit einem ATP (Adenosintriphosphat) und zwei NADPH (Nicotinamidadenindinukleotidphosphat) aus Pyrrolin-2-carbonsäure [(S)- 3,4-Dihydro- 2H-**pyrrol**- 2-carbonsäure].
Bei **Pflanzen** ist der Gehalt an L-Prolin ein Biomarker für Trocken- und Salz – Stress.
Bei **Tieren** ist L-Prolin beteiligt an der **Bildung von Kollagen** im Bindegewebe und im Knochen. L-Prolin ist die Vorgängersubstanz der im Kollagen des Knochens chemisch gebundenen α-Aminosäure L-Hydroxyprolin. L-Hydroxyprolin braucht zu seiner Entstehung **Vitamin C**. (Mangelkrankheit = Skorbut).
L-Prolin moderiert die Protein-Faltung und es puffert die enzymblockierende Funktion von Ionen.
Im Kollagenen häufig vorkommende Aminosäure-Sequenz: **Glycin-Prolin-Hydroxyprolin**.
(Das Medikament Captopril z.B. wird aus L-Prolin hergestellt).

L- Proline is a **non-essential secondary α - amino acid** , that is, L- proline has a terminal carboxyl group and in the direct vicinity of the amino group .
L- proline is synthesized in metabolism.
The starting material of L- proline is **L - glutamate**. The synthesis is carried out under energy expenditure with an ATP (adenosine triphosphate) and two NADPH (nicotinamide adenine dinucleotide) from pyrroline -2 -carboxylic acid [(S) - 3,4- dihydro -2H -**pyrrole**-2 -carboxylic acid] .
For **plants**, the content of L-proline is a biomarker for the dry and salt - stress.
In **animals**, L-proline participates in the **formation of collagen** in the connective tissue and bone. L- Proline is a precursor of the substance is chemically bound in the collagen of the bone, α - amino acid, L -hydroxyproline . L -hydroxyproline needs of its construction **Vitamin C**. (deficiency disease is scurvy).
L- proline moderates the protein folding and buffers the enzyme blocking function of ions.
Frequently occurring amino acid sequence in collagens are **glycine-proline-hydroxyproline**.
(The drug Captopril is produced from L- proline)

Hill MK, Shehu-Xhilaga M, Crowe SM et al. (2002) **Proline Residues within Spacer Peptide p1** Are Important for Human Immunodeficiency Virus Type 1 Infectivity, Protein Processing, and Genomic

RNA Dimer Stability. J Virol. Nov 76(22), 11245–11253. doi: 10.1128/JVI.76.22.11245-11253.2002 PMCID: PMC136739 http://www.ncbi.nlm.nih.gov/pmc/articles/PMC136739/

Talty C, Dahlitz M (2013) Pyrrole Disorder for Therapists. http://www.neuropsychotherapist.com/pyrrole-disorder-for-therapists/

True Vitality (2014) Pyrrole Disorder

Heisig et al. (2014) **Antivirulence Properties of an Antifreeze Protein**. Cell Reports, http://dx.doi.org/10.1016/j.celrep. 2014.09.034 http://www.cell.com/cell-reports/pdf/S2211-1247%2814%2900817-1.pdf

N-Acetylcystein und Glutathion Glutathione Information on MedicineNet.com (a WebMD feature)

Scholz RW. Graham KS. Gumpricht E. Reddy CC (1989) Mechanism of interaction of vitamin E and glutathione in the protection against membrane lipid peroxidation. Ann NY Acad Sci 570,514-7.

Vendemiale G, Altomare E, Trizio T, Le Grazie C, Di Padova C, Salerno MT, Carrieri V, Albano O (1989) Effects of Oral S-Adenosyl-l-Methionine on Hepatic Glutathione in Patients with Liver Disease. Scandinavian Journal of Gastroenterology 24 (4), 407–15. doi:10.3109/00365528909093067. PMID 2781235.

Witschi A, Reddy S, Stofer B, Lauterburg BH (1992) The systemic availability of oral glutathione. European Journal of Clinical Pharmacology 43 (6), 667–9. doi:10.1007/BF02284971. PMID 1362956.

Busse E, Zimmer G, Schopohl B, Kornhuber B (1992) Influence of alpha-lipoic acid on intracellular glutathione in vitro and in vivo. Arzneimittel-Forschung 42 (6), 829–31. PMID 1418040.

Völkl KP, Schneider B (1992) Therapy of respiratory tract diseases with N-acetylcysteine. An open therapeutic observation study of 2,512 patients. Fortschr Med 110(18), 346-50

Barlowwalden L, Reiter R, Abe M, Pablos M, Menendez-Pelaez A, Chen L, Poeggeler B (1995) Melatonin stimulates brain glutathione peroxidase activity. Neurochemistry International 26 (5), 497–502. doi:10.1016/0197-0186(94)00154-M. PMID 7492947

Gillissen A, Jaworska M, Orth M, et al. (1997) Nacystelyn and N-acetylcysteine augment cellular antioxidant defense in two distinctive ways. Resp Med 91, 159-168.

Noctor, Graham; Foyer, ChristineH. (1998) **ASCORBATE AND GLUTATHIONE**: Keeping Active Oxygen Under Control. Annual Review of Plant Physiology and Plant Molecular Biology 49, 249–279. doi:10.1146/annurev.arplant.49.1.249. PMID 15012235.

Lands LC, Grey VL, Smountas AA (1999) Effect of supplementation with a cysteine donor on muscular performance. Journal of applied physiology (Bethesda, Md. 1985) 87 (4), 1381–1385 PMID 10517767. edit

Bounous G, Molson J (1999) Competition for glutathione precursors between the immune system and the skeletal muscle: Pathogenesis of chronic fatigue syndrome. Med Hypotheses. 53(4) (oct), 347–9. doi:10.1054/mehy.1998.0780

Cheney PR (1999) Evidence of glutathione deficiency in chronic fatigue syndrome. American Biologics 11th International Symposium, Vienna, Austria, Tape no. 07-199, available from Professional Audio Recording, P.O. Box 7455, LaVerne, CA 91750 (phone 1-800-2274473).

Pereira C, Oliveira CR (2000) Oxidative glutamate toxicity involves mitochondrial dysfunction and perturbation of intracellular Ca2+ homeostasis. Neuroscience Research 37 (3), 227–36. doi:10.1016/S0168-0102(00)00124-3. PMID 10940457.

Reichenberger F, Tamm M (2002) N-acetylcystein in the therapy of chronic bronchitis. Pneumologie 56(12), 793-7

Lieber, Charles S. (2002) S-adenosyl-L-methionine: its role in the treatment of liver disorders. The American journal of clinical nutrition 76 (5), 1183S–7S. PMID 12418503.

Enlander, D (2002) **CFS Treatment** using Glutathione in Immunoprop. The CFS HandBook 58–62.

Pompella A, Visvikis A, Paolicchi A, Tata V, Casini AF (2003) The changing faces of glutathione, a cellular protagonist. Biochemical Pharmacology 66 (8), 1499–503. doi:10.1016/S0006-2952(03)00504-5. PMID 14555227

Balendiran, Ganesaratnam K.; Dabur, Rajesh; Fraser, Deborah (2004). "The role of glutathione in cancer". Cell Biochemistry and Function 22 (6), 343–52. doi:10.1002/cbf.1149. PMID 15386533.

Sabina AA et al. (2005) **The antioxidant function of the p53 tumor suppressor**. Nature Medicine, 11(12), 1306-13 http://www.ncbi.nlm.nih.gov/pubmed/16286925 http://www.ncbi.nlm.nih.gov/pubmed/16333263

Tirouvanziam R et al. (2006) High-dose oral N-acetylcysteine, a glutathione prodrug, modulates inflammation in cystic fibrosis. In: PNAS 103, 4628–4633

Bolcal C, Yildirim V et al. (2007) Do N-acetylcystein, beta-glucan, and coenzyme Q10 mollify myocardial ischemia-reperfusion injury? Heart Surg Forum 10(3), E222-7

Solov'eva ME, Solov'ev VV, Akatov VS (2007) Prooxidant and cytotoxic action of N-acetylcysteine and glutathione combined with vitamin Bl2b. Tsitologiia 49(1), 70-8

Nagasawa H, Oz HS, Chen, Chen TS, Nagasawa H (2007) Comparative efficacies of 2 cysteine prodrugs and a glutathione delivery agent in a colitis model. Transl Res. 150 (2), 122–9. doi:10.1016/j.trsl.2006.12.010. PMC 1991291. PMID 17656332

Giordano G, Afsharinejad Z, Guizzetti M, Vitalone A, Kavanagh T, Costa L (2007) Organophosphorus insecticides chlorpyrifos and diazinon and oxidative stress in neuronal cells in a genetic model of glutathione deficiency. Toxicology and Applied Pharmacology 219 (2–3), 181–9. doi:10.1016/j.taap.2006.09.016. PMID 17084875.

Van Konynenburg RA (2007) Glutathione Depletion—Methylation Cycle Block, A Hypothesis for the Pathogenesis of Chronic Fatigue Syndrome. poster paper, 8th Intl. IACFS Conf. on CFS, Fibromyalgia, and Other Related Illnesses, Fort Lauderdale, FL. http://phoenix-cfs.org/GSHMethylationVanKonynenburg.htm

Matsuki, Mitsuo; Watanabe, Toshihiko; Ogasawara, Ayako; Mikami, Takeshi; Matsumoto, Tatsuji (2008) Inhibitory Mechanism of Melanin Synthesis by Glutathione. Yakugaku Zasshi 128 (8) 1203–7. doi:10.1248/yakushi.128.1203. PMID 18670186

Franco R, Cidlowski JA (October 2009) Apoptosis and glutathione: beyond an antioxidant. Cell Death Differ. 16 (10), 1303–14. doi:10.1038/cdd.2009.107. PMID 19662025.

Park (2009) The effects of N-acetyl cysteine, buthionine sulfoximine, diethyldithiocarbamate or 3-amino-1,2,4-triazole on antimycin A-treated Calu-6 lung cells in relation to cell growth, reactive oxygen species and glutathione. Oncology Reports: 385–91. doi:10.3892/or_00000449.

Van Groningen L, Opdenoordt S, Van Sorge A, Telting D, Giesen A, De Boer H (2010) Cholecalciferol loading dose guideline for vitamin D-deficient adults. European Journal of Endocrinology 162 (4), 805–811. doi:10.1530/EJE-09-0932. PMID 20139241. edit

Gawryluk JW, Wang JF, Andreazza AC, Shao L, Young LT (2011) Decreased levels of glutathione, the major brain antioxidant, in post-mortem prefrontal cortex from patients with psychiatric disorders. The international journal of neuropsychopharmacology / official scientific journal of the Collegium Internationale Neuropsychopharmacologicum (CINP) 14 (1), 123–30. doi:10.1017/S1461145710000805. PMID 20633320.

Chitranshu Kumar et al. Glutathione revisited: a vital function in iron metabolism and ancillary role in thiol-redox control. The EMBO Journal (2011) 30, 2044–2056 doi:10.1038/emboj.2011.105

Koga M, Serritella AV, Messmer MM, Hayashi-Takagi A, Hester LD, Snyder SH, Sawa A, Sedlak TW (2011) Glutathione is a physiologic reservoir of neuronal glutamate. Biochemical and biophysical research communications 409 (4), 596–602. PMID 21539809.

Couto, Narciso; Malys, Naglis; Gaskell, Simon; Barber, Jill (2013) Partition and Turnover of Glutathione Reductase from Saccharomyces cerevisiae: a Proteomic Approach. Journal of Proteome Research 12 (6), 2885–94. doi:10.1021/pr4001948. PMID 23631642.

Sayin VI et al. (2014) **Antioxidants accelerate lung cancer progression in mice.** Science Translational Medicine**,** 6, 221ra15 http://stm.sciencemag.org/content/6/221/221ra15
http://www.cancer.org/cancer/news/antioxidant-supplements-fuel-lung-cancer-in-mice
« Thus, antioxidants accelerate tumor growth by disrupting the ROS-p53 axis. Because somatic mutations in p53 occur late in tumor progression, antioxidants may accelerate the growth of early tumors or precancerous lesions in high-risk populations such as smokers and patients with chronic obstructive pulmonary disease who receive NAC to relieve mucus production. »

➔ **Tumossuppressorprotein P53** http://www.erlebnishaft.de/p53.pdf

Alpha-Liponsäure

α-Liponsäure, (R)-Liponsäure, lipoic acid regelt den Wasserstoff- und Acyl-Gruppen-Transfer z.B. im Pyruvat-Dehydrogenase-Komplex der **Mitochondrien**, dem Verbindungsglied zwischen Glykolyse und Zitronensäurezyklus und dem α-Ketoglutarat-Dehydrogenase-Komplex im Zitronensäurezyklus.

α-Liponsäure ist ein Radikalfänger und ein starkes Antioxidans, das im Stoffwechsel verbrauchte Antioxidantien wie Vitamin C, Vitamin E, Coenzym Q10 oder Glutathion regenerieren kann.

α-lipoic acid, (R)-lipoic acid, lipoic acid regulates the hydrogen and acyl groups, for example, transfer the pyruvate dehydrogenase complex of the mitochondria, the link between glycolysis and citric acid cycle, and the α-ketoglutarate dehydrogenase complex in the citric acid cycle.

α-lipoic acid is a free radical scavenger and powerful antioxidant that can regenerate in the metabolism of consumed antioxidants such as vitamin C, vitamin E, coenzyme Q10 or glutathione.

Quelle: http://de.wikipedia.org/wiki/Lipons%C3%A4ure

O'Kane DJ. Gunsalus IC. (1948) Pyruvic acid metabolism: a factor required for oxidation by streptococcus faecalis. J. Bacteriol. 56, 499-506.

Grunert R. (1960) The effect of DL-alpha lipoic acid on heavy metal intoxication in mice and dogs. Arch. Biochem. Biophys. 86, 190-195.

Nakai S. (1960) Liver function promoting agents by experimental liver perfusion. I. Effect of thioctic acid on the detoxifying function of the liver. Chem Abst. 54, 11274.

Haugaard N, Haugaard E, et al. (1970) Stimulation of glucose utilization by thioctic acid in rat diaphragm incubated in vitro. Biochim. Biophys. Acta. 222, 583-586.

Berkson B. (1979) Thioctic acid in treatment of hepatotoxic mushroom poisoning. New England Journal of Medicine. 300, 371.

Bartter FC, Berkson B, Gallelli J, Hiranaka P. (1980) Thioctic acid in the treatment of poisoning with alpha-amanitin. In Amanita Toxins and Poisonings. Faulstich H., Kommerell B, Wieland T, Eds. Baden Baden: Wizstrock; 197-202.

Berkson B. (1980) Treatment of four patients with thioctic acid. In Amanita Toxins and Poisonings. Faulstich H, Kommerell B, Wieland T, Eds. Baden-Baden: Wizstrock 203-207.

Loginov AS, Nilova TV, Bendikov EA, Petrakov AV. (1989) Pharmacokinetics of lipoic acid preparations and their effects on ATP synthesis, processes of microsomal and cytosole oxidation in human hepatocytes during liver damage. Farmacol. Toksikol. 52, 78-82.

Nuhn P (1990) Naturstoffchemie, S. Hirzel Wissenschaftliche Verlagsgesellschaft Stuttgart, 359

Baur A, Harrer T. (1991) Alpha lipoic acid is an effective inhibitor of human immuno-deficiency virus (HIV-1) replication. Klin. Wochenzchr. 69, 722-724.

Busse E, Zimmer G, et al. (1992) Influence of alpha-lipoic acid on intracellular glutathione in vitro and in vivo. Arzneim-Forsch/Drug Res. 42, 829-831.

Gregus Z, Stein A, et al. (1992) Effects of lipoic acid on biliary excretion of glutathione and metals. Toxicol. Appl. Pharmacol. 114, 88-96.

Prehn JH, Karkoutly, et al. (1992) Dihydrolipoic acid reduces neuronal injury after cerebral ischemia. J. Cereb. Blood Flow Metab. 12, 78-87.

Ramakrishnan N, et al. (1992) **Radioprotection** of hematopoietic tissues in mice by lipoic acid. Radiation Research. 130, 360-365.

Burkhart V, Koike T, et al. (1993) Dihydrolipoic acid protects pancreatic islet cells from inflammatory attack. Agents and Actions. 38, 60-65.

Cao X, et al. (1995) The free radical scavenger alpha-lipoic acid, protects against cerebral ischemia-reperfusion injury in gerbils. Free Radical Research (Switzerland). 23, 365-370.

Jacob S, Henriksen A, et al. (1995) Enhancement of glucose disposal in patients with type 2 diabetes by alpha-lipoic acid. Arzneimittel-forschung/drug research. 45, 872-874.

Nagamatsu M, Nickander, K. (1995) Lipoic acid improves nerve blood flow, reduces oxidative stress, and improves distal nerve conduction in experimental **diabetic neuropathy**. Diabetes Care. 18, 1160-1167.

Ou P, Tritschler H, Wolff S. (1995) Thioctic (lipoic) acid: a therapeutic metal-chelating antioxidant? Biochemical Pharmacology. 50,123-126.

Sandhya P, et al. (1995) Role of DL alpha lipoic acid in gentamycin-induced nephrotoxicity. Mol. Cell. Biochem. (Netherlands) 145, 11-17.

Estrada D, Ewart H, et al. (1996) Stimulation of glucose uptake by the natural coenzyme alpha lipoic acid. Diabetes. 45, 1798-1804.

Koch K (1996) **Alpha-Liponsäure bessert kurzfristig Nervenfunktion**: Studie soll langfristigen Nutzen abklären Dtsch Arztebl 93(36), A-2200 / B-1866 / C-1758

Packer L, Tritschler HJ, Wessel K (1997) **Neuroprotection** by the metabolic antioxidant alpha-lipoic acid. In: Free radical biology & medicine. 22(1-2), 359-378.

Berkson BM. (1999) A conservative triple antioxidant approach to the treatment of **hepatitis c**. combination of alpha-lipoic acid (thioctic acid), silymarin and selenium. Three case histories. Medizinische Klinik. 94(3), 84-89.

Berkson BM. (2000) A triple antioxidant approach to the treatment of **hepatitis c** using alpha-lipoic acid (thioctic acid), silymarin, selenium, and other fundamental nutraceuticals. Clinical Practice of Alternative Medicine. 1(1), 27-33.

Yamamoto H, Watanabe T, Mizuno H et al. (2001) The antioxidant effect of DL-alpha-lipoic acid on copper-induced acute hepatitis in Long-Evans Cinnamon (LEC) rats. Free Radic Res. 34(1), 69-80 http://www.ncbi.nlm.nih.gov/pubmed/11234997

Femiano F, Scully C (2002) **Burning mouth syndrome** (BMS): double blind controlled study of alpha-lipoic acid (thioctic acid) therapy. Journal of Oral Pathology & Medicine 31 (5), 267–9

Yadav V, Marracci G, Lovera J, Woodward W, Bogardus K, Marquardt W, Shinto L, Morris C et al. (2005) Lipoic acid in multiple sclerosis: a pilot study. **Multiple sclerosis** (Houndmills, Basingstoke, England) 11 (2), 159–65

Berkson BM, Rubin D, Berkson AJ. (2006) Long-term survival of a 46-year-old man with **pancreatic cancer** and liver metastases and treated with intravenous alpha lipoic acid and low dose naltrexone. Integrative Cancer Therapies. March 5(1), 83-89.

Rooney J (2007) The role of thiols, dithiols, nutritional factors and interacting ligands in the toxicology of **mercury**. In: Toxicology. 234(3), 145-156.

Vincent HK, Bourguignon CM, Vincent KR, Taylor AG (2007) Effects of alpha-lipoic acid supplementation in **peripheral arterial disease**: a pilot study. Journal of alternative and complementary medicine 13 (5), 577–84.

Holmquist L, Stuchbury G, Berbaum K et al. (2007) Lipoic acid as a novel treatment for **Alzheimer's disease and related dementias**. Pharmacology & therapeutics 113 (1), 154–64.

Hager K, Kenklies M, McAfoose J, Engel J, Münch G (2007) Alpha-lipoic acid as a new treatment option for **Alzheimer's disease**—a 48 months follow-up analysis. Journal of neural transmission. Supplementum (72), 189–93

Salinthone S, Yadav V, Bourdette DN, Carr DW (2008) Lipoic acid: a novel therapeutic approach for **multiple sclerosis and other chronic inflammatory diseases of the CNS**. Endocrine, metabolic & immune disorders drug targets 8 (2), 132–42

MacZurek A, Hager K, Kenklies M, Sharman M, Martins R, Engel J, Carlson DA, Münch G (2008) Lipoic acid as an anti-inflammatory and neuroprotective treatment for **Alzheimer's disease**. Advanced drug delivery reviews 60 (13–14), 1463–70

Liu J (2008) The effects and mechanisms of mitochondrial nutrient alpha-lipoic acid on improving age-associated mitochondrial and cognitive dysfunction: an overview. Neurochemical research 33(1), 194–203.

Ghibu S, Richard C, Vergely C, Zeller M, Cottin Y, Rochette L (2009) Antioxidant properties of an endogenous thiol: Alpha-lipoic acid, useful in the prevention of **cardiovascular diseases**. Journal of cardiovascular pharmacology 54 (5), 391–8

Shay KP, Moreau RF, Smith EJ et al. (2009) Alpha-lipoic acid as a dietary supplement: Molecular mechanisms and therapeutic potential. Biochimica et Biophysica Acta 1790 (10), 1149–60.

Ying Z, Kherada N, Farrar B, Kampfrath T, Chung Y, Simonetti O, Deiuliis J, Desikan R et al. (2010) Lipoic acid effects on established **atherosclerosis**. Life Sciences 86 (3–4), 95–102.

Gorąca A, Huk-Kolega H et al. (2011) Lipoic acid - biological activity and therapeutic potential. In: Pharmacological reports: PR. Band 63(4), 849–858

Alliin, Cycloalliin, Sulfoxyde, Sulfonsäuren, sulfatierte Polysaccharide

Ellmore G. S. und Feldberg R. S. (1994) Allin Lyase Localization in Bundle Sheaths of the Garlic Clove (Allium sativum). Am. J. Bot, 81(1), 89–94

- **Küchenkräuter, Gewürzpflanzen , Kohlarten**
  http://de.wikipedia.org/wiki/Liste_der_K%C3%BCchenkr%C3%A4uter_und_Gew%C3%BCrzpflanzen
  http://de.wikipedia.org/wiki/Kohl

Protonenpumpenhemmer

- Pantoprazol, Omeprazol, Esomeprazol, Lansoprazol, Rabeprazol

Dimerkaptopropansulfonsäure (DMPS) Dimaval®

Chelatbildner dienen seit ca. 70 Jahren der Behandlung von Metallvergiftungen. Elektrolyte, Spurenelemente und Schwermetallgifte sind an Eiweiß gebunden.

Ruprecht J (1997) Dimaval® (DMPS) DMPD-HEYL®. Wissenschaftliche Produktmonographie. Heyl Chem.-pharm. Fabrik GmbH

Bayer W (2008) Durchführung, Referenzbereiche und Interpretation des DMPS-Testes Eine kritische Datenanalyse (pdf; 1,8 MB) http://www.labor-bayer.de/publikationen/11_DrBayer-DMPS-2008.pdf

s.a. Radiogardase-CS, Prussian blue capsules HEYL (2014) http://www.gifte.de/Antidote/radiogardase.htm
http://www.accessdata.fda.gov/drugsatfda_docs/label/2008/021626s007lbl.pdf

- **Elektrolyte, PH Wert und Spurenelemente**
  http://www.xerlebnishaft.de/elektro_spur_ph.pdf

- **Intoxikationen** http://www.kabilahsystems.de/ph.pdf
- **Entgiftung** http://www.kabilahsystems.de/ph.pdf

Dimethylsulfoxyd (DMSO)

Dimethylsulfoxid (DMSO) wirkt **antiphlogistisch und analgetisch**. Es ist eine **Schlepper-Substanz**, ein Penetrationsverstärker. Es **moduliert den Eiweiß-Stoffwechsel** in akuten Situationen. Bei Daueranwendung und in Konzentrationen über **10 % ist DMSO Zellgift.**

Stanley J (2001-2014) DMSO http://www.dmso.org/subLevels/stanley.htm

Carls J (2013) DMSO in der Handtherapie.
http://www.akademie-fuer-handrehabilitation.de/downloads/dmso.pdf

Fischer H (2014) **-** DMSO - Verborgenes Heilwissen aus der Natur // SPIRIT OF HEALTH
https://www.youtube.com/watch?v=gOdZGhnyycg

Fischer H (2014) Das DMSO-Handbuch: Verborgenes Heilwissen aus der Natur

http://www.amazon.de/Das-DMSO-Handbuch-Verborgenes-Heilwissen-Natur/dp/3981525515

MSM (Methylsulfonmethan) = organischer Schwefel

z.B. MSM **evtl.** plus Glucosamin, Omega-3-Fettsäuren und Mangan **bei Arthritis**.

Barrager E, Veltmann JR Jr, Schauss AG et al 2002) A multicentered, open-label trial on the safety and efficacy of methylsulfonylmethane in the **treatment of seasonal allergic rhinitis**. J Altern Complement Med 8(2), 167-73

Usha PR, Naidu MU (2004) Randomised, double- blind, parallel, placebo-controlled study of oral glucosamine, methylsulfonylmethane and their combination in **osteoarthritis**. Clinical Drug Investigation 24(6), 353-63

Kim LS, Axelrod LJ, Howard P et al (2006) Efficacy of methylsulfonylmethane (MSM) in **osteoarthritis pain of the knee**: a pilot clinical trial. Osteoarthritis Cartilage 14(3), 286-94

Xie, Q, et al (2008) Effects of AR7 Joint Complex on arthralgia for patients with **osteoarthritis**: results of a three-month study in Shanghai, China. Nutr J. 7, 31. doi: 10.1186/1475-2891-7-31

Andruski B, McCafferty DM, Ignacy T, Millen B, McDougall JJ (2008) Leukocyte trafficking and **pain behavioral responses** to a hydrogen sulfide donor in acute monoarthritis. Am J Physiol Regul Integr Comp Physiol 295(3), R814–R820

H2S und NO

Shatalin K, Shatalina E, Mironov A et al. (2011) **H_2S: A Universal Defense Against Antibiotics in Bacteria.** Science 334(6058), 986-990. http://www.sciencemag.org/content/334/6058/986
"The mechanism of gas-mediated antibiotic resistance relies on mitigation of oxidative stress imposed by antibiotics".

Sulfatierte Polysaccharide

Carrageen ist die Sammelbezeichnung einer Gruppe von antiviral wirkenden, **langkettigen sulfatierten Polysacchariden (Kohlenhydraten)**, die in Rotalgenzellen vorkommen.

González ME, Alarcón B, Carrasco L (1987) **Polysaccharides as Antiviral Agents:** Antiviral Activity of Carrageenan. Antimicrobial Agents and Chemotherapy. 31(9), 1388-1393

(1992) **Sulfatierte Polysaccharide zur Langzeitprophylaxe gegen Erkrankungen, die durch Viren oder durch unkonventionelle Viren verursacht werden**. EP 0464759 A2.
http://www.google.com/patents/EP0464759A2?cl=de

➔ Walter T Makroalgen: Wirkstoffe und Potenziale
http://fileserver.futureocean.org/wissenstransfer/thorsten-walter.pdf

Histone

Histone sind basische Eiweisstoffe, die im Zellkern von Eukaryoten für die Verpackung der Nukleinsäureketten und für die Expression mancher auf ihr codierter Gene zuständig sind.

Kossel A (1927) The Protamines and Histones. Longmans, Green and Co. http://archive.org/stream/protaminesandhis004288mbp#page/n3/mode/2up

Hirsch JG. (1958) **Bactericidal action of histone**. J Exp Med 108, 925–44. PMC free article PubMed http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2136925/

Blazsek VA, Bukaresti L (1964) The study of the **cysteine content** of the chicken erythrocyte histone by polarography. Experientia 20(7), 369-370 http://link.springer.com/article/10.1007%2FBF02147963

Zhang Y, Reinberg D (2001) **Transcription regulation by histone methylation**: interplay between different covalent modifications of the core histone tails. In: Genes Dev. 15(18), 2343–60. doi:10.1101/gad.927301. PMID 11562345

Weake VM, Workman JL (2008) **Histone ubiquitination: triggering gene activity**. In: Mol. Cell. 29(6), 653–63. doi:10.1016/j.molcel.2008.02.014. PMID 18374642

Hamon MA, Cossart P (2008) **Histone** modifications and chromatin remodeling during bacterial infections. Cell Host Microbe 4(2), 100-9 http://www.ncbi.nlm.nih.gov/pubmed/18692770

Noga EJ, Borron PJ, Seo JK (2011) Identification of **histones** as endogenous antibiotics in fish and quantification in rainbow trout (Oncorhynchus mykiss) skin and gill. Fish Physiol Biochem 37(1), 35-52 http://www.ncbi.nlm.nih.gov/pubmed/20711849

Anand P, Cermelli S, Li Z et al. (2012) **A novel role for lipid droplets in the organismal antibacterial response.** eLife, 1 DOI: 10.7554/eLife.00003 http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3491588/

Ammar R**,** Torti D, Tsui K et al. (2012) **Chromatin is an ancient innovation conserved between Archaea and Eukarya.** eLife, 1, e00078 http://phylogenomics.files.wordpress.com/2012/12/nislow-accepted-version.pdf

Li Z et al. (2012) **Lipid droplets** control the maternal histone supply of Drosophila embryos. Curr Biol, 22, 2104-13 http://www.ncbi.nlm.nih.gov/pubmed/23084995

Schaefer U, Ho JS, Prinjha RK et al. (2014) The **"Histone Mimicry"** by Pathogens. Cold Spring Harb Symp Quant Biol. http://www.ncbi.nlm.nih.gov/pubmed/24733380?dopt=Abstract

Gaydos LJ et al. (2014) H3K27me and PRC2 transmit a memory of repression across generations and during development. Science, 345, 1515-18. http://www.sciencemag.org/content/345/6203/1515.short "**These results demonstrate that H3K27me and PRC2 each contribute to epigenetically transmitting the memory of repression across generations and during development.**"

Carnosin

Gulewitsch WI, Amiradžibi S (1900) Ueber das Carnosin, eine neue organische Base des Fleischextractes. In: Berichte der deutschen chemischen Gesellschaft. 33(2), 1902. doi:10.1002/cber.19000330275

Wang AM, M, C, Xie ZH, Shen F (2000) Use of carnosine as a natural **anti-senescence drug** for human beings. Biochemistry. Biokhimiia 65 (7), 869–71. PMID 10951108

Karton A, O'Reilly RJ, Pattison DI et al. (2012) Computational design of effective, bioinspired HOCl antioxidants: The role of intramolecular Cl+ and H+ shifts. Journal of the American Chemical Society 134 (46), 19240–5. doi:10.1021/ja309273n

Spezielle Peptide und Autovaccine

Reiter B (1983) The biological significance of **lactoferrin**. In: Int J Tissue React. 5(1), 87–96.

Harmsen, Martin C. et al. (1995) Antiviral effects of plasma and milk proteins: **lactoferrin** shows potent activity against both human immunodeficiency virus and human cytomegalovirus replication in vitro. Journal of Infectious Diseases, 172(2), 380-388 http://jid.oxfordjournals.org/content/172/2/380.short

de Wit JN, van Hooydonk ACM (1996) Structure, functions and applications of **lactoperoxidase** in natural antimicrobial systems. In: Netherlands Milk & Dairy Journal. 50, 227–244.

Weiss HE, Weiss H, Nolte O et al. (1998) Deutsches Patent Nr. 198 60438: Ein neues Verfahren zur Herstellung einer **Autovakzine zur Behandlung von Chlamydiosen** bei Säugetieren und Menschen.

Singh PK, Parsek MR, Greenberg EP et al. (2002) **A component of innate immunity** revents bacterial biofilm development. Nature. 417(6888), 552-5 http://www.ncbi.nlm.nih.gov/pubmed/12037568

Ochoa TJ, Clearly TG (2004) **Lactoferrin** disruption of bacterial type III secretion systems. Biometals. 17, Nr. 3, S. 257–60.

Gorlewska-Roberts KM, Teitel CH, Lay JO, Roberts DW, Kadlubar FF (2004) **Lactoperoxidase-catalyzed activation of carcinogenic aromatic and heterocyclic amines**. Chem. Res. Toxicol.. 17(12), 1659–66.

Xu Y, Szép S, Lu Z (2009) The antioxidant role of **thiocyanate** in the pathogenesis of cystic fibrosis and other inflammation-related diseases. In: Proc. Natl. Acad. Sci. U.S.A.. 106(48), 20515–9.

Manzoni P, Rinaldi M, Cattani S, et al. (2009) Bovine **lactoferrin** supplementation for prevention of late-onset sepsis in very low-birth-weight neonates: a randomized trial. In: JAMA. 302, Nr. 13, 1421–1428.

Nolte O, Thrull R. (2010) Die **autogene Vakzine** zur Behandlung chronisch-rezidivierender Infektionen – Evaluierung der Wirksamkeit und Verträglichkeit in deutschen Arztpraxen Münchener Medizinische Wochenschrift (Fortschritte der Medizin Originalien) Ergänzungsband I/2010 152, 30-36

Boal AK, Grove TL, McLaughlin MI, et al. (2011) Structural Basis for Methyl Transfer by a Radical **SAM Enzyme**. Published online http://www.ncbi.nlm.nih.gov/pubmed/21527678

Robertson MP, Joyce GF (2014) **Highly efficient self-replicating RNA enzymes**. Chem Biol 21, 1-8 http://www.ncbi.nlm.nih.gov/pubmed/24388759

➔ **Lebensstrukturvergleich** http://www.xerlebnishaft.de/lebensstrukturenvergleich.pdf

Peptid-Antibiotika, Peptid-Transmitter und biogene Proteine

„Fast alle Aminosäuren existieren in zwei zueinander spiegelbildlichen Versionen, D- und L-Form genannt.
Höhere Lebewesen nutzen gewöhnlich nur die L-Variante.
Mikrobielle Zellwände und Peptid-Antibiotika enthalten auch D-Aminosäuren, rechtshändige Aminosäuren.
Bakterien benutzen D- Aminosäuren für ihre Kommunikation und beim Aufbau ihrer Biofilm-Organisationen.
Der Biofilm Klebstoff Peptidoglykan enthält D-Alanin, D-Glutamat sowie vereinzelt D-Serin.
Bakterien verkitten Peptidoglykan über Artgrenzen hinweg mit Hilfe von D-Methionin und D-Leucin.
Rechtshändige Aminosäuren, D-Aminosäuren bewahren Peptide oder Proteine davor, durch die Enzyme des Wirtes oder eines Feindes, die nur die Bindung zwischen den L-Formen spalten können, sofort abgebaut zu werden.
D-Aspartat ist ein Botenstoff, ein Neurotransmitter im menschlichen Gehirn und es ist an der Entwicklung des menschlichen Gehirns beteiligt.
Hirnzellen erzeugen ein Enzym, das L-Serin in D-Serin verwandelt.

D-Serin scheint für die geistige Gesundheit von Bedeutung zu sein und es aktiviert gemeinsam mit L-Glutamat neuronale Moleküle, die für die neuronale Plastizität entscheidend sind“.

"Almost all amino acids exist in two mutually mirror-image versions , called D- and L-form. Living beings usually only use the L variant.
Microbial cell walls and peptide antibiotics contain D-amino acids, right-handed amino acids.
Bacteria use D-amino acids for their communication and to build their biofilm organizations.
The biofilm adhesive peptidoglycan contains D -alanine, D- glutamate and occasionally D -serine.
Bacterial spatula peptidoglycan across species barriers with the help of D -methionine and D -leucine.
Right-handed amino acids, D -amino acids preserve peptides or proteins from being degraded by the enzymes of the host or an enemy that can only cleave the bond between the L forms immediately.
D-aspartate is a neurotransmitter, a neurotransmitter in the human brain and it is involved in the development of the human brain.
Brain cells produce an enzyme that converts L-serine in D -serine.
D -serine appears to be essentially for mental health and it activates together with L-glutamate neuronal molecules that are critical for neuronal plasticity.
Source: Everts S. (2014) Moleküle im Spiegel. Spektrum der Wissenschaft 2, 31-33

Smith C, Pangburn M, Vogel C-W, Müller-Eberhard H (1984) Molecular Architecture of Human **Properdin**, a Positive Regulator of the Alternative Pathway of Complement. J of Biol Chem 259, R4582–4588

Patent: Ibis Gmbh Bio Innovationen, Frank Mayer (2002)
Ef-tu-bindende Substanzen als antibakterielles Mittel. WO 2002087554 A2
http://www.google.com.ar/patents/WO2002087554A2?cl=de
http://patent.ipexl.com/WO/woZZSLASHZZ2002ZZSLASHZZ087554.html
“Die Erfindung betrifft die Verwendung von Substanzen, die an den bakteriellen Translationsfaktor EF-Tu binden, zur Hemmung des Aufbaus eines Cytoskeletts in Bakterienzellen und zur Herstellung antibakterieller Mittel. Weiterhin betrifft die Erfindung antibakterielle Mittel, die Teilabschnitte der Aminosäuresequenzen der Domänen 2 und/oder 3 eines bakteriellen EF-Tu Proteins mit einer Länge von vorzugsweise 4-20 Aminosaüren enthalten”.

Gardner M. (2005) The New Ambidextrous Universe Symmetry and Asymmetry from Mirror Reflections to Superstrings. Dritte überarbeitete Ausgabe. Dover. Mineola (New York)
http://www.amazon.de/The-New-Ambidextrous-Universe-Superstrings/dp/0486442446

Hourcade D (2006) The Role of **Properdin** in the Assembly of the Alternative Pathway C3 Convertases of Complement. J of Biol Chem 281, R2128–2132.

Giuliani A, Pirri G, Nicoletto SF, (2007) **Antimicrobial peptides**: an overview of a promising class of therapeutics. CEJB 2(1), 1-33

Soscia SJ, Kirby JE, Washicosky KJ, et al. (2010) **The Alzheimer's disease-associated amyloid beta-protein is an antimicrobial peptide**. PLoS ONE. 5, Nr. 3, S. e9505.

Findlay B, Zhanel GG, Schweizer F (2010) **Cationic Amphiphiles**, a New Generation of Antimicrobials Inspired by the Natural Antimicrobial Peptide Scaffold. Antimicrob Agents Chemother. 54(10), 4049–4058

Kantrowitz J et al. (2010) High Dose **D-Serine** in the Treatment of Schizophrenia. In: Schizophrenia Research 121, 125-130 http://www.ncbi.nlm.nih.gov/pubmed/20541910

KNAPPE D., PIANTAVIGNA S., HANSEN A., et al. (2010) **Oncocin**, a novel antibacterial peptide optimized against Gram-negative human pathogens. Journal of Medicinal Chemistry
http://peer.ccsd.cnrs.fr/docs/00/65/99/01/PDF/PEER stage2 10.1016%252Fj.ijantimicag.2010.10.028.pdf

Kolodkin-Gal I, Romero D, Cao S et al. (2010) **d-Amino Acids Trigger Biofilm Disassembly**. Science 328(5978) 627-629 DOI: 10.1126/science.1188628 http://www.sciencemag.org/content/328/5978/627.abstract

Habets MGJL, Brockhurst MA (2011) Therapeutic **antimicrobial peptides** may compromise natural immunity. Biology Letters,1203.

Brückner H, Noriko Fujii N (2011) **D-Amino Acids in Chemistry**, Life Sciences, and Biotechnology. Wiley-VCH, Weinheim. http://www.amazon.de/D-Amino-Acids-Chemistry-Sciences-Biotechnology/dp/3906390659

Cava F et al. (2011) **Emerging Knowledge of Regulatory Roles of D-Amino Acids in Bacteria**. In: Cellular and Molecular Life Sciences 68, 817-831 http://www.ncbi.nlm.nih.gov/pubmed/21161322

Allison KR, Brynildsen MP, Collins JJ (2011) Metabolite-enabled **eradication of bacterial persisters by aminoglycosides**. Nature. 473, 216-220 http://www.ncbi.nlm.nih.gov/pubmed/21562562

McGrath MD, Barbu EM, Driessen WHP et al. (2013) Mechanism of action and initial evaluation of a membrane active all-D-enantiomer **antimicrobial peptidomimetic.** Proceedings of the National Academy of Sciences. http://www.pnas.org/content/early/2013/01/18/1221924110

Khan O, Rieckmann P, Boyko A, Selmaj K, Zivadinov R (2013) GALA Study Group. Three times weekly **glatiramer acetate** in relapsing-remitting multiple sclerosis. Ann Neurol. 73(6), 705-13. http://www.consultant360.com/exclusives/fda-approves-new-treatment-regimen-multiple-sclerosis **Glatirameracetat (GA) (Handelsname: Copaxone®) ist ein heterogenes Gemisch synthetischer Polypeptide. Diese bestehen aus vier natürlichen Aminosäuren Glutaminsäure, Lysin, Alanin und Tyrosin („GLAT"), welche in einem festen molaren Verhältnis von 0,14 zu 0,34 zu 0,43 zu 0,09 vorliegen. Die mittlere Molare Masse von GA liegt bei 5.000 bis 9.000 (4.700 bis 11.000) Dalton.**

Alia YM, Hayata A, Saeeda BM et al. (2014) **Low-dose recombinant properdin** provides substantial protection against Streptococcus pneumoniae and Neisseria meningitidis infection. PNAS www.pnas.org/cgi/doi/10.1073/pnas.1401011111

Malav S. Trivedi MS, Jayni S. Shah JS, Sara Al-Mughairy SA et al. (2014) **Food-derived opioid peptides inhibit cysteine uptake with redox and epigenetic consequences.** 7 published online 09 June 2014. http://www.jnutbio.com/article/S0955-2863%2814%2900114-4/abstract

Rolland T et al. (2014) **A proteome-scale map of the human interactome network.** Cell, 159, 1212-26. http://www.cell.com/cell/abstract/S0092-8674%2814%2901422-6 http://www.sciencedirect.com/science/article/pii/S0092867414014226

Miller S (2014) **Artilysine**, Lisando GmbH. http://www.ars.usda.gov/alternativestoantibiotics/PDF/posters/IABS%20Poster1-31.pdf

Ling LL, Schneider T, Peoples AJ et al. (2015) **A new antibiotic kills pathogens without detectable resistance.** Nature. 22, 517(7535), 455-9. doi: 10.1038/nature14098. Epub 2015 Jan 7. http://www.ncbi.nlm.nih.gov/pubmed/25561178 s.a. http://de.wikipedia.org/wiki/Teixobactin

Bishop BM, Juba ML, Russo PS et al. (2017) **Discovery of Novel Antimicrobial Peptides from Varanus komodoensis (Komodo Dragon) by Large-Scale Analyses and De-Novo-Assisted Sequencing Using Electron-Transfer Dissociation Mass Spectrometry.** J. Proteome Res., Article ASAP **DOI:** 10.1021/acs.jproteome.6b00857 http://pubs.acs.org/doi/abs/10.1021/acs.jproteome.6b00857

Newman J, Sharp JA, Enjapoori AK et al. (2018) **Structural characterization of a novel monotreme-specific protein with antimicrobial activity from the milk of the platypus**. Acta Crystallographica Section F Structural Biology Communications. 74 (1), 39 DOI: 10.1107/S2053230X17017708

Komplement, Proteo-Hormone, Hormone

- **Komplement** http://www.xerlebnishaft.de/complement.pdf
- **Proteo-Hormone** http://de.wikipedia.org/wiki/Proteohormone
- **Polyphenole** http://www.kabilahsystems.de/polyphenole.pdf

Probiotika, Zytoskelett, Proteom

- **Probiotika** http://www.kabilahsystems.de/probiotika.pdf
- **Zytoskelett** http://www.xerlebnishaft.de/zytoskelett.pdf
- **The Human Protein Atlas** http://www.proteinatlas.org/
- **A Tissue-Based Map of the Human Proteome** http://www.proteinatlas.org/humanproteome

Prione, Virulenzinhibitoren

- **Prione** http://www.erlebnishaft.de/prione.pdf
- **Virulenz-Inhibitoren, Chaperone u.a.** http://www.kabilahsystems.de/virulenz_inhibitoren.pdf

L-Tryptophan, L-Kynurenin und Indoleamine 2,3-dioxygenase (IDO)

Indoleamine 2,3-dioxygenase (IDO) oxidiert L-Tryptophan und D-Tryptophan zu N-Formyl-L-Kynurenin. Auch Superoxid kann dabei Sauerstoffdonator sein.

L-Tryptophansubstitution erst nach der Behandlung einer aktiven Entzündung, weil bei Entzündungen vermehrt das toxische Kynurenin gebildet wird. Zuerst antientzündlich behandeln!

Methoden der Entzündungshemmung: http://www.kabilahsystems.de/antizyt-chem.pdf

Diem S, Herderich M. (2001) Reaction of **tryptophan** with carbohydrates. Journal of Agricultural and Food Chemistry 49, 2486-2492

Quan J, Tan PH, MacDonald A, Friend PJ (2008) Manipulation of indoleamine 2,3-dioxygenase (IDO) for clinical transplantation: promises and challenges. Expert Opin Biol Ther. 8(11), 1705–19. doi:10.1517/14712598.8.11.1705. PMID 18847306 http://www.ncbi.nlm.nih.gov/pubmed/18847306

Katz JB, Muller AJ, Prendergast GC (2008) Indoleamine 2,3-dioxygenase in T-cell tolerance and tumoral immune escape. Immunol. Rev. 222, 206–21. doi:10.1111/j.1600-065X.2008.00610.x. PMID 18364004 http://www.ncbi.nlm.nih.gov/pubmed/18364004

Prendergast GC, Smith C, Thomas S et al. (2014) Indoleamine 2,3-dioxygenase pathways of pathogenic inflammation and immune escape in cancer. Cancer Immunol Immunother. 63(7), 721-35. doi: 10.1007/s00262-014-1549-4. http://www.ncbi.nlm.nih.gov/pubmed/24711084

Love AC, Schwartz I, Petzke MM (2014) Induction of indoleamine 2,3-dioxygenase by **Borrelia burgdorferi** in human immune cells correlates with pathogenic potential**.** J Leukoc Biol. pii: jlb.4A0714-339R. http://www.ncbi.nlm.nih.gov/pubmed/25420916

Protease Inhibitoren

Abbenante G, Fairlie DP (2005) Protease Inhibitors in the Clinic. Medicinal Chemistry, 1, 71-104 71 http://www.ncbi.nlm.nih.gov/pubmed/16789888

International Protease Network http://www.protease.net/

Ozon

Yamashita K, Miyoshi T, Arai T et al. (2008) **Ozone production by amino acids contributes to killing of bacteria.** Proc Natl Acad Sci U S A. 105(44), 16912–16917. doi: 10.1073/pnas.0807952105 http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2579352/

Synthetische Aminosäuren und Proteine, synthetic amino acids and proteins

Mandell DJ, Lajoie MJ, Mee MT et al. (2014) **Biocontainment of genetically modified organisms by synthetic protein design**. Nature**,** doi:10.1038/nature14121. http://www.nature.com/nature/journal/vaop/ncurrent/full/nature14121.html

Rovner AJ et al. (2015) **Recoded organisms engineered to depend on synthetic amino acids**. Nature, doi:10.1038/nature14095.
http://www.indiaenvironmentportal.org.in/content/405096/recoded-organisms-engineered-to-depend-on-synthetic-amino-acids/