Hericium erinaceus in Neurological Conditions

Kevin Spelman, PhD, MCPP

Health, Education & Research

Ashland, OR

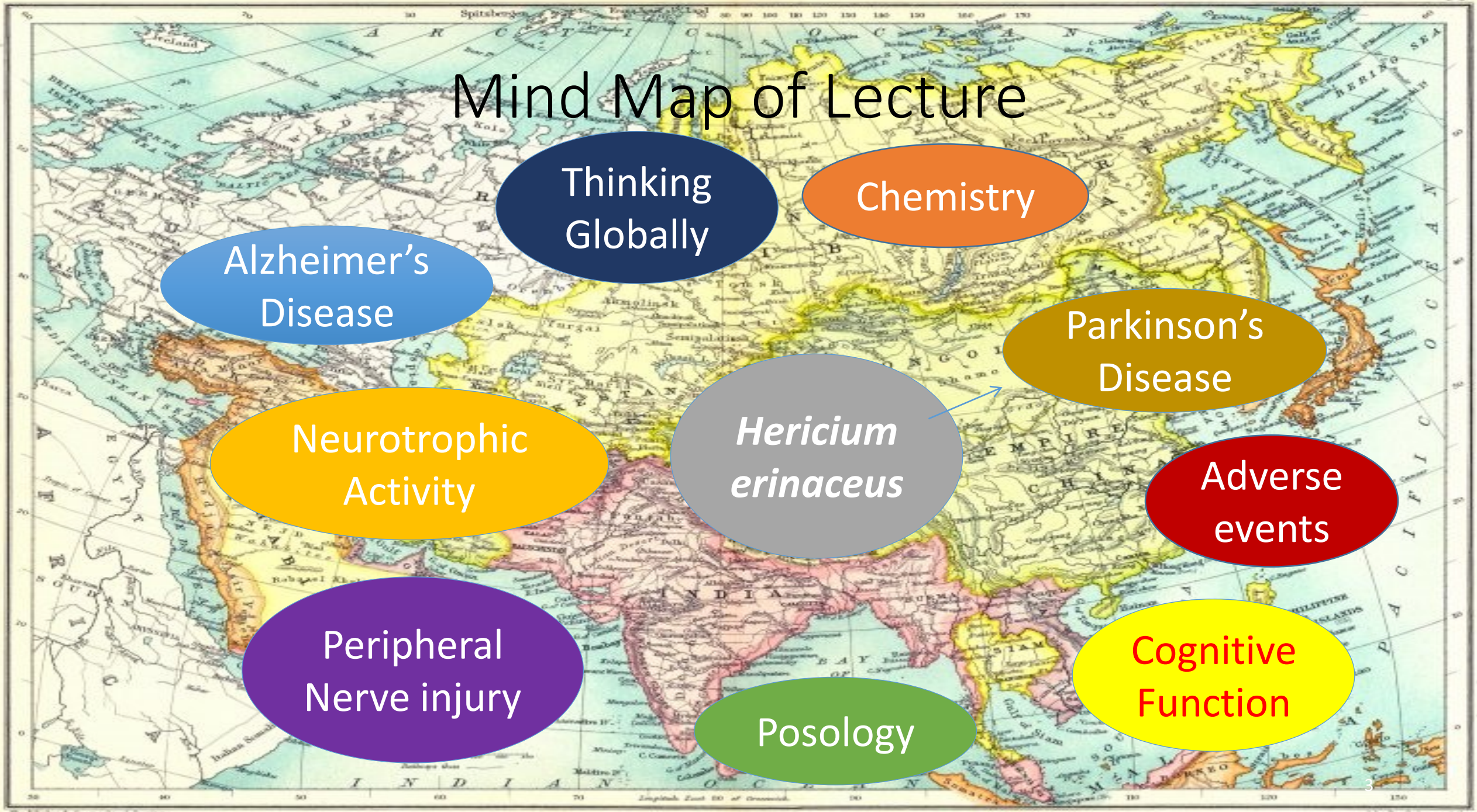
AARM
Association for the Advancement of Restorative Medicine

Conflicts of Interest

I am a Pharma and Natural Products Industry Consultant

Nothing to Declare

Mind Map of Lecture



A comment on animal models

Hericium Traditional Use

Fortify the spleen

Nourish the gut, promotes good digestion

gastric and duodenal ulcers, as well as chronic gastritis

Anti-cancer

Good for the 5 internal organs (liver, lung, spleen, heart, kidney)

general vigor, strength, and nutrition;

Known for its effects on the central nervous system -

Insomnia Vacuity (weakness) Hypodynamia

Kha MA, Tania M, Liu R, Rahman MM. Hericium erinaceus: an edible mushroom with medicinal values. J Complement Integr Med. 2013 May 24;10.

Jiang S, Wang S, Sun Y, Zhang Q. Medicinal properties of Hericium erinaceus and its potential to formulate novel mushroom-based pharmaceuticals. Appl Microbiol Biotechnol..2014 Sep;98(18):7661-70

Hobbs Christopher. Medicinal Mushrooms. Botanica Press, Santa Cruz, 3 edition (February 1, 1995)

Jia ju Zhou, Guirong Xie, Xinjian Yan. Encyclopedia of Molecular Structures, Pharmacological Activities, Natural Sources and Applications Traditional Chinese Medicines Vol. 5: Isolated Compounds. T-Z Springer-Verlag Berlin Heidelberg 2011

H. erinaceus
Chemistry & Pharmacology

Chemistry

- High molecular weight compounds, such as polysaccharides
- low molecular weight compounds such as polyketides and terpenoids

Kwagishi H, Shimada A, Shirai R, Okamoto K, Ojima F, Sakamoto H, Ishiguro Y, Furukawa S (1994) Erinacines A, B and C strong stimulators of nerve growth factor (NGF)-synthesis from the mycelia of Hericium erinaceum. *Tetrahedron Lett* 35:1569–1572

Shen JW, Yu HY, Ruan Y, Wu TT, Zhao X (2010) Hericenones and erinacines: stimulators of nerve growth factor (NGF) biosynthesis in Hericium erinaceus. *Mycol Int J Fungal Biol* 1:92–98

Mizuno T, Wasa T, Ito H, Suzuki C, Ukai N (1992) Antitumor-active polysaccharides isolated from the fruiting body of Hericium erinaceum, an edible and medicinal mushroom called Yamabushitake or Houtou. *Biosci Biotechnol Biochem* 56:347–348

Hericium erinaceus

- Polysaccharides
- Terpenoids; Sesterpenes & Diterpenoids
- Isoindolinones
- Sterols
- Myconutrients

Polysaccharides

In cells that were toxic from Aβ, *H. erinaceus*

polysaccharides decreased the production of ROS from 80% to 58 % in a dose-dependent manner and increased the efficacy of free radical scavenging

Cheng, J. H., Tsai, C. L., Lien, Y. Y., Lee, M. S., & Sheu, S. C. (2016). High molecular weight of polysaccharides from Hericium erinaceus against amyloid beta-induced neurotoxicity. *BMC Complement Altern Med*, 16, 170.
Liu, J., Du, C., Wang, Y., & Yu, Z. (2015). Anti-fatigue activities of polysaccharides extracted from Hericium erinaceus. *Exp Ther Med*, 9(2), 483-487.

Polysaccharides

H. erinaceus polysaccharides promoted cell viability under Aβ-induced toxic conditions and protected cells against Aβ-induced apoptosis

Cheng, J. H., Tsai, C. L., Lien, Y. Y., Lee, M. S., & Sheu, S. C. (2016). High molecular weight of polysaccharides from Hericium erinaceus against amyloid beta-induced neurotoxicity. *BMC Complement Altern Med*, 16, 170.
Liu, J., Du, C., Wang, Y., & Yu, Z. (2015). Anti-fatigue activities of polysaccharides extracted from Hericium erinaceus. *Exp Ther Med*, 9(2), 483-487.

Polysaccharides

H. erinaceus polysaccharides possesses significant anti-fatigue activity by decreasing blood lactic acid, serum urea nitrogen, tissue glycogen and malondialdehyde

Cheng, J. H., Tsai, C. L., Lien, Y. Y., Lee, M. S., & Sheu, S. C. (2016). High molecular weight of polysaccharides from Hericium erinaceus against amyloid beta-induced neurotoxicity. *BMC Complement Altern Med*, 16, 170.

Liu, J., Du, C., Wang, Y., & Yu, Z. (2015). Anti-fatigue activities of polysaccharides extracted from Hericium erinaceus. *Exp Ther Med*, 9(2), 483-487.

Polysaccharides

A purified polysaccharide from the liquid culture broth of *H. erinaceus* mycelia was also found to provide neuroprotective activity through a dramatic delay of apoptosis (20 – 50% compared to control)

Park, Y. S., Lee, H. S., Won, M. H., Lee, J. H., Lee, S. Y., & Lee, H. Y. (2002). Effect of an exo-polysaccharide from the culture broth of Hericium erinaceus on enhancement of growth and differentiation of rat adrenal nerve cells. *Cytotechnology*, 39(3), 155-162.

Polysaccharides

Mycelia more effective than control, NFG or BDNF alone in enhancing the growth of rat adrenal nerve cells and neurite extension

Park, Y. S., Lee, H. S., Won, M. H., Lee, J. H., Lee, S. Y., & Lee, H. Y. (2002). Effect of an exo-polysaccharide from the culture broth of Hericium erinaceus on enhancement of growth and differentiation of rat adrenal nerve cells. *Cytotechnology*, 39(3), 155-162.

Terpenoids

- Two classes of terpenoid compounds,
- **Hericenones**
- **Erinacines**
- Along with aromatic compounds have been found to stimulate nerve growth factor (NGF) synthesis

Wang, K., Bao, L., Qi, Q., Zhao, F., Ma, K., Pei, Y., & Liu, H. (2015). Erinacerins C-L, isoindolin-1-ones with alpha-glucosidase inhibitory activity from cultures of the medicinal mushroom Hericium erinaceus. *J Nat Prod*, 78(1), 146-154.

Hericenones and Erinacines

Both the mycelia (erinacines A-I) and the fruiting bodies (hericenone C-H) are compounds of interest in bioactive extracts

Easily cross the blood brain barrier

Wang, K., Bao, L., Qi, Q., Zhao, F., Ma, K., Pei, Y., & Liu, H. (2015). Erinacerins C-L, isoindolin-1-ones with alpha-glucosidase inhibitory activity from cultures of the medicinal mushroom Hericium erinaceus. J Nat Prod, 78(1), 146-154.

Hericenones and Erinacines

Neurotrophic activities

neurite outgrowth stimulation and induced NGF synthesis

Moldavan MG, Gryganski AP, Kolotushkina OV, Kirchhoff B, Skibo GG, Pedarzani P (2007) Neurotropic and trophic action of lion's mane mushroom Hericium erinaceus (Bull.: Fr.) Pers.(Aphyllophoromycetideae) extracts on nerve cells in vitro. Int J Med Mushrooms 9:15–28

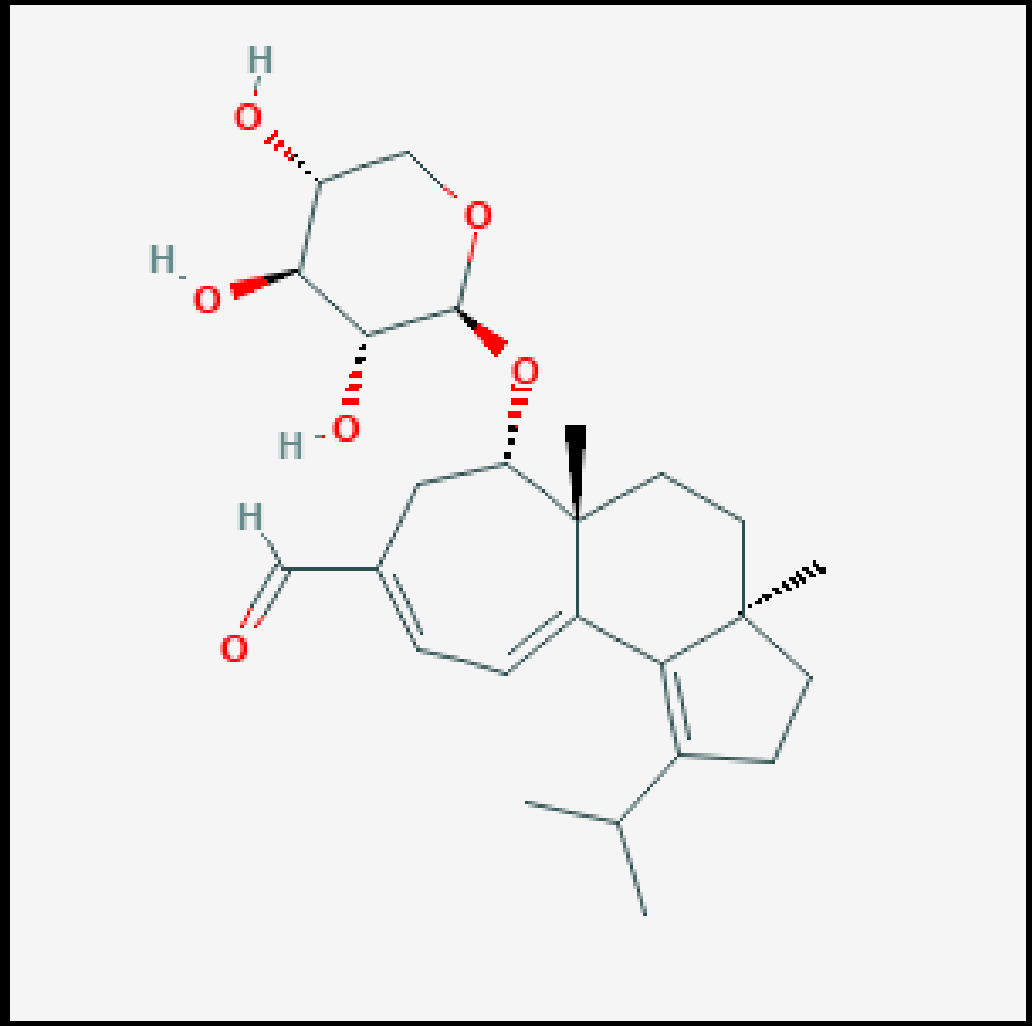
Erinacines

Erinacines A, B, C, D, E, F, G, H, and I showed a stronger biological activity that stimulates NGF synthesis than epinephrine (positive control) on murine astroglial cells

Thongbai, B , Rapior S, Hyde KD, Wittstein K, Stadler M. (2015), Hericium erinaceus, an amazing medicinal mushroom, Mycol Progress 14:91

Erinacine A

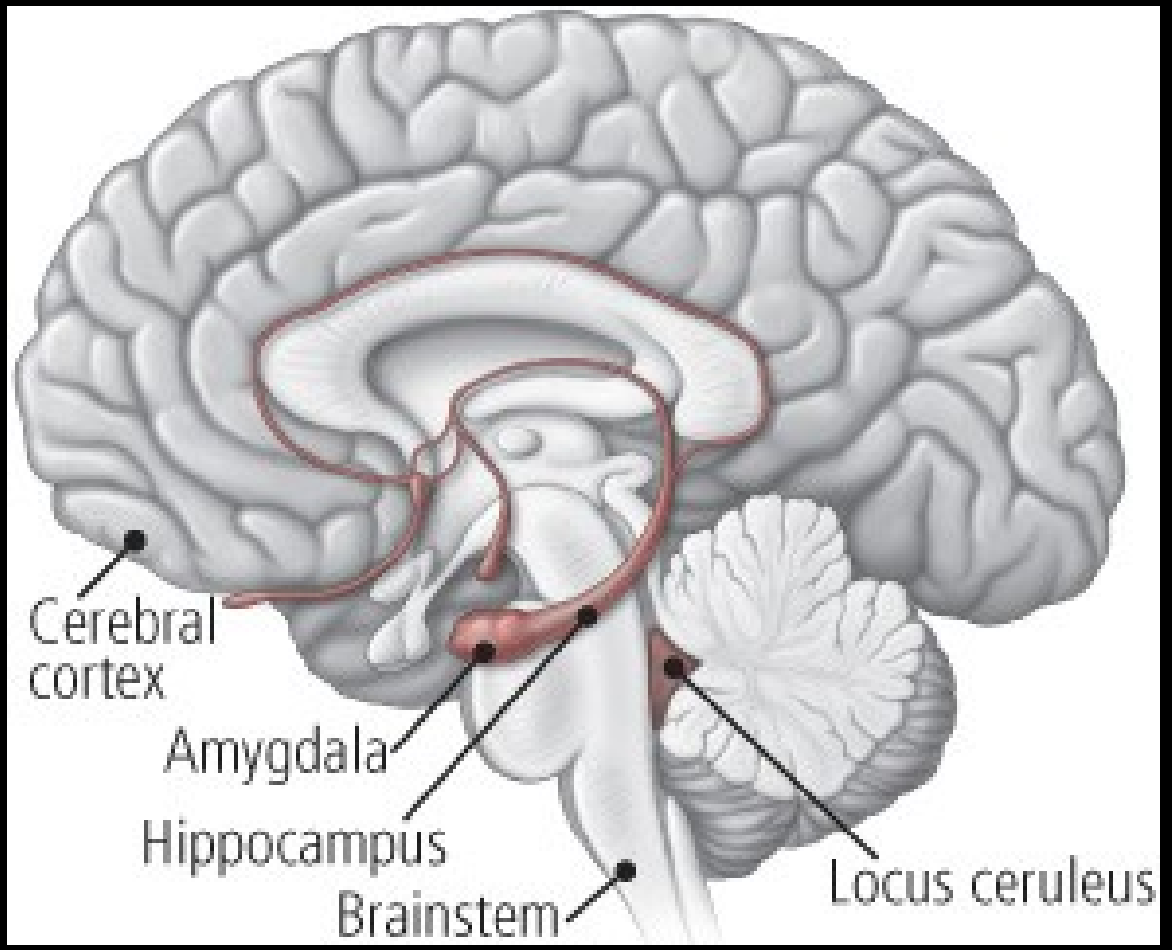
Isolated from the cultured mycelia of *H. erinaceus* may act as an anti-inflammatory agent to bring about neuroprotection as well as contain potent nerve growth enhancing properties



Thongbai, B , Rapior S, Hyde KD, Wittstein K, Stadler M. (2015), Hericium erinaceus, an amazing medicinal mushroom, Mycol Progress 14:91

Erinacine A

Significantly increased the level of NGF in the locus coeruleus and hippocampus, but not in the cerebral cortex



Thongbai, B , Rapior S, Hyde KD, Wittstein K, Stadler M. (2015), Hericium erinaceus, an amazing medicinal mushroom, Mycol Progress 14:91

Int. J. Mol. Sci. **2014**, *15*, 15073-15089; doi:10.3390/ijms150915073

OPEN ACCESS

International Journal of

Molecular Sciences

ISSN 1422-0067

www.mdpi.com/journal/ijms

Article

Protective Effects of *Hericium erinaceus* Mycelium and Its Isolated Erinacine A against Ischemia-Injury-Induced Neuronal Cell Death via the Inhibition of iNOS/p38 MAPK and Nitrotyrosine

H. erinaceus mycelium has shown reduction of infarct volumes in global ischemic stroke by 22% at 50 mg/kg and 44% at concentrations of 300 mg/kg as compared to a control group

Institute of Traditional Medicine, School of Medicine, National Yang-Ming University, Taipei 112, Taiwan; E-Mail: chenjiannhwa@yahoo.com.tw

Int. J. Mol. Sci. **2014**, *15*, 15073-15089; doi:10.3390/ijms150915073

OPEN ACCESS

International Journal of

Molecular Sciences

ISSN 1422-0067

www.mdpi.com/journal/ijms

Article

Protecti
Its Isola
Neuron
and Nit

Kam-Fai Le

Chien-Cha

Wen-Shih I

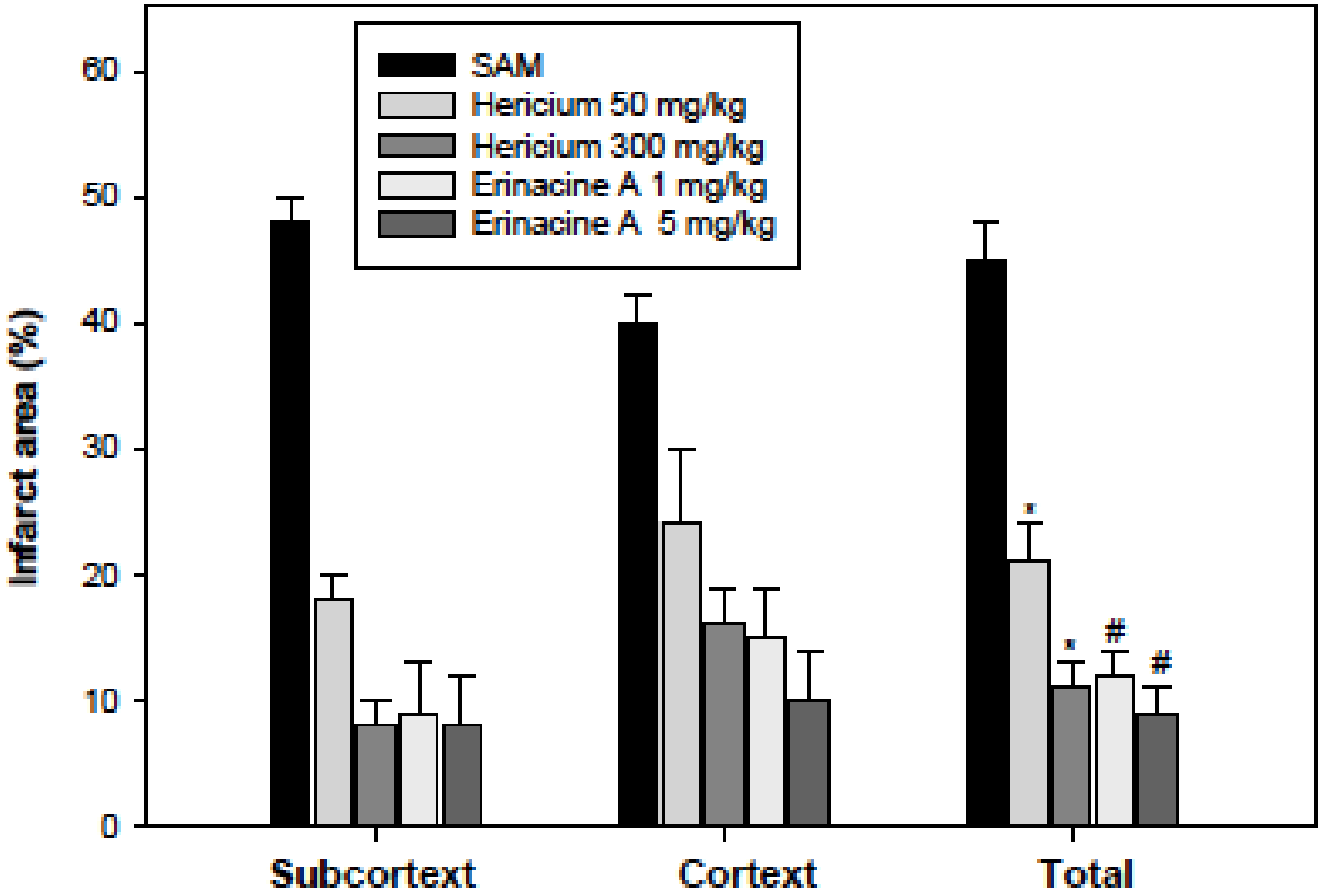
[1] Departm

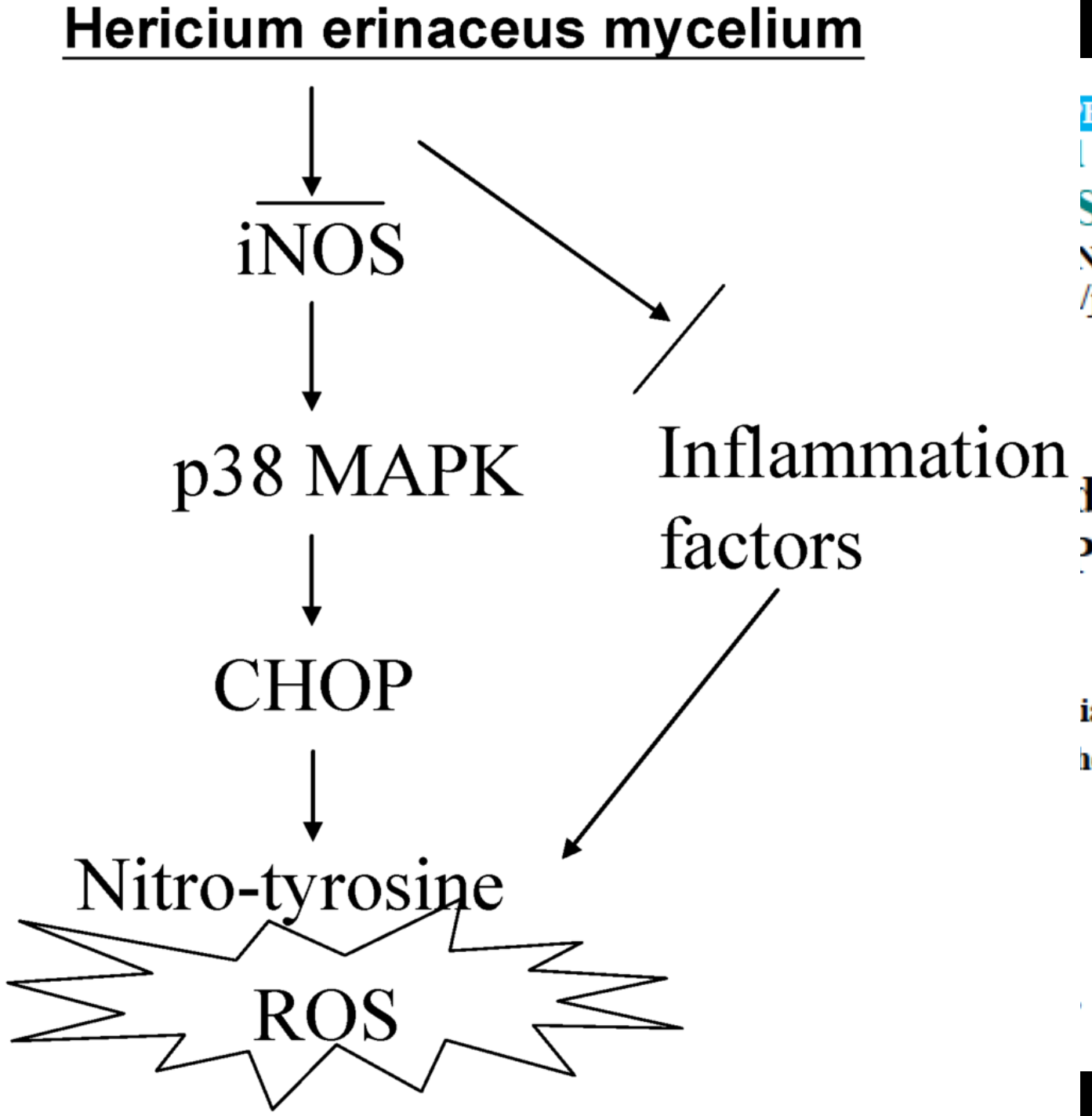
E-Mail: l

[2] Institute

Taipei 11

ieh [7,8],





Int. J. Mol. S

EN ACCESS
Journal of
Sciences
N 1422-0067
/journal/ijms

Article

Protecti
Its Isola
Neurona
and Nitr

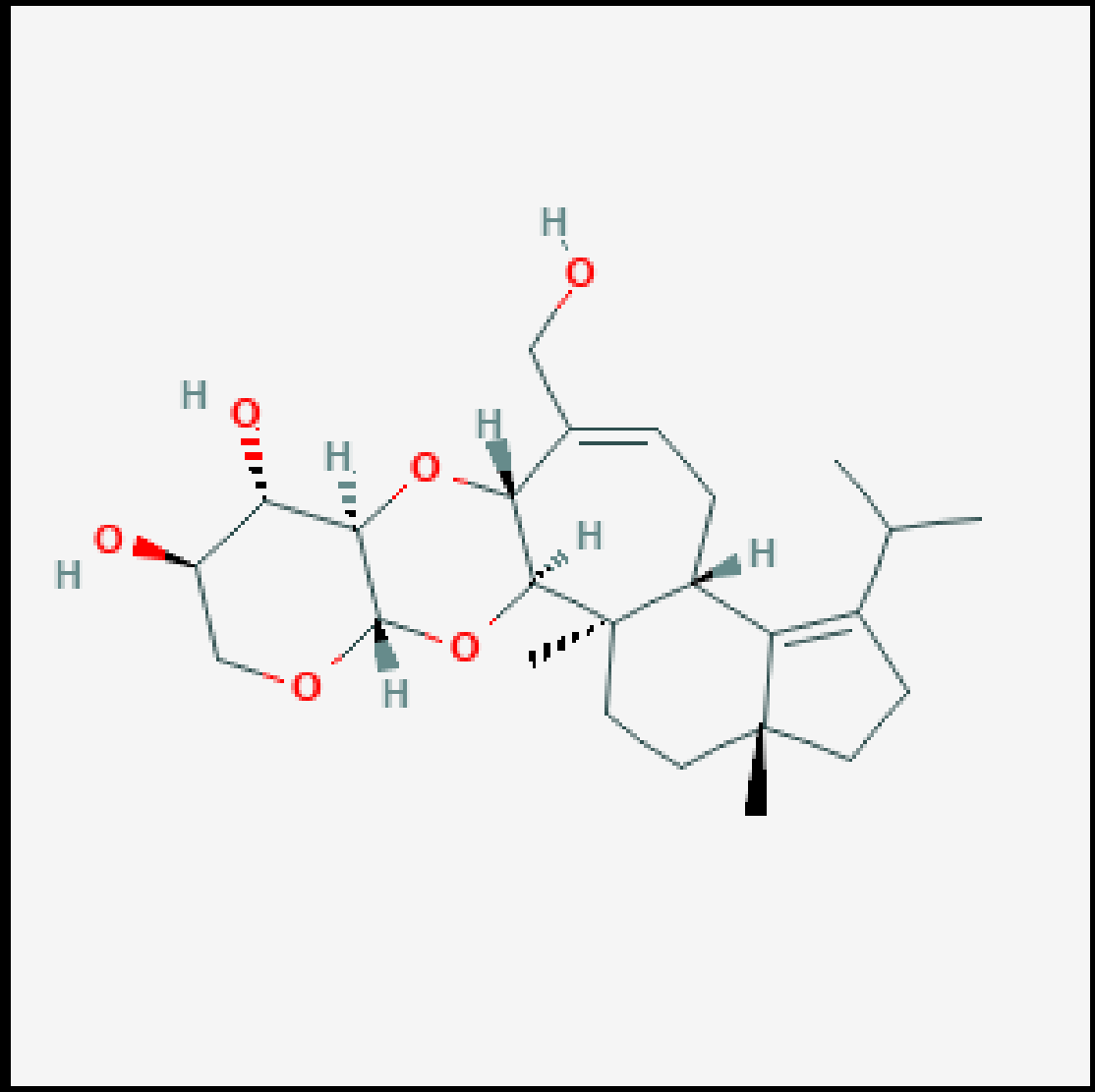
Kam-Fai Le
Chien-Chan
Wen-Shih H

iao Hsieh [7,8],
hen [11],

[1] Departme
E-Mail: lk
[2] Institute o
Taipei 11

Erinacine C

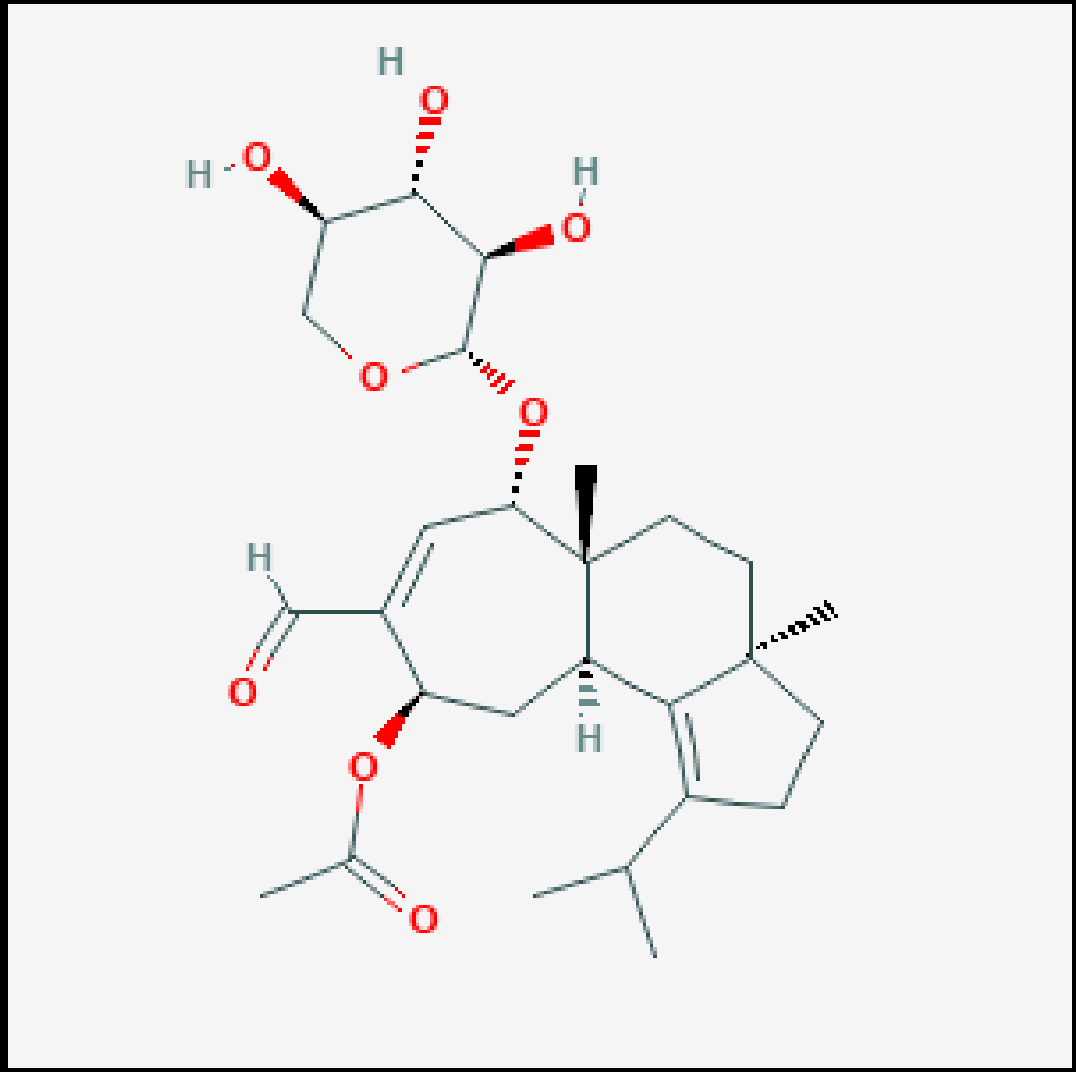
Strongest inducing effect on NGF synthesis, indicating a high potential to treat nervous diseases such as Alzheimer's disease



Thongbai, B , Rapior S, Hyde KD, Wittstein K, Stadler M. (2015), Hericium erinaceus, an amazing medicinal mushroom, Mycol Progress 14:91

Erinacine P

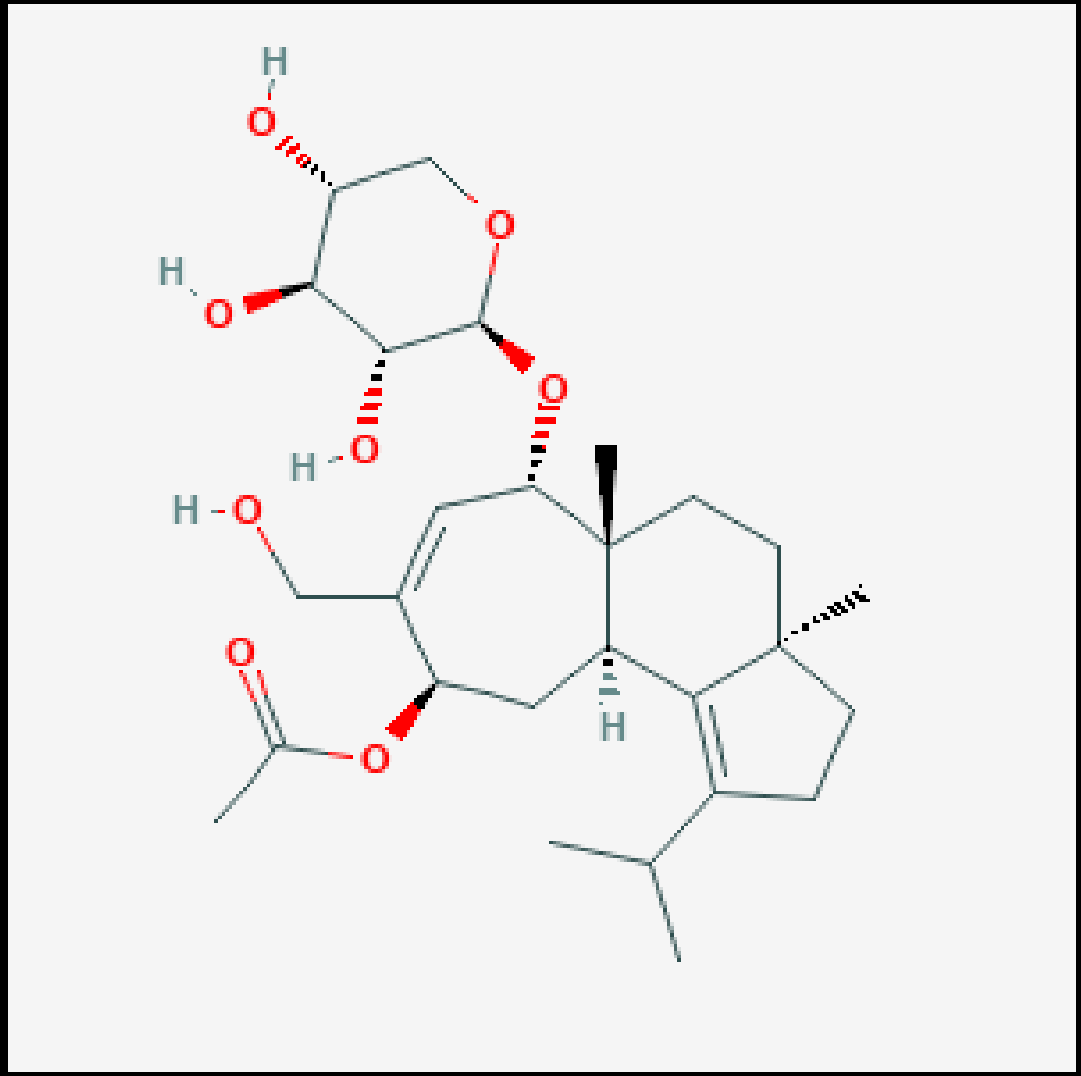
Erinacine P, a cyathane-xyloside, and its biomimetic conversions into erinacine A and erinacine B was also found to induce NGF synthesis



Thongbai, B , Rapior S, Hyde KD, Wittstein K, Stadler M. (2015), Hericium erinaceus, an amazing medicinal mushroom, Mycol Progress 14:91

Erinacine Q

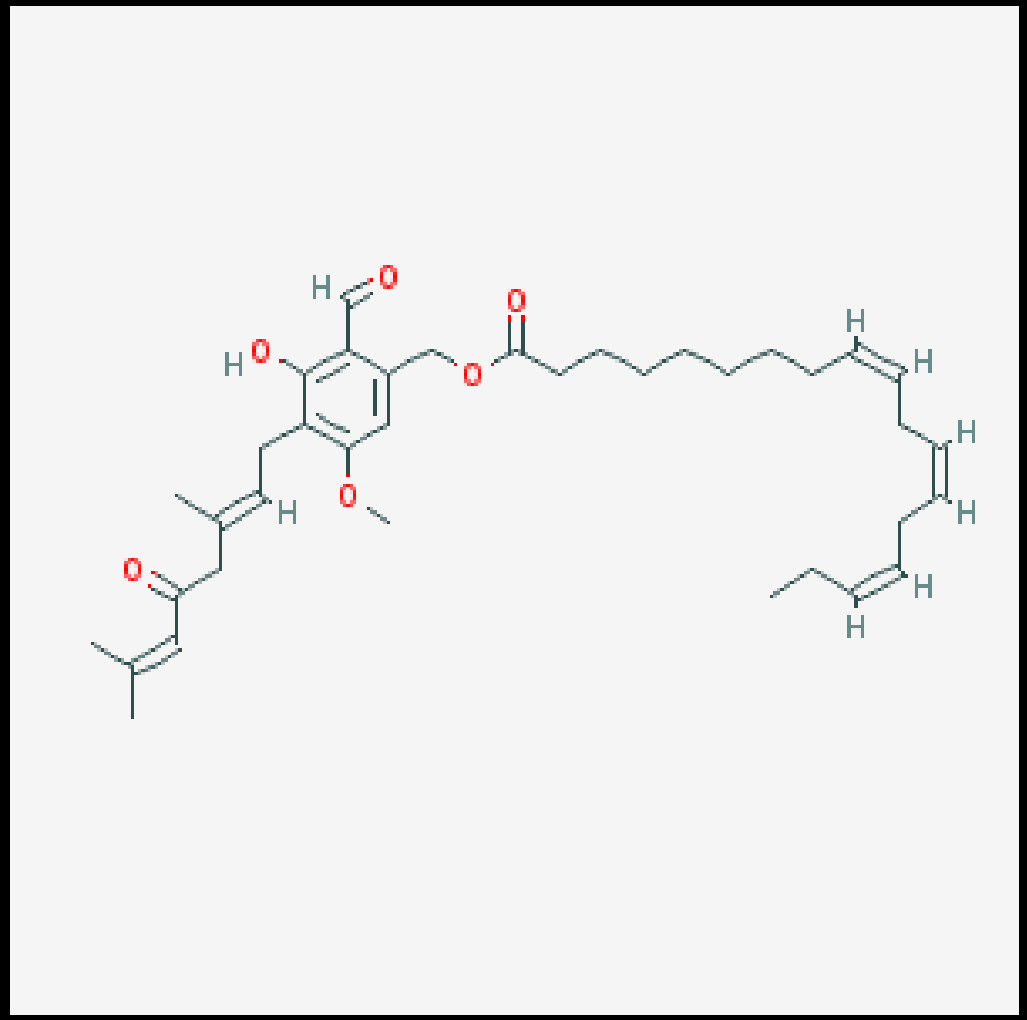
Erinacine Q give rise to cyatha-3,12-dien- 14-β-ol named erinacol and 11-O-acetylcyathin A3 are reported to have NGF-enhancing activities



Thongbai, B , Rapior S, Hyde KD, Wittstein K, Stadler M. (2015), Hericium erinaceus, an amazing medicinal mushroom, Mycol Progress 14:91

Hericenone E

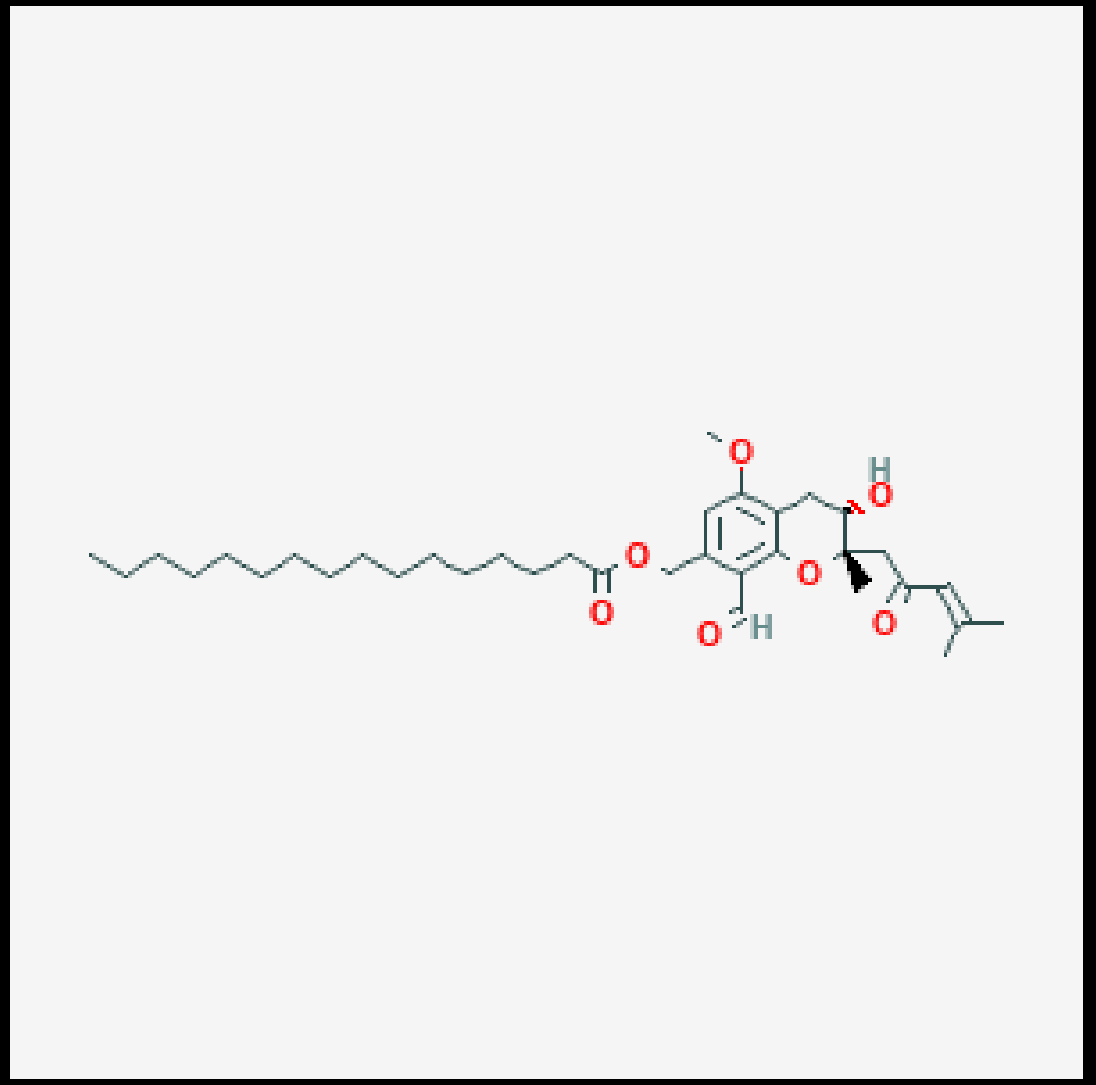
Hericenone E was able to stimulate NGF secretion that was two-fold higher than that of the positive control (50 ng/mL of NGF)

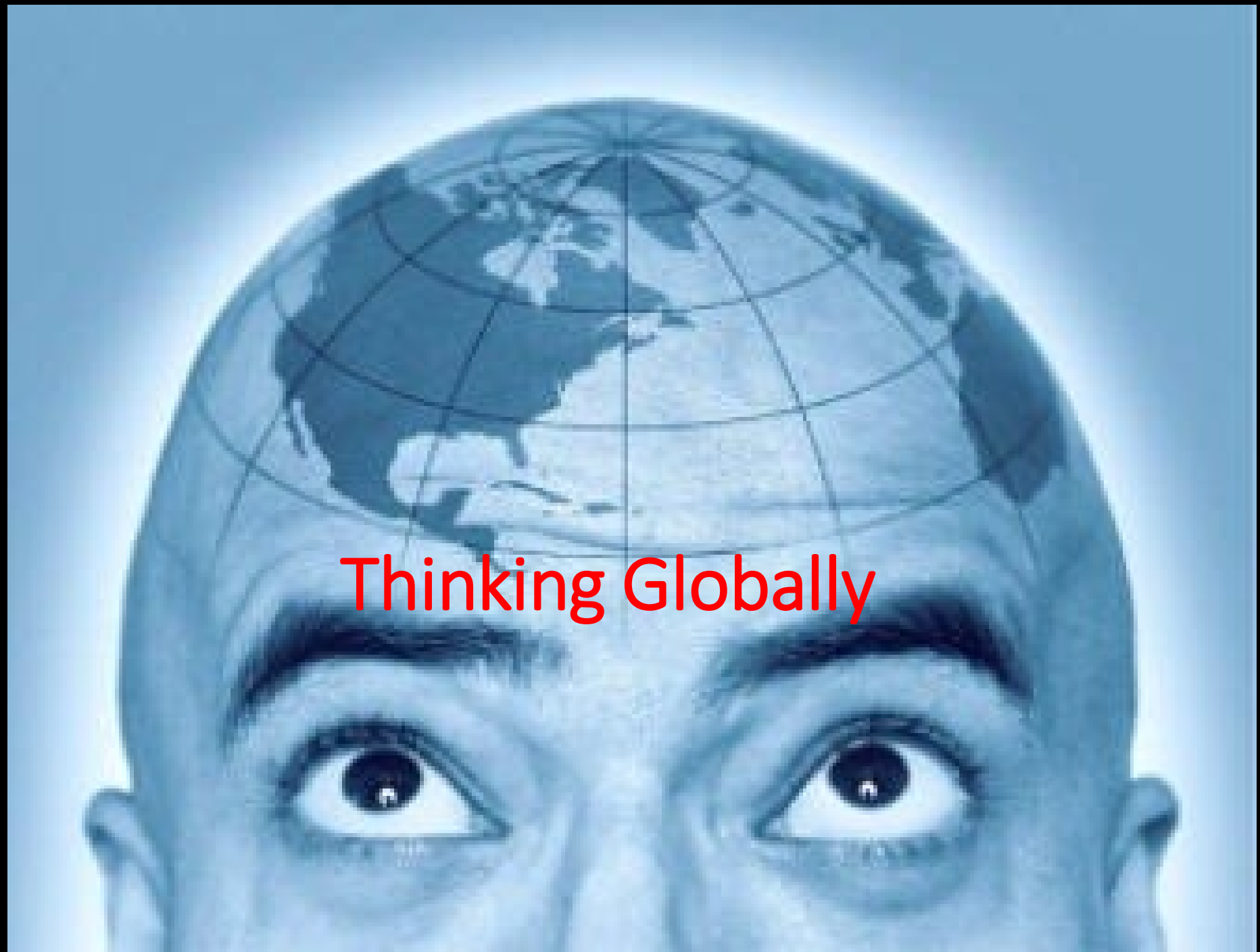


Thongbai, B , Rapior S, Hyde KD, Wittstein K, Stadler M. (2015), Hericium erinaceus, an amazing medicinal mushroom, Mycol Progress 14:91

3-Hydroxyhericenone F

Inhibits β-site Amyloid Precursor Protein-Cleaving Enzyme 1 (BACE1)




Thinking Globally

Toxicology 307 (2013) 35–41

Contents lists available at SciVerse ScienceDirect

Toxicology

journal homepage: www.elsevier.com/locate/toxicol

Epigenetics and pesticides

M. Collotta, P.A. Bertazzi, V. Bollati*

Center of Molecular and Genetic Epidemiology, Department of Clinical Sciences and Community Health, Università degli Studi di Milano and Fondazione IRCCS Ospedale Maggiore Policlinico, Mangiagalli e Regina Elena, Via San Barnaba 8, Milan 20122, Italy

Several investigations have examined the effects of environmental exposures and epigenetic markers, and identified toxicants that modify epigenetic states

mechanisms of pesticides health effects, as well as for predicting health-related risks due to conditions of environmental exposure and individual susceptibility.

available evidence supports the concept that epigenetics can predict health-related risks due to conditions of environmental exposure and individual susceptibility

living species (Baxter et al., 2010). Therefore, they find use in agriculture, in public health for controlling vector borne diseases, in industry to protect machineries and products from biological degradation and in "do it yourself" activities, such as gardening.

* Corresponding author. Tel.: +39 02 503 20127; fax: +39 02 503 20103.
E-mail address: valentina.bollati@unimi.it (V. Bollati).

0300-483X/$ – see front matter © 2013 Elsevier Ireland Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.tox.2013.01.017

Table 1
Epigenetic modifications induced by pesticides.

Class	Exposure	Modification	Type	Tissue	Reference
Endocrine Disruptors	Methoxychlor	DNA methylation	Rat	Sperm, tail, liver, skeletal muscle, and ovaries	Stouder and Paoloni-Giacobino (2011) and Zama and Uzumcu (2009)
Endocrine disruptors	Vinclozolin	DNA methylation	Mouse embryo	Placenta, yolk sac, amnion, head, body, heart, liver, lung, stomach, and intestines	Kang et al. (2011)
Persistent organic pollutants (POPs)	Dichlorodiphenyl-trichloroethane (DDT)	DNA methylation	Rat	Hypothalamus	Shutoh et al. (2009)
Persistent organic pollutants (POPs)	Organochlorine pesticides	DNA methylation	Human	Blood	Kim et al. (2010)
Persistent organic pollutants (POPs)	DDT, DDE, β-BHC, oxychlordane, α-chlordane, mirex, PCBs	DNA methylation	Human	Blood	Rusiecki et al. (2008)
Metals	Arsenic	DNA methylation	In vitro	Rat liver epithelial cells	Zhao et al. (1997)
Metals	Arsenic	DNA methylation	In vitro	Mouse liver	Chen et al. (2004)
Metals	Arsenic	DNA methylation	In vitro	V79-CH Chinese hamster cells: ASO cells	Sciandrello et al. (2004)
Metals	Arsenic	DNA methylation	Human	Blood	Chanda et al. (2006) and Pilsner et al. (2007, 2009)
Metals	Arsenic	microRNA expression	Human	Human lymphoblastoid cells	Marsit et al. (2006)
Herbicides	Paraquat	Histone modifications	In vitro	Immortalized rat mesencephalic dopaminergic cells (N27 cells)	Song et al. (2010) and Song et al. (2011)
Herbicides	Dieldrin	Histone modifications	In vitro	Mesenchephalic dopaminergic neuronal cells	Song et al. (2010)
Insecticides	Propoxur	Histone modifications	In vitro	Gastric cells	Kuo et al. (2008)
Insecticides	Dichlorvos	microRNA expression	In vitro	Porcine kidney epithelial cells	Li et al. (2011)
Insecticides	Fipronil, triazophos	microRNA expression	Zebrafish	Whole body homogenate	Wang et al. (2010)
Fungicides	Triadimefon, propiconazole, myclobutanil	microRNA expression	Mouse	Liver	Ross et al. (2010)

Published in final edited form as:

JAMA Intern Med. 2015 March 1; 175(3): 401–407. doi:10.1001/jamainternmed.2014.7663.

Cumulative Use of Strong Anticholinergic Medications and Incident Dementia

Shelly L. Gray, PharmD, MS[1], **Melissa L. Anderson, MS**[2], **Sascha Dublin, MD, PhD**[2,3],

Higher cumulative anticholinergic medication use is associated with an increased risk for dementia

[3]Department of Epidemiology, University of Washington, Seattle, Washington

[4]Division of Geriatric Medicine, University of Pittsburgh

[5]Department of Biostatistics, University of Washington, Seattle, Washington

[6]Division of General Internal Medicine, University of Washington, Seattle, Washington

Mitochondrial Damaging Medications

Mitochondrial toxicity testing is still not required by the US FDA for drug approval

Dykens, J. A., Will, Y., The significance of mitochondrial toxicity testing in drug development. Drug Discov Today 2007, 12, 777–785.

DOI 10.1002/mnfr.200700075 Mol. Nutr. Food Res. 2008, *52*, 780–788

Review

Medication-induced mitochondrial damage and disease

John Neustadt and Steve R. Pieczenik

Montana Integrative Medicine, Bozeman, MT, USA

Since the first mitochondrial dysfunction was described in the 1960s, the medicine has advanced in its understanding the role mitochondria play in health and disease. Damage to mitochondria is now understood to play a role in the pathogenesis of a wide range of seemingly unrelated disorders such as schizophrenia, bipolar disease, dementia, Alzheimer's disease, epilepsy, migraine headaches, strokes, neuropathic pain, Parkinson's disease, ataxia, transient ischemic attack, cardiomyopathy, coronary artery disease, chronic fatigue syndrome, fibromyalgia, retinitis pigmentosa, diabetes, hepatitis C, and primary biliary cirrhosis. Medications have now emerged as a major cause of mitochondrial damage, which may explain many adverse effects. All classes of psychotropic drugs have been documented to damage mitochondria, as have stain medications, analgesics such as acetaminophen, and many others. While targeted nutrient therapies using antioxidants or their prescursors (*e.g.*, *N*-acetylcysteine) hold promise for improving mitochondrial function, there are large gaps in our knowledge. The most rational approach is to understand the mechanisms underlying mitochondrial damage for specific medications and attempt to counteract their deleterious effects with nutritional therapies.

Drug class	Drugs
Alcoholism medications	Disulfiram (Antabuse®)
Analgesic (for pain) and anti-inflammatory	Aspirin, acetaminophen (Tylenol), diclofenac (Voltaren®, Voltarol®, Diclon®, Dicloflex® Difen and Cataflam®), fenoprofen (Nalfon®), indomethacin (Indocin®, Indocid®, Indochron E-R® Indocin-SR®), Naproxen (Aleve®, Naprosyn®)
Anesthetics	Bupivacaine, lidocaine, propofol
Angina medications	Perhexiline, amiodarone (Cordarone®), Diethylaminoethoxyhexesterol (DEAEH)
Antiarrhythmic (regulates heartbeat)	Amiodarone (Cordarone)
Antibiotics	Tetracycline, antimycin A
Antidepressants	Amitriptyline (Lentizol), amoxapine (Asendis), citalopram (Cipramil), fluoxetine (Prozac, Symbyax, Sarafem, Fontex, Foxetin, Ladose, Fluctin, Prodep, Fludac, Oxetin, Seronil, Lovan)
Antipsychotics	Chlorpromazine, fluphenazine, haloperidol, risperidone, quetiapine, clozapine, olanzapine
Anxiety medications	Alprazolam (Xanax®), diazepam (valium, diastat)
Barbiturates	Amobarbital (Amytal®), aprobarbital, butabarbital, butalbital (Fiorinal®, hexobarbital (Sombulex®), methylphenobarbital (Mebaral®), pentobarbital (Nembutal®), phenobarbital (Luminal®), primidone, propofol, secobarbital (Seconal®), Talbutal®), thiobarbital
Cholesterol medications	Statins – atorvastatin (Lipitor®, Torvast®), fluvastatin (Lescol®), lovastatin (Mevacor®, Altocor®), pitavastatin (Livalo®, Pitava®), pravastatin (Pravachol®, Selektine®, Lipostat®), rosuvastatin (Crestor®), simvastatin (Zocor®, Lipex®) bile acids – cholestyramine (Questran®), clofibrate (Atromid-S®), ciprofibrate (Modalim®), colestipol (Colestid®), colesevelam (Welchol®)
Cancer (chemotherapy) medications	Mitomycin C, profiromycin, adriamycin (also called doxorubicin and hydroxydaunorubicin and included in the following chemotherapeutic regimens – ABVD, CHOP, and FAC)
Dementia	Tacrine (Cognex®),Galantamine (Reminyl®)
Diabetes medications	Metformin (Fortamet®, Glucophage®, Glucophage XR, Riomet[1]), troglitazone, rosiglitazone, buformin
HIV/AIDS medications	AtriplaÔ, Combivir®, Emtriva®, Epivir® (abacavir sulfate), EpzicomÔ, Hivid® (ddC, zalcitabine), Retrovir® (AZT, ZDV, zidovudine), Trizivir®, Truvada®, Videx® (ddI, didanosine), Videx® EC, Viread®, Zerit® (d4T, stavudine), Ziagen®, Racivir®
Epilepsy/Seizure medications	Valproic acid (Depacon®, Depakene®, Depakene syrup, Depakote®, depakote ER, depakote sprinkle, divalproex sodium)
Mood stabilizers	Lithium
Parkinson's disease medications	Tolcapone (Tasmar®, Entacapone (COMTan®, also in the combination drug Stalevo®)

DTD 5 ARTICLE IN PRESS

Psychoneuroendocrinology (2005) xx, 1–7

ELSEVIER

PNEC

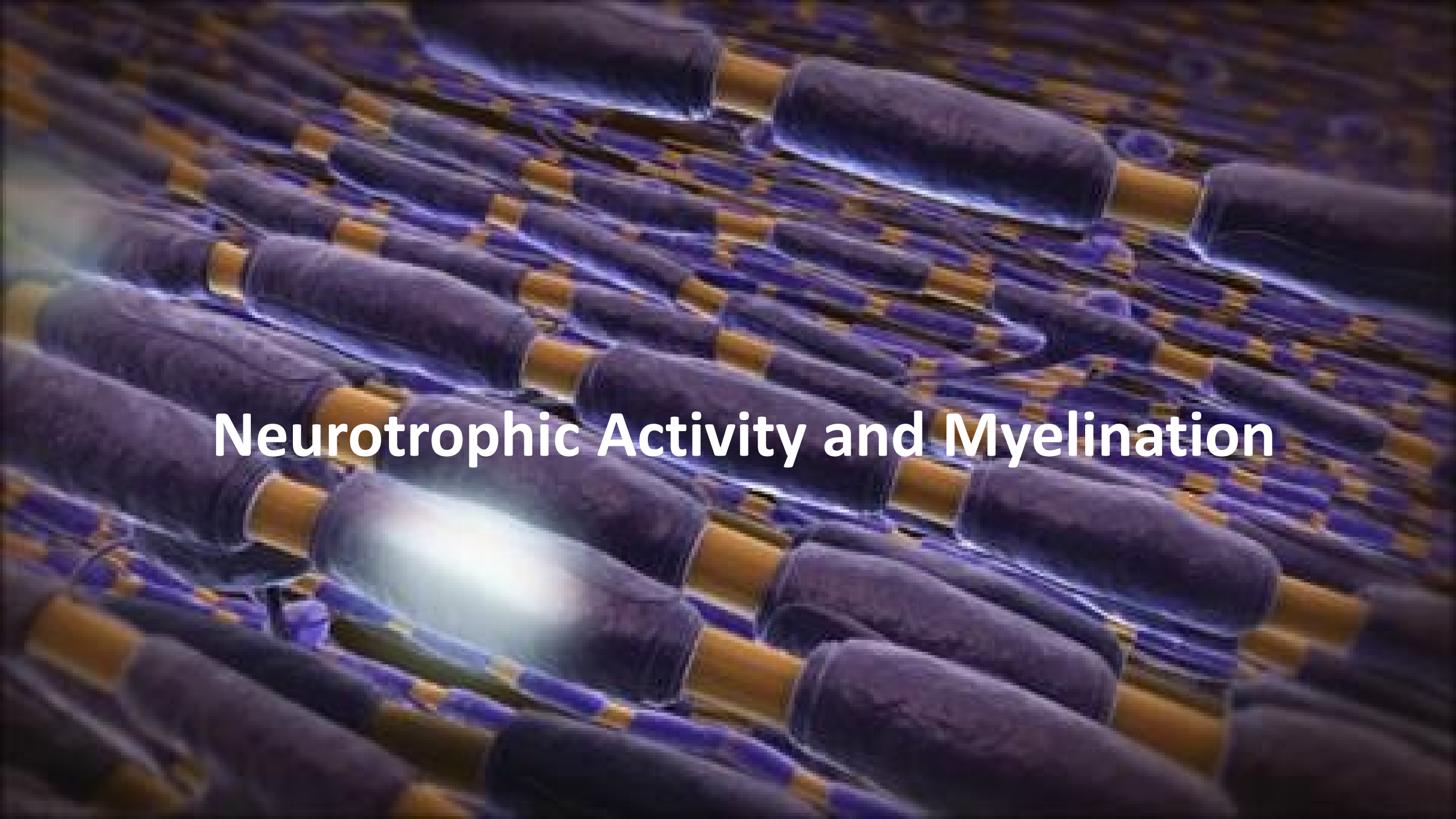
www.elsevier.com/locate/psyneuen

Raised plasma nerve growth factor levels associated with early-stage romantic love

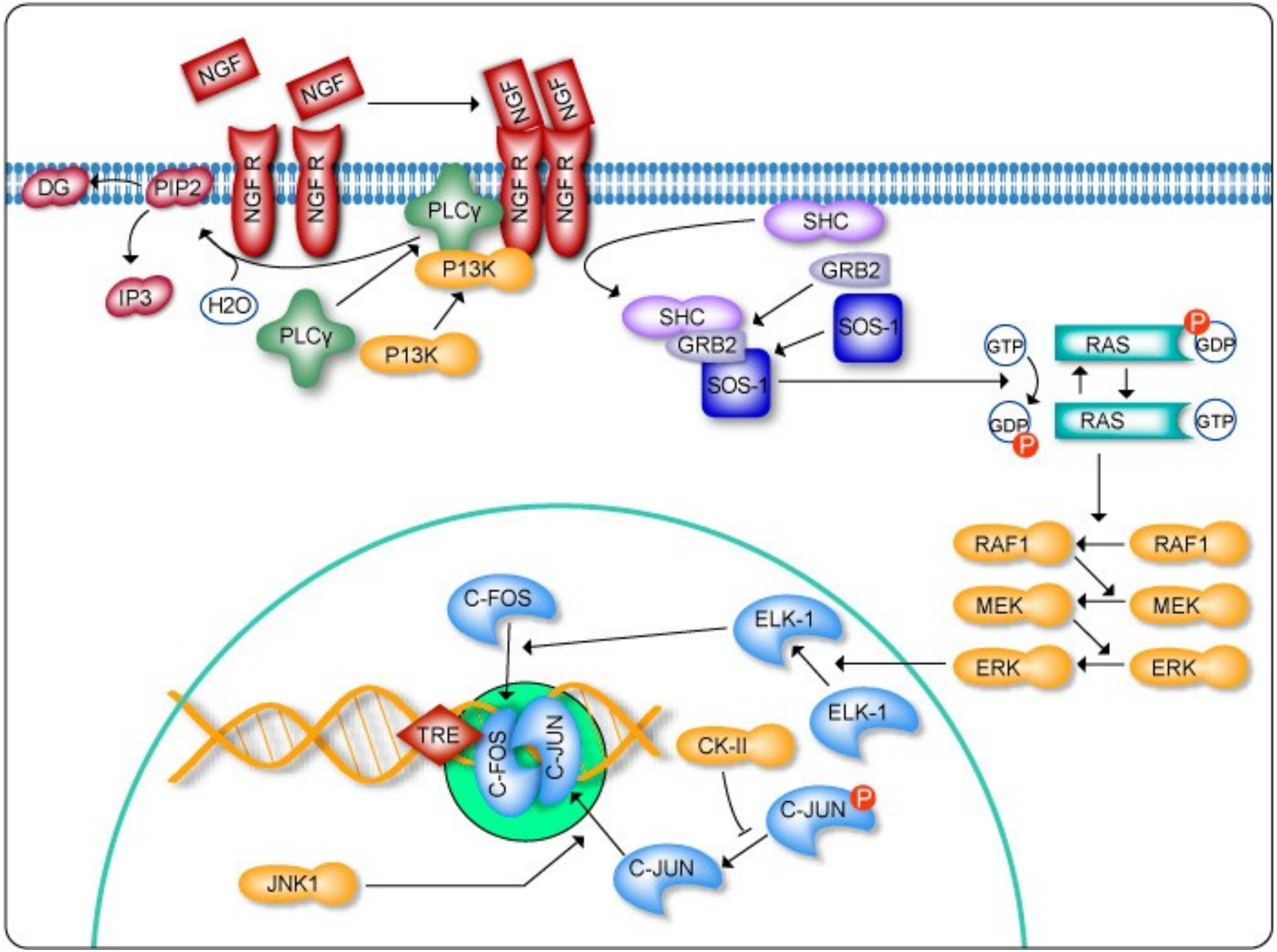
Enzo Emanuele[a,*], Pierluigi Politi[b], Marika Bianchi[a], Piercarlo Minoretti[a], Marco Bertona[a], Diego Geroldi[a]

[a]*Interdepartmental Center for Research in Molecular Medicine (CIRMC), University of Pavia, Viale Taramelli 24, I-27100 Pavia, Italy*
[b]*Department of Health Sciences, Section of Psychiatry, University of Pavia, Pavia, Italy*

Received 5 August 2005; received in revised form 12 September 2005; accepted 15 September 2005



Neurotrophic Activity and Myelination


NGF
NGF
NGF
NGF
NGF R
NGF R
NGF R
NGF R
DG
PIP2
IP3
H2O
PLCγ
P13K
PLCγ
P13K
SHC
GRB2
SOS-1
SHC
GRB2
SOS-1
GTP
GDP
RAS
GDP
RAS
GTP
RAF1
RAF1
MEK
MEK
ERK
ERK
C-FOS
ELK-1
ELK-1
TRE
C-FOS
C-JUN
CK-II
C-JUN
C-JUN
JNK1

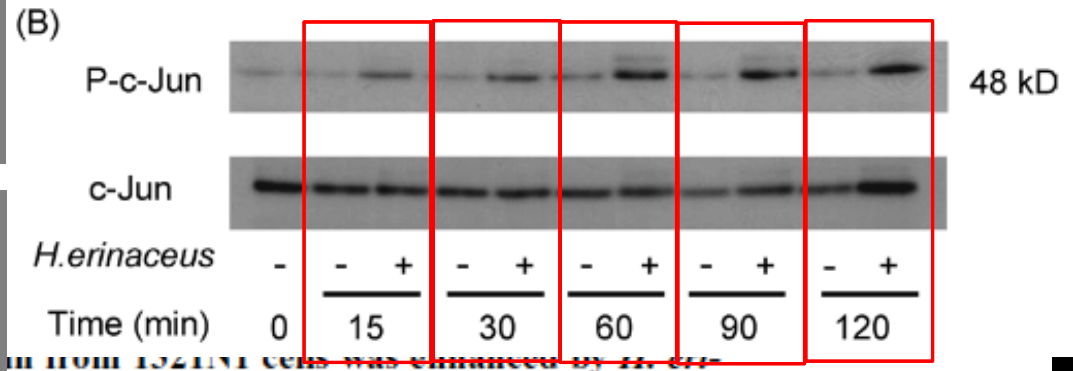
Nerve Growth Factor-Inducing Activity of *Hericium erinaceus* in 1321N1 Human Astrocytoma Cells

Koichiro MORI,[a,c] Yutaro OBARA,[a,b] Mitsuru HIROTA,[d] Yoshihito AZUMI,[c] Satomi KINUGASA,[c]

s, Tohoku University; [b] 21st Century COE
u University; Aoba 6–3, Aramaki, Aoba-
0–8 Shimokomazawa, Nagano 381–0008,
lture, Shinshu University; 8304 Minami-

An ethanol extract of *H. erinaceus* fruiting body demonstrated NGF gene expression in astrocytoma cells in a concentration dependent manner

Secretion of NGF was also enhanced by *Hericium* extracts, and the neurite outgrowth was improved



Induced phosphorylation of c-Jun increased c-Fos expression

such as Alzheimer's disease. In the present study, we firstly exam

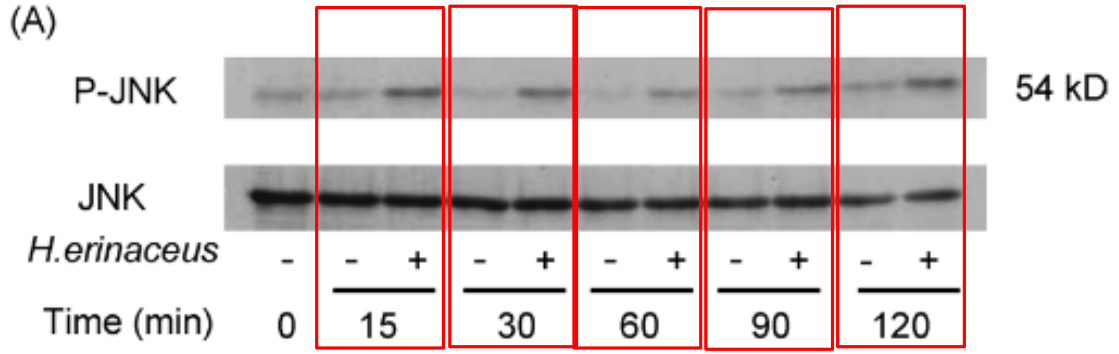
bated with *H. erinaceus* extract enhanced the

duced phosphorylation of JNK and its downstream substrate c-Jun, and increased c-fos expression, suggesting that *H. erinaceus* promotes NGF gene expression *via* JNK signaling. Furthermore we examined the efficacy of *H. erinaceus in vivo*. ddY mice given feed containing 5% *H. erinaceus* dry powder for 7 d showed an increase in

Nerve Growth Factor-Inducing Activity of *Hericium erinaceus* in 1321N1 Human Astrocytoma Cells

In vivo 5% *H. erinaceus* fruiting body dry powder for 7 days showed an increase in the level of NGF mRNA expression in the hippocampus by activation of the JNK pathway

hito Azumi,[c] Satomi Kinugasa,[c]

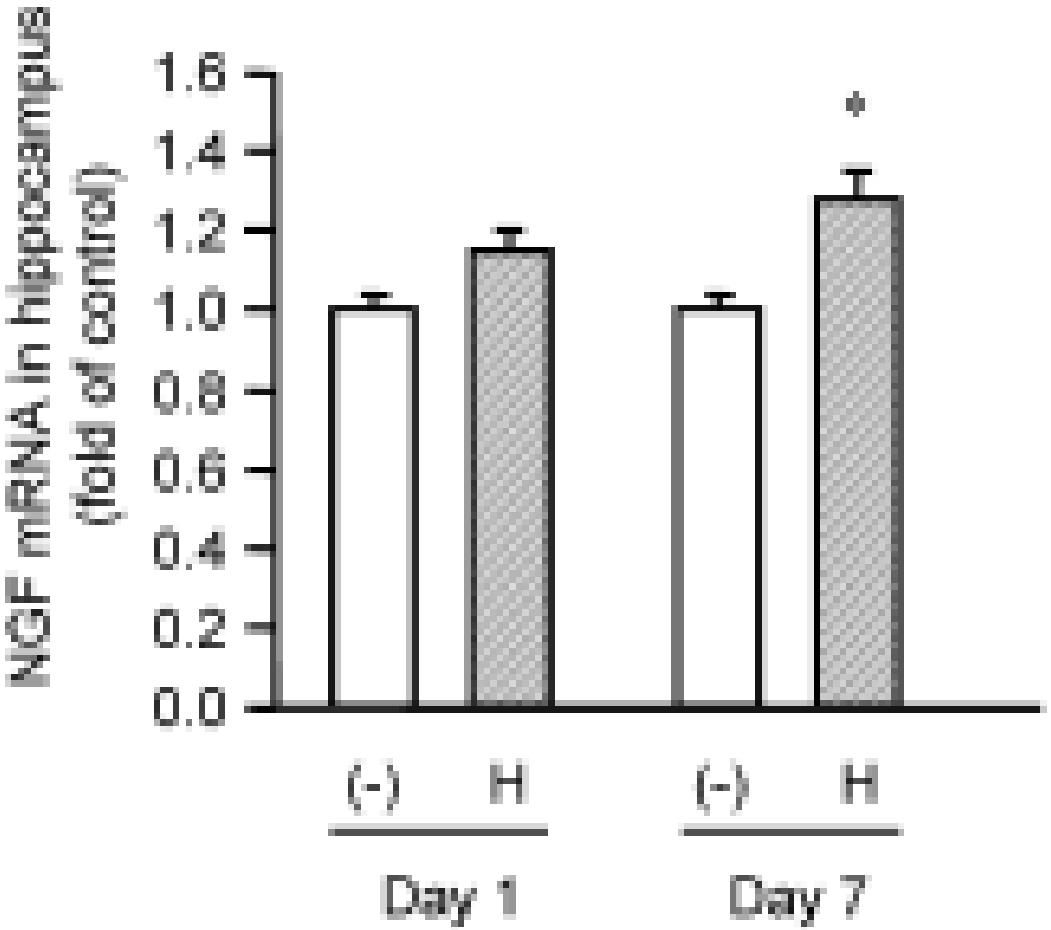


applied to the treatment of neurodegenerative diseases
ly examined the effects of ethanol extracts of four edible
rotus eryngii (Eringi), *Grifola frondosa* (Maitake), and
(NGF) gene expression in 1321N1 human astrocytoma
eus extract promoted NGF mRNA expression in a con-
GF protein from 1321N1 cells was enhanced by *H. eri-*
cells incubated with *H. erinaceus* extract enhanced the
C, D and E, constituents of *H. erinaceus*, failed to pro-
ement of NGF gene expression by *H. erinaceus* extracts
ibitor SP600125. In addition, *H. erinaceus* extracts in-
duced phosphorylation of JNK and its downstream substrate c-Jun, and increased c-fos expression, suggesting that *H. erinaceus* promotes NGF gene expression *via* JNK signaling. Furthermore we examined the efficacy of *H. erinaceus in vivo*. ddY mice given feed containing 5% *H. erinaceus* dry powder for 7 d showed an increase in

Nerve Growth Factor-Inducing Activity of *Hericium erinaceus* in 1321N1 Human Astrocytoma Cells

Koichiro MORI,[a,c] Yutaro OBARA,[a,b] Mitsuru HIROTA,[d] Yosh
Satoshi INATOMI,[c] and Norimichi NAKAHATA*,[a,b]

[a] *Department of Cellular Signaling, Graduate School of Pharmaceuti*
Program "CRESCENDO", Graduate School of Pharmaceutical Scie
ku, Sendai 980–8578, Japan: [c] *Mushroom Laboratory, Hokuto Corp*
Japan: and [d] *Department of Bioscience and Biotechnology, Faculty*
minowa, Kami-ina, Nagano 399–4598, Japan.
Received March 24, 2008; accepted June 20, 2008; published online J



Neurotrophic factors are essential to maintain and
tor-like substances or their inducers are expected to be
such as Alzheimer's disease. In the present study, we firs
mushrooms, *Hericium erinaceus* (Yamabushitake), *Pleu*
***Agaricus blazei* (Himematsutake), on nerve growth facto**
cells. Among the four mushroom extracts, only *H. erina*
centration-dependent manner. In addition, secretion of
***naceus* extracts, and the conditioned medium of 1321N1**
neurite outgrowth of PC12 cells. However, hericenones
mote NGF gene expression in 1321N1 cells. The enhanc
was inhibited by the c-jun N-terminal kinase (JNK) in
duced phosphorylation of JNK and its downstream sub
that *H. erinaceus* promotes NGF gene expression *via* JNK signaling. Furthermore we examined the efficacy of *H. erinaceus in vivo*. ddY mice given feed containing 5% *H. erinaceus* dry powder for 7 d showed an increase in

Neurotrophic Properties of the Lion's Mane Medicinal Mushroom, *Hericium erinaceus* (Higher Basidiomycetes) from Malaysia

Aqueous extract of *H. erinaceus* fruiting body has demonstrated an increase in the secretion of extracellular NGF in neurons and neurite outgrowth activity

Kuala Lumpur, Malaysia; Tel.: 603-7967 4249; Fax: 603-7967 [illegible]; E-mail: [illegible]

A synergistic interaction between *H. erinaceus* aqueous extract and exogenous NGF on the neurite outgrowth stimulation of neurons at physiological relevant concentrations was observed

in pre-treatment and co-treatment modes. In conclusion, the aqueous extract of *H. erinaceus* contained neuroactive

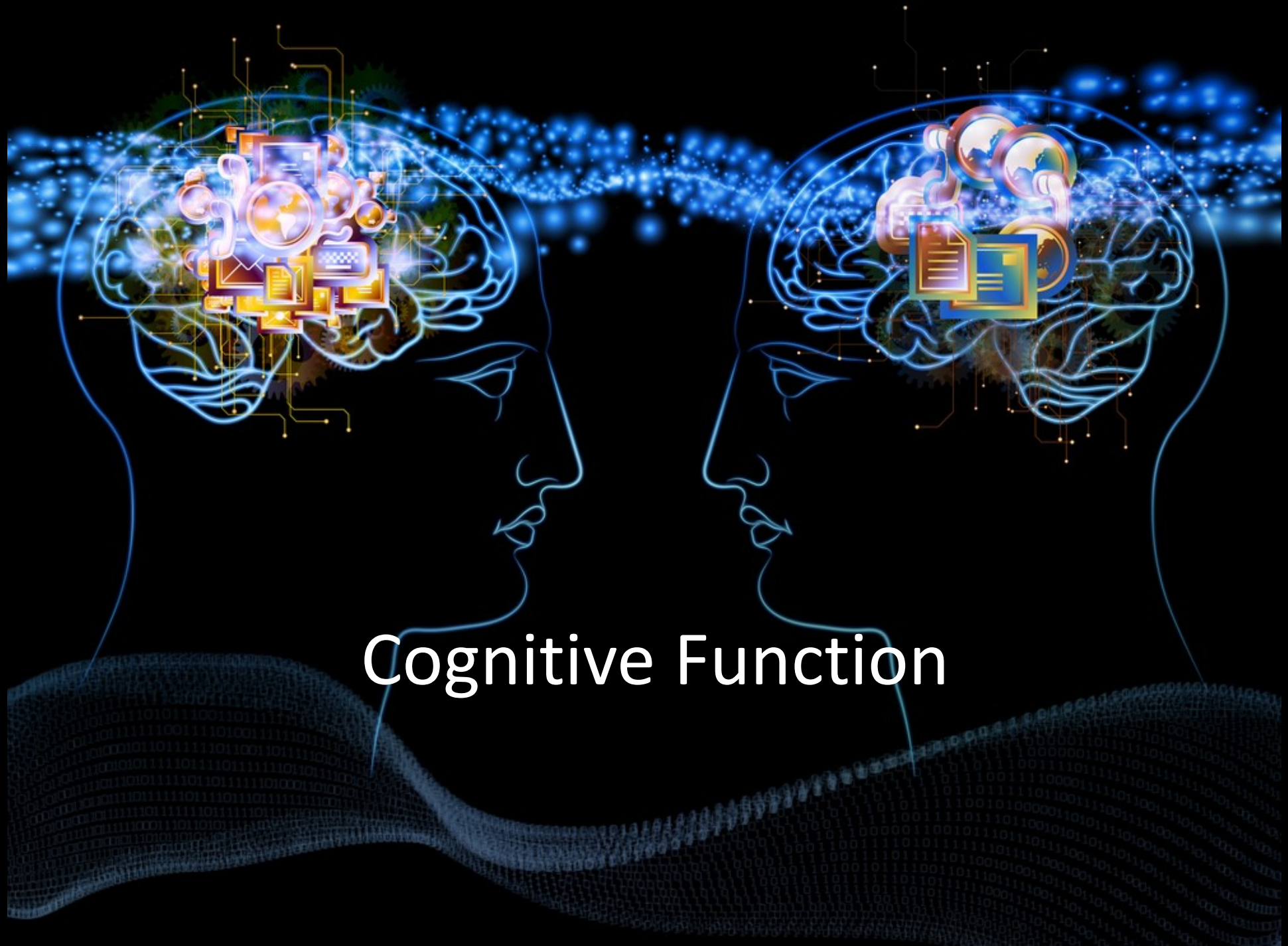
УДК 576.31:57.086.83

E.V. Kolotushkina, M.G. Moldavan, K.Yu. Voronin, G.G. Skibo

The influence of *Hericium erinaceus* extract on myelination process in vitro

The process of the myelin sheath formation in the presence of *H. erinaceus* extract proceeded at a higher rate and was completed by day 26 as compared to controls

результатами, нервові та гліальні клітини розвивалися нормально у онаявності екстракту протягом культивування. Екстракт не викликав патологічних змін і не демонстрував токсичної дії щодо клітин. Ультраструктура клітинних елементів була інтактною і не відрізнялась від такої, що спостерігається у клітин мозочка in vivo. Процес мієлінізації при наявності екстракту починався раніше і проходив швидше, порівняно з контролем. Таким чином, екстракт H. erinaceus *сприяв нормальному розвитку та росту культивованих клітин мозочка і демонстрував регулювальну та стимулювальну дію щодо процесу мієлінізації in vitro.*



Cognitive Function

PHYTOTHERAPY RESEARCH
Phytother. Res. **23**, 367–372 (2009)
Published online 10 October 2008 in Wiley InterScience
(www.interscience.wiley.com) **DOI**: 10.1002/ptr.2634

Improving Effects of the Mushroom Yamabushitake (*Hericium erinaceus*) on Mild Cognitive Impairment: A Double-blind Placebo-controlled Clinical Trial

50-80 year old Japanese adults diagnosed with mild cognitive impairment, 250 mg tablets of dry *H. erinaceus* powder (TID x 4 wk) showed marked improvement in revised Hasegawa Dementia Scale (HDS-R) as compared to the placebo group

of Yamabushitake (*Hericium erinaceus*), an edible mushroom, for improving cognitive impairment, using a cognitive function scale based on the Revised Hasegawa Dementia Scale (HDS-R). After 2 weeks of preliminary examination, 30 subjects were randomized into two 15-person groups, one of which was given Yamabushitake and the other given a placebo. The subjects of the Yamabushitake group took four 250 mg tablets containing 96% of Yamabushitake dry powder three times a day for 16 weeks. After termination of the intake, the

Research Article

Dietary Supplementation of *Hericium erinaceus* Increases Mossy Fiber-CA3 Hippocampal Neurotransmission and Recognition Memory in Wild-Type Mice

In wild-type mice, the oral supplementation of *H. erinaceus* induced a significant improvement in recognition memory

[2]*Department of Biology and Biotechnology (DBB) "L. Spallanzani", University of Pavia, Via Ferrata 1, 27100 Pavia, Italy*
[3]*MycoMedica d.o.o., Podkoren 72, 4280 Kranjska Gora, Slovenia*

In hippocampal slices, an increase in spontaneous and evoked excitatory synaptic current in mossy fiber-CA3 synapse shown in a behaviour test

Academic Editor: Giuseppe Venturella

Research Article

Dietary Supplementation of *Hericium erinaceus* Increases Mossy Fiber-CA3 Hippocampal Neurotransmission and Recognition Memory in Wild-Type Mice

Federico Brandalise,[1] Valentina Cesaroni,[2] Andrej Gregori,[3] Margherita Repetti,[2] Chiara Romano,[2] Germano Orrù,[4] Laura Botta,[2] Carolina Girometta,[5] Maria Lidia Guglielminetti,[5,6] Elena Savino,[5,6] and Paola Rossi[2,6]

H. erinaceus prevents the impairment of spatial short-term and visual recognition memory

[6]*Miconet s.r.l, Academic Spin-Off of the University of Pavia, Via Moruzzi 13, 27100 Pavia, Italy*

Correspondence should be addressed to Paola Rossi; paola.rossi@unipv.it

Received 6 October 2016; Revised 1 December 2016; Accepted 7 December 2016; Published 1 January 2017

Academic Editor: Giuseppe Venturella

Cytotechnology 39: 155–162, 2002.
© 2003 Kluwer Academic Publishers. Printed in the Netherlands.

Effect of f *Hericium erinaceus* of rat adrenal nerve cell

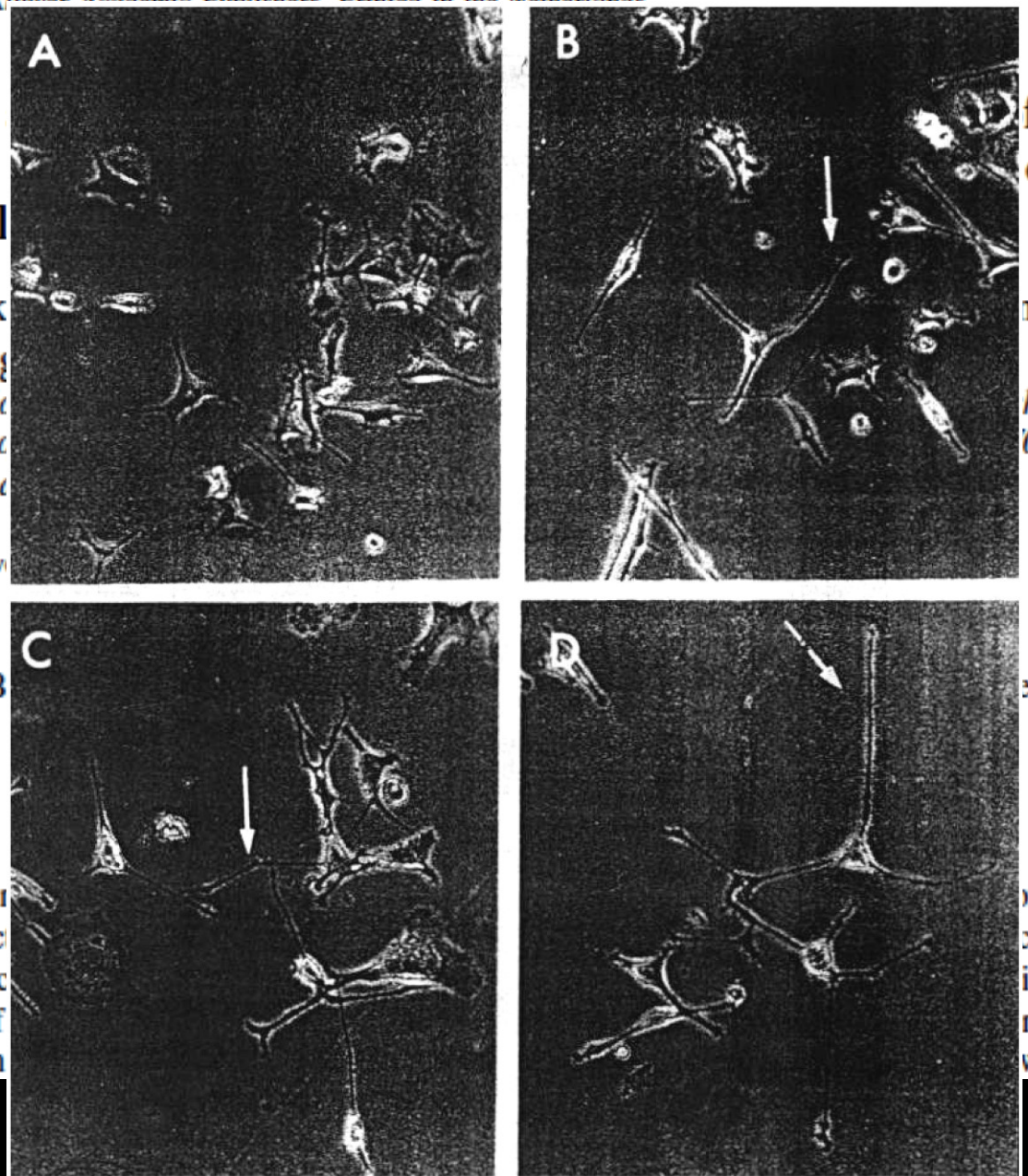
Young Shik n Young Lee[1] and Hyeon Yong
[1]*School of Bi hon 200-701, S. Korea;*
[2]*Department c 02, S. Korea; *Author for correspon*

Received 14 Nov

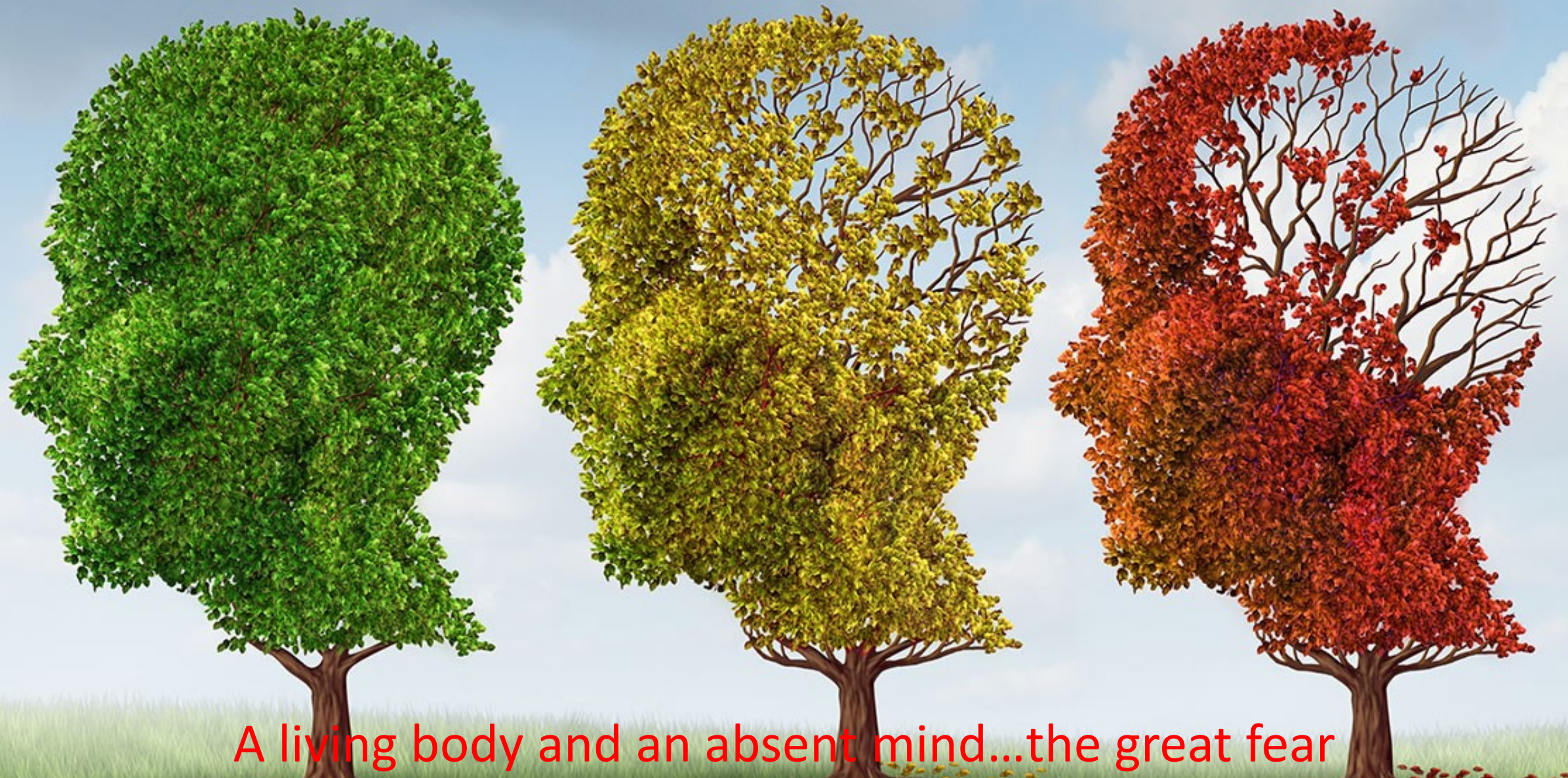
Key words: B es, NGF, PC12 cell

Abstract

It was fou f 1.5 : 1.7 : 1.2 : 0.6 : 0.9, glucose : galac culture broth of *Hericium erinaceus* myc improved the extension of the neurites of rve growth factors such as Nerve Growth wo standards has not been



Alzheimer's Disease



A living body and an absent mind…the great fear

With the increased lifespan of the world’ s population, it is estimated that about 80 million people will suffer from dementia by 2040 whereby AD will account for almost 60% of dementia cases

Martorana A, Bulati M, Buffa S, Pellicano M, Caruso C, et al. Immunosenescence, inflammation and Alzheimer’s disease. Longev Healthspan. 2012;1:8.

“A genuinely new Alzheimer’s drug has not been approved since 2003, and the currently approved Alzheimer’s medications are ineffective in stopping or slowing the course of the disease.”

Alzheimer’s Association

243 of 244 drug failures from 2000 – 2010

FDA

The Gerontologist
Vol. 37, No. 2, 150–156

Sister Mary, the gold standard for the Nun Study, was a remarkable woman who had high cognitive test scores before her death at 101 years of age. What is more remarkable is that she maintained this high status despite having abundant neurofibrillary tangles and senile plaques, the classic lesions of Alzheimer's disease. Findings from Sister Mary and all 678 participants in the Nun Study may provide unique clues about the etiology of aging and Alzheimer's disease, exemplify what is possible in old age, and show how the clinical expression of some diseases may be averted.

Key Words: Neuropathology, Alzheimer's disease, Dementia, Cognition

Aging and Alzheimer's Disease: Lessons From the Nun Study[1]

David A. Snowdon, PhD[2]

And what was the secret to her longevity? I remember her telling me that one day she had wondered out loud to her doctor if perhaps he was giving her medicine to keep her alive, and after all, her desire was to be with Jesus. Her doctor replied, "Sister, it's not my medicine that's keeping you alive. It's your attitude!" And it was that wonderful attitude that we all loved. It was

Catholics, had grade school educations, and were members of the working class.

Shortly before the close of the nineteenth century, Sister Mary began attending St. Boniface Grade School in Philadelphia. A few months shy of her 13th birthday, she received her First Holy Communion. Later that year, her mother died giving birth to Sister Mary's tenth sibling.

www.impactaging.com AGING, September 2014, Vol 6 N 9

Review

Reversal of cognitive decline: A novel therapeutic program

Dale E. Bredesen[1, 2]

[1] *Mary S. Easton Center for Alzheimer's Disease Research, Department of Neurology, University of California, Los Angeles, CA 90095;*
[2] *Buck Institute for Research on Aging, Novato, CA 94945.*

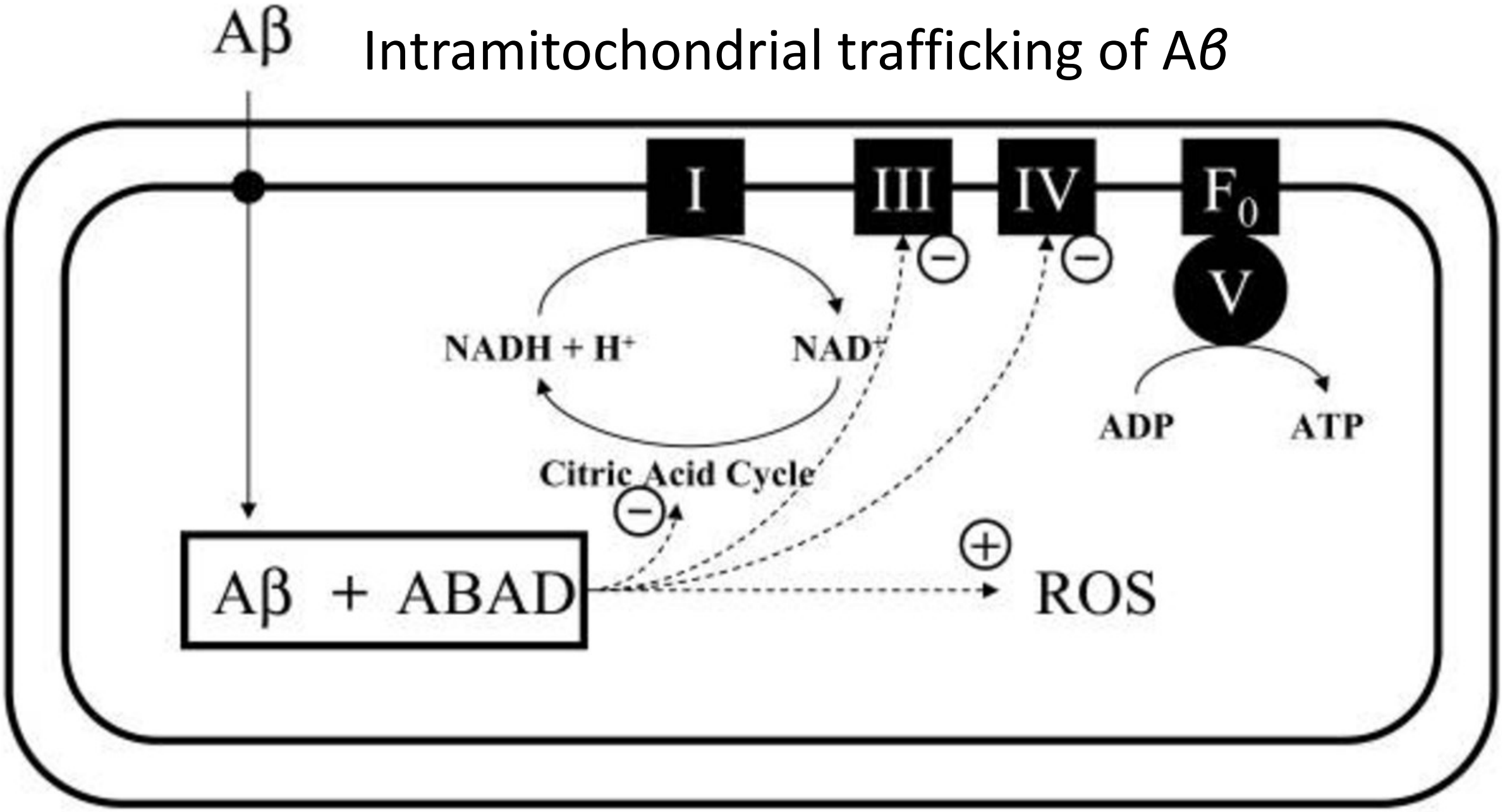
Key words: *Alzheimer's, dementia, mild cognitive impairment, neurobehavioral disorders, neuroinflammation, neurodegeneration, systems biology*
Received: *9/15/14; Accepted: 9/26/14; Published: 9/27/14*
Correspondence to: *Dale E. Bredesen, MD;* ***E-mail:*** *dbredesen@mednet.ucla.edu; dbredesen@buckinstitute.org*

Abstract: **This report describes a novel, comprehensive, and personalized therapeutic program that is based on the underlying pathogenesis of Alzheimer's disease, and which involves multiple modalities designed to achieve metabolic enhancement for neurodegeneration (MEND). The first 10 patients who have utilized this program include patients with memory loss associated with Alzheimer's disease (AD), amnestic mild cognitive impairment (aMCI), or subjective cognitive impairment (SCI). Nine of the 10 displayed subjective or objective improvement in cognition beginning within 3-6 months,**

Physiological Nudges

- Synaptoblastic Inputs
- Lipoxins
- Neurotrophic Factors
  - NGF
  - BDNF
- Glutamate Inhibition
- Antioxidants
  - Endogenous
  - Exogenous
    - Hormesis

Intramitochondrial trafficking of A*β*



Chen JX and Yan SD. Amyloid-*β*-Induced Mitochondrial Dysfunction. J Alzheimers Dis 2007 12(2):177-184.

FULL PAPER *Immunology*

Expression of Nerve Growth Factor in Itchy Skins of Atopic NC/NgaTnd Mice

Akane TANAKA[1)] and Hiroshi MATSUDA[1)]*

[1)]*Laboratory of Veterinary Molecular Pathology and Therapeutics, Division of Animal Life Science, Graduate School, Institute of Symbiotic Science and Technology, Tokyo University of Agriculture and Technology, Fuchu, Tokyo 183–8509, Japan*

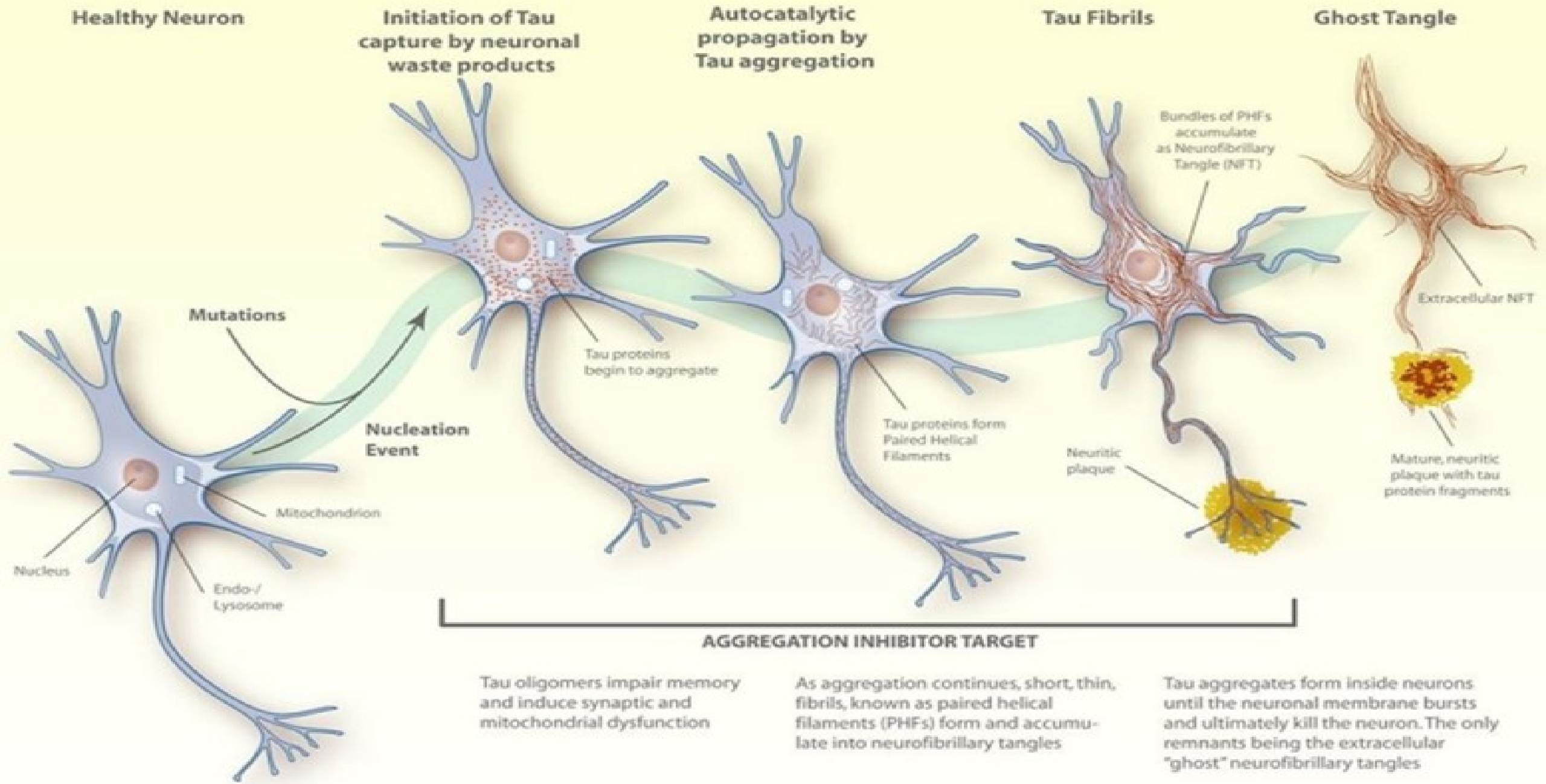
In an Alzheimer's model a 30 day oral administration of *H. erinaceus* mycelium and its ethanol extracts attenuated cerebral Aβ plaque burden

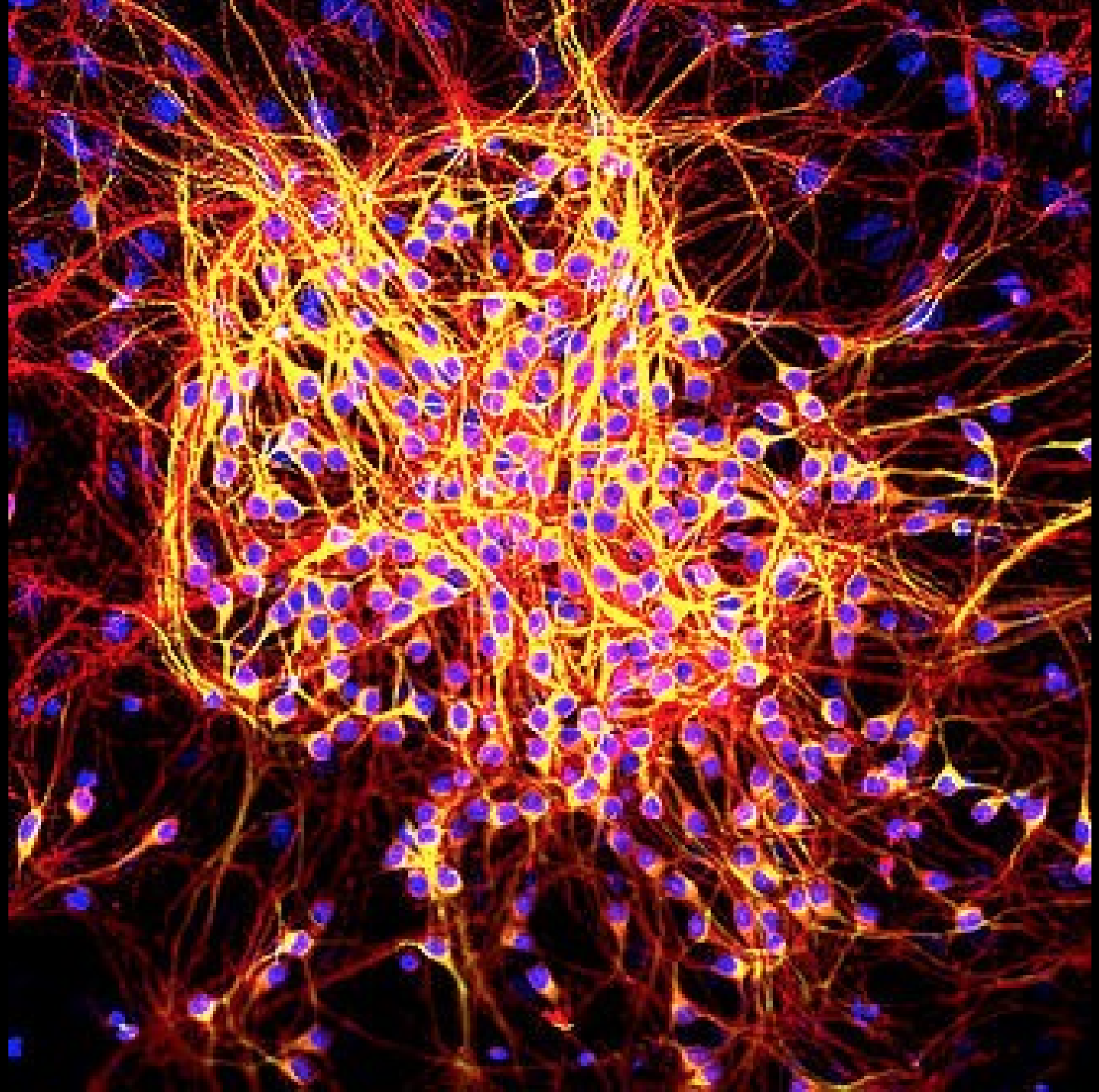
tional circumstances. We quantified scratching behavior of NC/NgaTnd mice during the development of dermatitis using a novel ana-

The results showed diminished number of plaque-activated microglia and astrocytes in cerebral cortex and hippocampus, increased ratio of nerve growth factor (NGF) to NGF precursor (proNGF), in turn promoting hippocampal neurogenesis after the *H. erinaceus* mycelia administrations

Itch is one of major clinical symptoms in atopic dermati-

exhibits various effects in periphery at an inflammatory con-





Docking Studies and Biological Evaluation of a Potential β-Secretase Inhibitor of 3-Hydroxyhericenone F from *Hericium erinaceus*

Chen Diling[1], Yong Tianqiao[1], Yang Jian[1], Zheng Chaoqun[1,2], Shuai Ou[1] and*

Molecular docking studies demonstrated 3-Hydroxyhericenone F, Hericenone G, Hericenone F, Hericerin, and Hericene B, respectively with potential activity against BACE1 inhibition

Reviewed by:
Luigia Trabace,

approximately more than 5% of the population worldwide over the age 65, annually. The incidence of AD is expected to be higher in the next 10 years. AD patients

Administration with *H. erinaceus* decreased the serum cytokine levels (IFN-γ, IL-1β , IL-17α, and TNF-α) and further decreased the production of ROS

Xie Yizhen
xieyizhen@126.com

Specialty section:

erinaceus were evaluated on a dementia rat model. The model was established by intraperitoneal injection of 100 mg/kg/d D-galactose in rats. The results indicated that the extracts can significantly ameliorate the learning and memory abilities. Specific active

Docking Studies and Biological Evaluation of a Potential β-Secretase Inhibitor of 3-Hydroxyhericenone F from *Hericium erinaceus*

Chen Diling[1], Yong Tianqiao[1], Yang Jian[1], Zheng Chaoqun[1,2], Shuai Ou[1] and Xie Yizhen[1]**

[1] State Key Laboratory of Applied Microbiology Southern China, Guangdong Provincial Key Laboratory of Microbial Culture

3HF can ameliorate neuronal damage by reversing the decreased levels of $[Ca^{2+}]_i$ and ROS and improve mitochondrial function, via the increase in mitochondrial membrane potential and ATP levels of the mitochondrial respiratory chain complexes

Washington University in St. Louis, USA

are required in order to improve the clinical responses and outcomes of AD. The purpose

Decreased expression levels of the AD intracellular markers BACE1, p-Tau, and $A\beta_{42}$

xieyizhen@126.com

intraperitoneal injection of 100 mg/kg/d D-galactose in rats. The results indicated that the extracts can significantly ameliorate the learning and memory abilities. Specific active

Specialty section:

Trovato *et al. Immunity & Ageing* (2016) 13:23
DOI 10.1186/s12979-016-0078-8

Immunity & Ageing

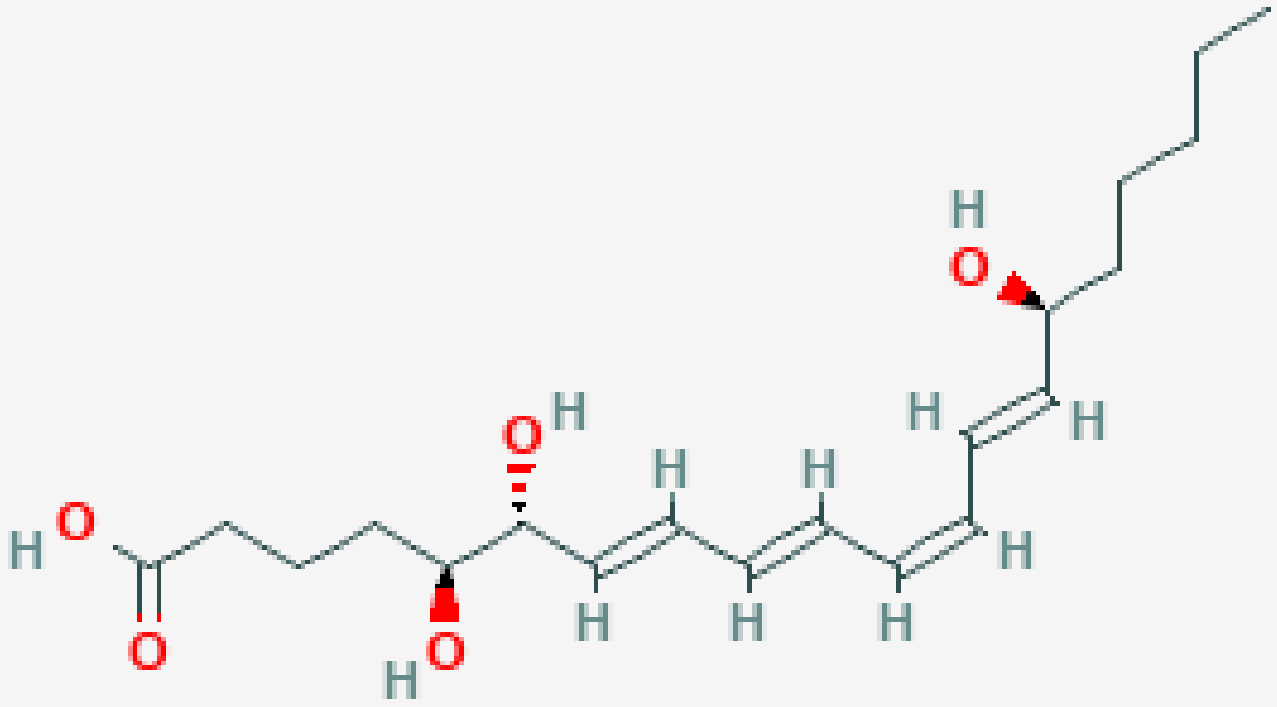
RESEARCH Open Access

Redox modulation of cellular stress response and lipoxin A4 expression by *Hericium Erinaceus* in rat brain: relevance to Alzheimer's disease pathogenesis

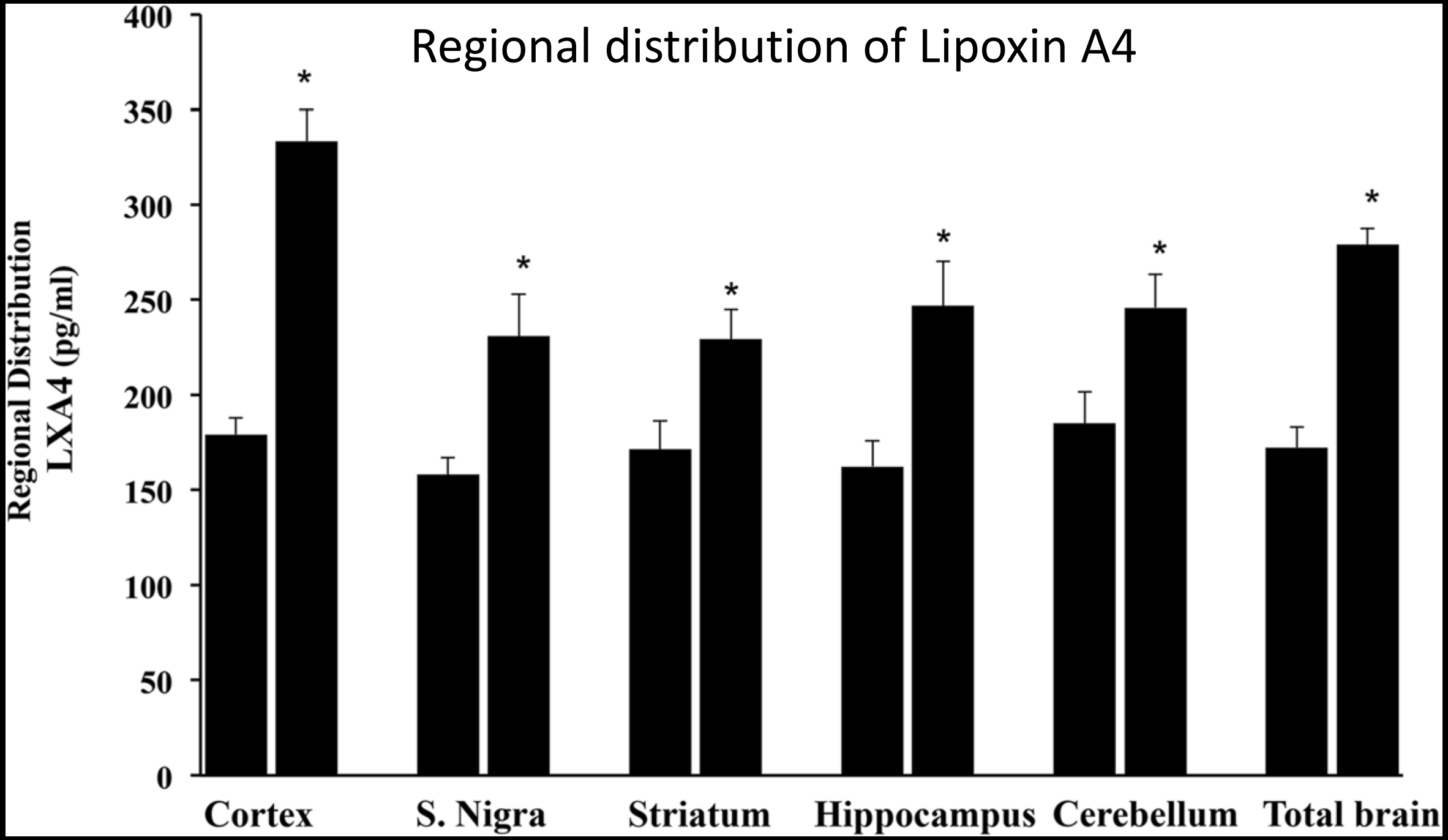
In a model of AD, oral administration of a mixture of *H. erinaceus* fruiting body and mycelium, was given for three months and demonstrated up-regulation of lipoxin A4 (LXA4) in the cortex > hippocampus > substantia nigra > striatum and cerebellum

used in traditional medicine for thousands of years, being now increasingly recognized as antitumor, antioxidant, antiviral, antibacterial and hepatoprotective agent also capable to stimulate host immune responses.

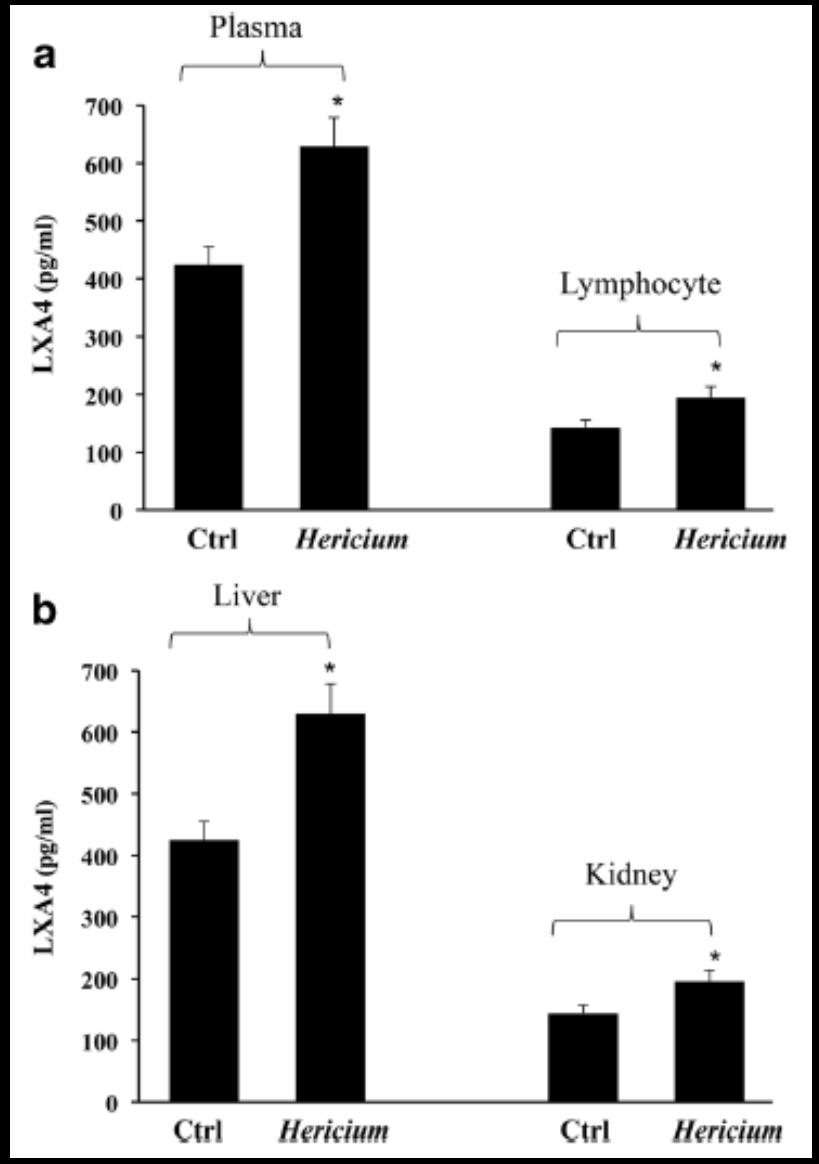
Lipoxin A4



Regional distribution of Lipoxin A4



Lipoxin in Tissues after *H. erinaceus* Feeding



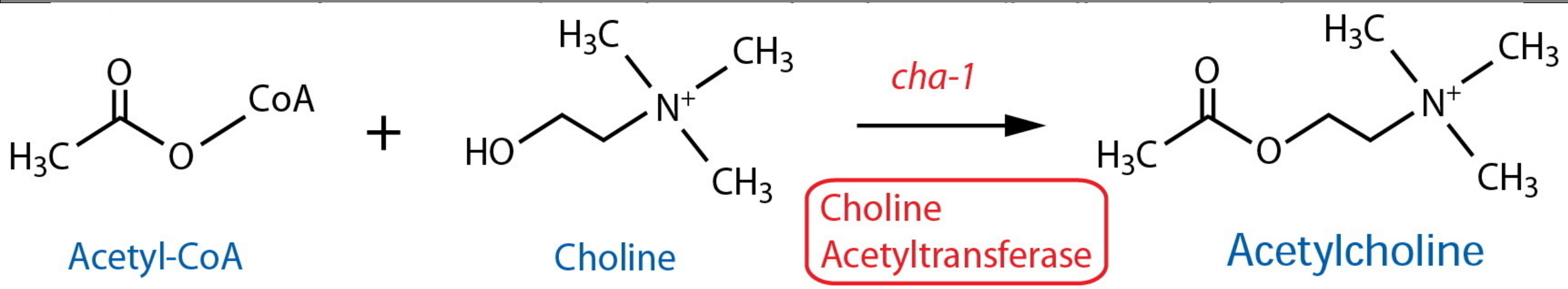
International Journal of *Molecular Sciences*

MDPI

Article

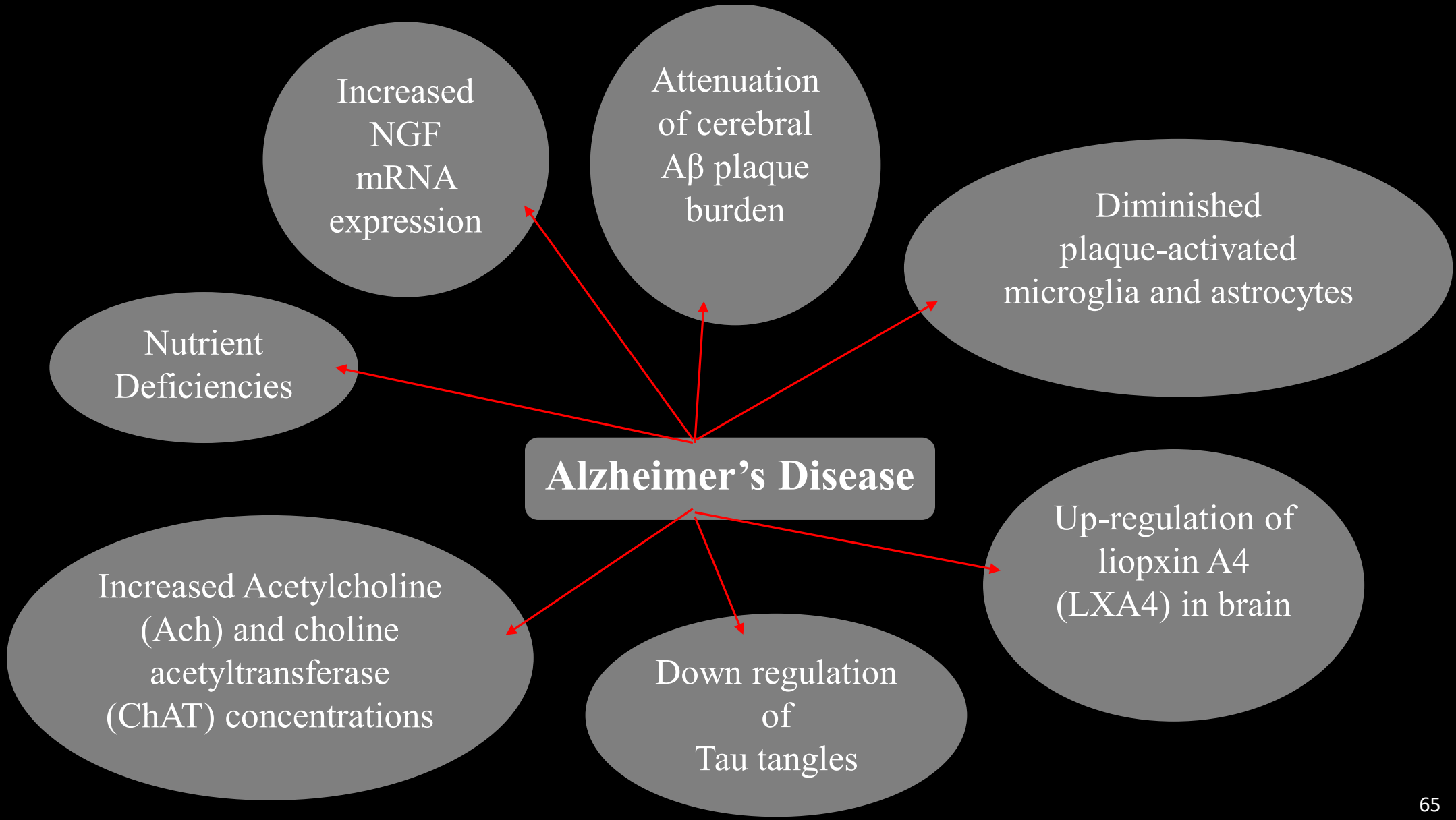
The Neuroprotective Properties of *Hericium erinaceus* in Glutamate-Damaged Differentiated PC12 Cells and an Alzheimer's Disease Mouse Model

In an animal model of AD, *H. erinaceus* successfully enhanced the acetylcholine and choline acetyltransferase concentrations in both the serum and the hypothalamus in a dose dependent manner



PC12 (DPC12) cellular apoptosis model and an $AlCl_3$ combined with D-galactose-induced

MOA of *H. erinaceus* in Alzheimer's disease



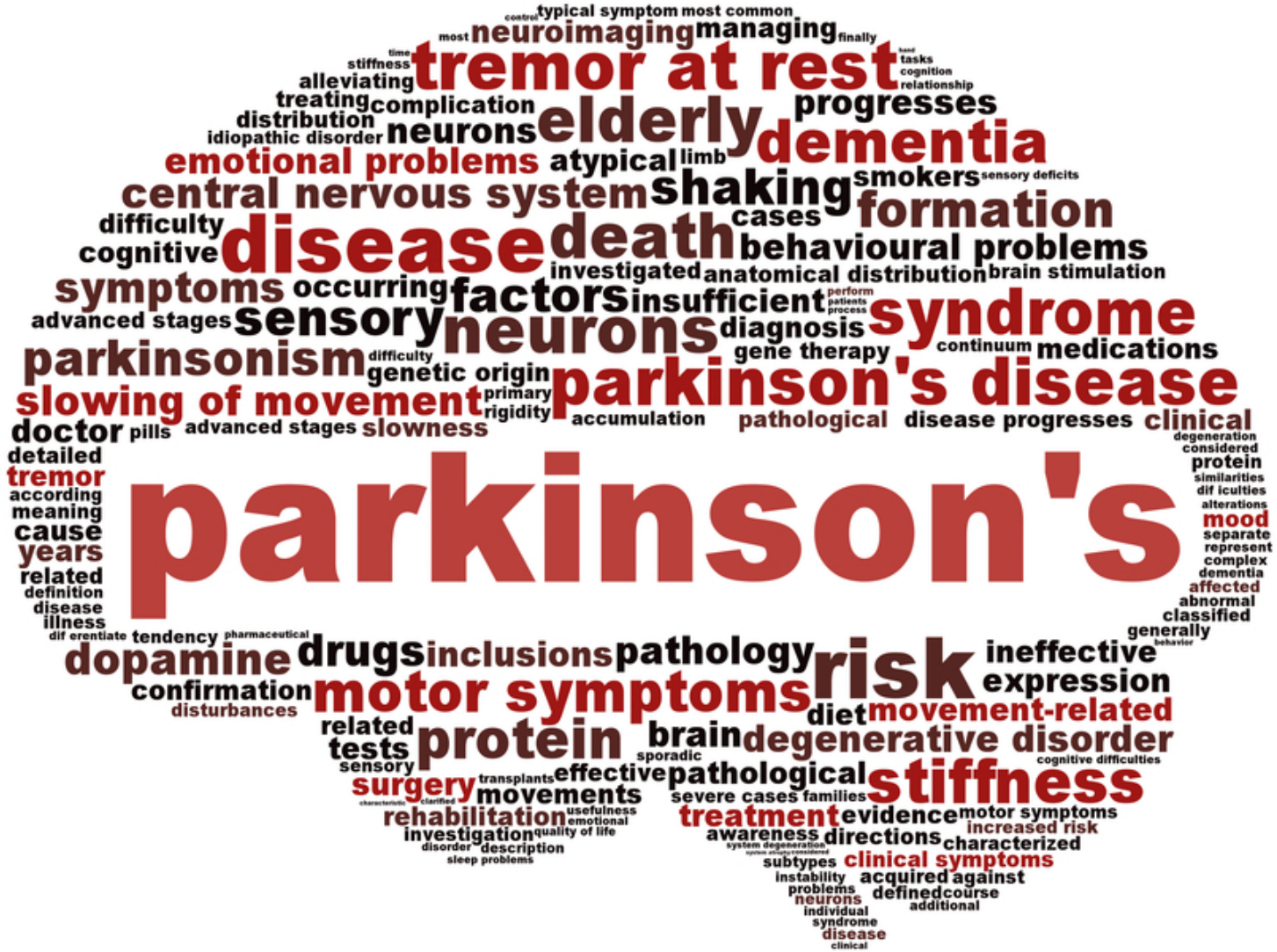
Nutrients associated with Dementia

Serum zinc in the normal range may be associated with low senile plaque counts in the elderly

Serum zinc levels significantly lower in dementia pts than controls who were not demented

Same results for a younger group just starting to show dementia signs

Tully CL, Snowdon DA, Markesbery WR. Serum zinc, senile plaques, and neurofibrillary tangles: findings from the Nun Study. *Neuroreport.* 1995 Nov 13;6(16):2105-8.
Hullin RP. Serum zinc in psychiatric patients. *Prog Clin Biol Res* 1983 129:197-206.


parkinson's
tremor at rest
disease
dementia
elderly
neurons
death
shaking
formation
syndrome
parkinson's disease
parkinsonism
slowing of movement
motor symptoms
risk
dopamine
drugs
protein
stiffness
degenerative disorder
central nervous system
emotional problems
behavioural problems
symptoms
factors
sensory
neuroimaging
managing
progresses
treatment
surgery
rehabilitation
movement-related
clinical symptoms
typical symptom most common
alleviating
treating
complication
distribution
idiopathic disorder
atypical
limb
smokers
sensory deficits
difficulty
cognitive
cases
investigated
anatomical distribution
brain stimulation
occurring
insufficient
diagnosis
advanced stages
gene therapy
continuum
medications
genetic origin
pathological
disease progresses
clinical
doctor
pills
advanced stages
slowness
accumulation
detailed
tremor
according
meaning
cause
years
related
definition
disease
illness
tendency
pharmaceutical
inclusions
pathology
ineffective
expression
confirmation
disturbances
diet
related
tests
brain
sporadic
cognitive difficulties
sensory
effective
pathological
movements
severe cases
families
evidence
motor symptoms
increased risk
awareness
directions
characterized
subtypes
instability
acquired
against
problems
defined
course
neurons
additional
individual
syndrome
disease
clinical
degeneration
considered
protein
similarities
dif iculties
alterations
mood
separate
represent
complex
dementia
affected
abnormal
classified
generally
behavior
transplants
usefulness
emotional
quality of life
description
sleep problems
tasks
cognition
relationship
finally
most
stiffness
time
control
hand
perform
patients
process

Kuo et al. J Transl Med (2016) 14:78
DOI 10.1186/s12967-016-0831-y

Journal of Translational Medicine

RESEARCH Open Access

Hericium erinaceus mycelium and its isolated erinacine A protection

In vivo data showed oxidative stress and dopaminergic lesions in the striatum and substantia nigra significantly improved after 25 days of oral treatment with *H. ericanceus* mycelia at low doses (10.76 or 21.52 mg/d).

Consistent with cell culture results, MPTP protection by HEM and erinacine A treatment appeared to be due to a significant reduction of Fas expression in the mouse model.

Peripheral Nerve Injury

International Journal of Medicinal Mushrooms, 14(5): 427–446 (2012)

Neuroregenerative Potential of Lion's Mane Mushroom, *Hericium erinaceus* (Bull.: Fr.) Pers. (Higher Basidiomycetes), in the Treatment of Peripheral Nerve Injury (Review)

Aqueous extract of HEFB (pretreatment of 10 mL/kg 1:1 aqueous extract x 14 days) improved nerve regeneration and increased the rate of motor functional recovery after crush injury. The HEFB animals recovered to pre-surgery values 4 to 7 days earlier than animals in the control group as assessed by walking track analysis.

bodies in promoting functional recovery following crush injury to the peroneal nerve in adult female Sprague-Dawley

Normal toe spreading, was achieved 5 to 10 days earlier in the aqueous extract group than in the control group. HEFB aqueous extract promoted peripheral nerve regeneration with significant functional recovery.

dorsal root ganglia neurons ipsilateral to the crush injury in rats of treated groups expressed higher immunoreactivities

Clinical Trials

PHYTOTHERAPY RESEARCH
Phytother. Res. **23**, 367–372 (2009)
Published online 10 October 2008 in Wiley InterScience
(www.interscience.wiley.com) **DOI**: 10.1002/ptr.2634

Improving Effects of the Mushroom Yamabushitake (*Hericium erinaceus*) on Mild Cognitive Impairment: A Double-blind Placebo-controlled Clinical Trial

50-80 year old Japanese adults diagnosed with mild cognitive impairment, 250 mg tablets of dry *H. erinaceus* powder (TID x 4 wk) showed marked improvement in revised Hasegawa Dementia Scale (HDS-R) as compared to the placebo group

of Yamabushitake (*Hericium erinaceus*), an edible mushroom, for improving cognitive impairment, using a cognitive function scale based on the Revised Hasegawa Dementia Scale (HDS-R). After 2 weeks of preliminary examination, 30 subjects were randomized into two 15-person groups, one of which was given Yamabushitake and the other given a placebo. The subjects of the Yamabushitake group took four 250 mg tablets containing 96% of Yamabushitake dry powder three times a day for 16 weeks. After termination of the intake, the

Biomedical Research **31** (4) 231-237, 2010

Reduction of depression and anxiety by 4 weeks *Hericium erinaceus* intake

Mayumi NAGANO[1], Kuniyoshi SHIMIZU[†2], Ryuichiro KONDO[2], Chickako HAYASHI[3], Daigo SATO[4], Katsuyuki KITAGAWA[4] and Koichiro OHNUKI[3]

In a study of questionable quality, HEFB (2.0 g/d in cookies over 4 weeks) showed a reduction in some symptoms of anxiety and depression in menopausal women (n = 30).

ABSTRACT

Using the Indefinite Complaints Index categories for palpitation and incentive showed a statistically significant improvement compared to placebo. For the categories of irritating (p=0.076), anxious (p=0.067) and concentration (0.090) there were trends of improvement as compared to placebo.

than that before. In two terms of the ICI, “insentive” and “palpitation”, each of the mean score of

Posology

Cognition & NGF production

H. erinaceus at doses 3 g (98% *H. erinaceus* powder) showed significant improvement in dementia rating scale in general cognitive decline subjects in a clinical trial

Mori K, *et al* Improving effects of the mushroom Yamabushitake (Hericium erinaceus) on mild cognitive impairment: a double-blind placebo-controlled clinical trial. *Phytother Res*. (2009)

Cognition & NGF production

3–5 g/day is the recommended daily dosage of dried fruiting body of *H. erinaceus* for increasing NGF production

Chinese pharmacopoeia, 2010. Beijing:Chinese Medicine Science and Technology Publishing House.

Cognition & NGF production

In a study on anxiety and depression, 2.0 g/d of *Hericium* fruiting body (in cookies) was the dose utilized

Nagano M, et al. Reduction of depression and anxiety by 4 weeks Hericium erinaceus intake. *Biomed Res.* (2010)

Safety

Toxicology

In an *in vitro* model, HEFB aqueous extract on MRC-5 and NG108-15 cell lines showed a remarkable lack of cytotoxicity. The IC_{50} value for MRC cells was 34.095 $\pm$ 1.200 mg/mL and for NG108-15 cells it was 17.446 $\pm$ 1.548 mg/mL

Lai PL, Naidu M, Sabaratnam V, Wong KH, David RP, Kuppusamy UR, Abdullah N, Malek NA. Neurotrophic properties of the Lion's mane medicinal mushroom, Hericium erinaceus (Higher Basidiomycetes) from Malaysia. *Int J Med Mushrooms* 2013, 15 (6): 539-54.

Toxicology

In an animal model, toxicology studies on *H. erinaceus* suggest that *H. erinaceus* mycelia, enriched with 5 mg/g erinacine A at doses up to 5 g/kg bodyweight are safe

Li, I.C., Chen, Y.L., Lee, L.Y., Chen, W.P., Tsai, Y.T., Chen, C.C., Chen, C.S., 2014. Evaluation of the toxicological safety of erinacine A-enriched Hericium erinaceusin a 28-day oral feeding study in Sprague-Dawley rats. Food Chem. Toxicol. 70, 61-67.

Toxicology

In clinical trials no toxicity has been reported

Nagano M, Shimizu K, Kondo R, Hayashi C, Sato D, Kitagawa K, Ohnuki K.Reduction of depression and anxiety by 4 weeks Hericium erinaceus intake. Biomed Res. 2010 Aug;31(4):231-7.
Mori K, Inatomi S, Ouchi K, Azumi Y, Tuchida T. Improving effects of the mushroom Yamabushitake (Hericium erinaceus) on mild cognitive impairment: a double-blind placebo-controlled clinical trial. Phytother Res. 2009 Mar;23(3):367-72.

Reported Adverse Events

In a double-blind, placebo controlled trial on 50-80 year old Japanese with *H. erinaceus* mycelia (250 mg tablets of 96% dry powder) for 16 weeks, there was no adverse events reported clinically or biochemically in all the study subjects

Mori K, Inatomi S, Ouchi K, Azumi Y, Tuchida T. Improving effects of the mushroom Yamabushitake (Hericium erinaceus) on mild cognitive impairment: a double-blind placebo-controlled clinical trial. Phytother Res. 2009 Mar;23(3):367-72.

Reported Adverse Events

One study subject in a clinical trial on menopausal depression, reported epimenorrhea and discontinued intake of *H. erinaceus* fruiting body cookies

The possibility of *H. erinaceus* resulting in epimenorrhea in this trial could not be conclusive

Nagano M, Shimizu K, Kondo R, Hayashi C, Sato D, Kitagawa K, Ohnuki K.Reduction of depression and anxiety by 4 weeks Hericium erinaceus intake. Biomed Res. 2010 Aug;31(4):231-7.

Sensitivities and Allergies

Case report of a 53 y/o male occupationally exposed to *H. erinaceus* fruiting body, after 1 mo developed chronic dermatitis on his finger pulp and dorsa of hands, with painful fissures.

The dermatitis spread to his forearms, face and legs at which point exposure discontinued and symptoms resolved

Maes MF, van Baar HM, van Ginkel CJ. Occupational allergic contact dermatitis from the mushroom White Pom Pom (Hericium erinaceum). Contact Dermatitis 1999 May;40(5):289-90.


Thank You