

# FOOD AS MEDICINE:

## LION'S MANE MUSHROOM

### *HERICIUM ERINACEUS*

By

Kevin KF Ng, MD. PhD  
Former Associate Professor of Medicine  
Division of Clinical Pharmacology  
University of Miami, Miami, FL, USA

Email: [kevinng68@gmail.com](mailto:kevinng68@gmail.com)

A slide presentation for HealthCare Provider Seminar Jan 2019



# Lecture outline

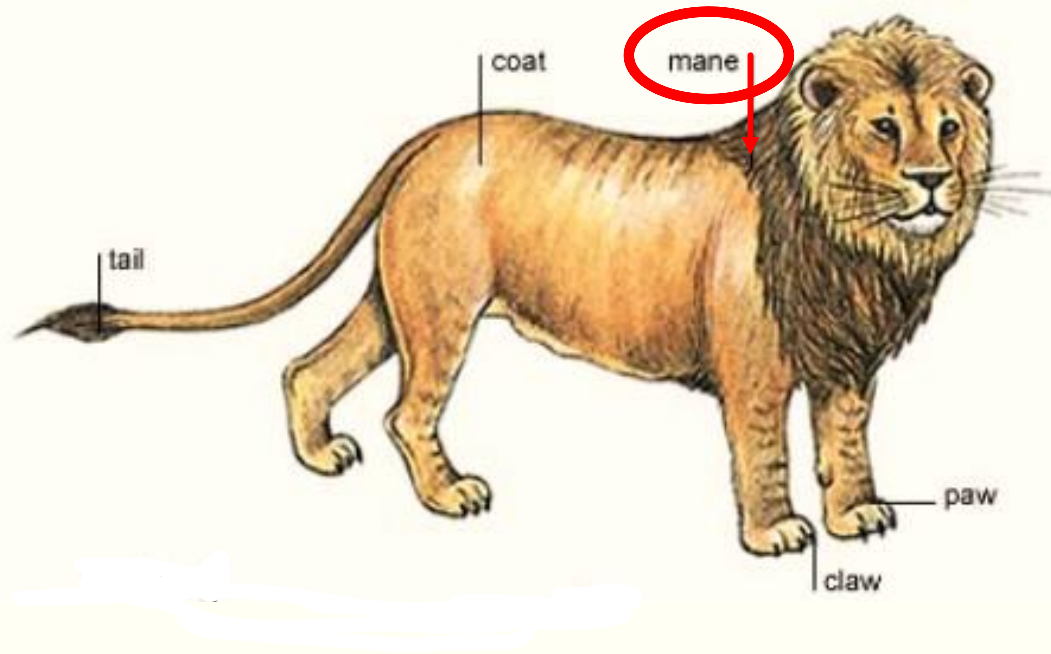
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- What is a lion's mane mushroom?
- Stats, cultivation, scientific classification
- Anatomy, life cycle
- Nutrients and bioactive compounds
- Health benefits
- Pharmacological effects, interactions, toxicity
- Clinical studies
- Summary

# What is a Lion's Mane Mushroom

## *(Hericium erinaceus)*

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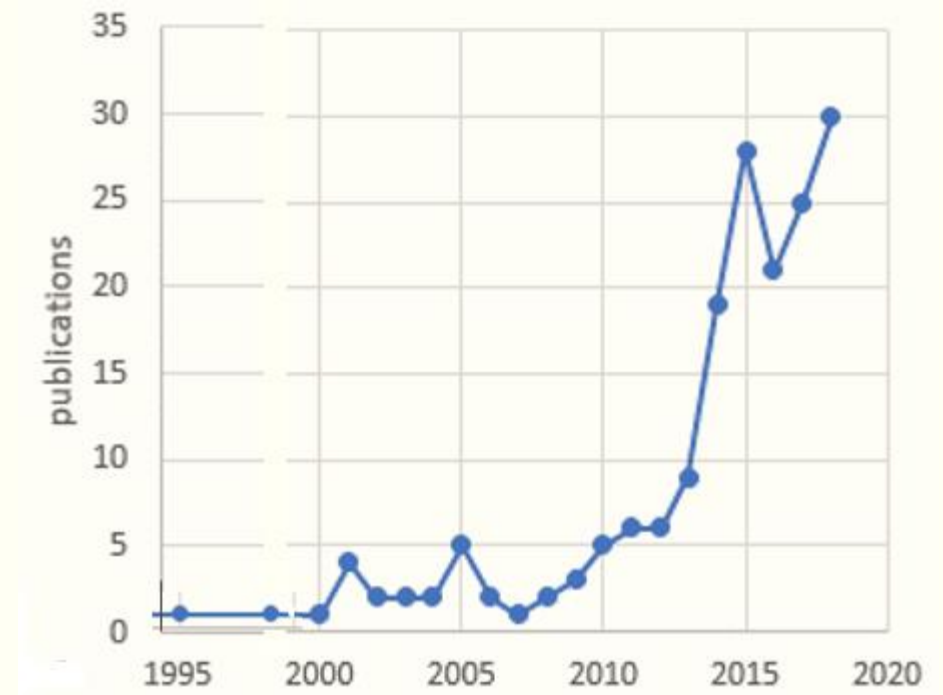


# Advances in the scientific study of lion's mane mushroom:

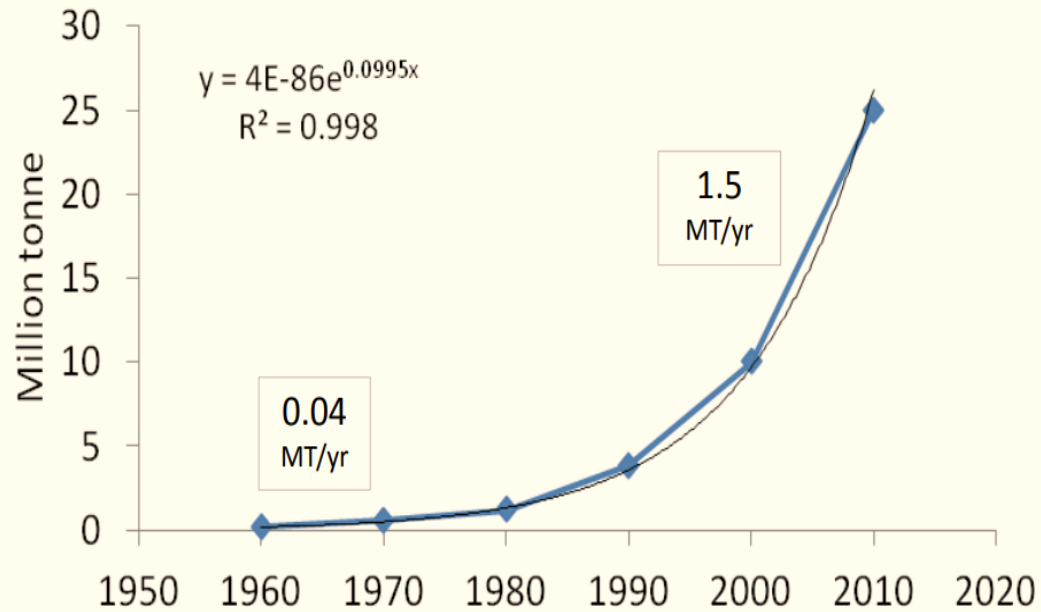
number of publication in PubMed from 2000 to 2018

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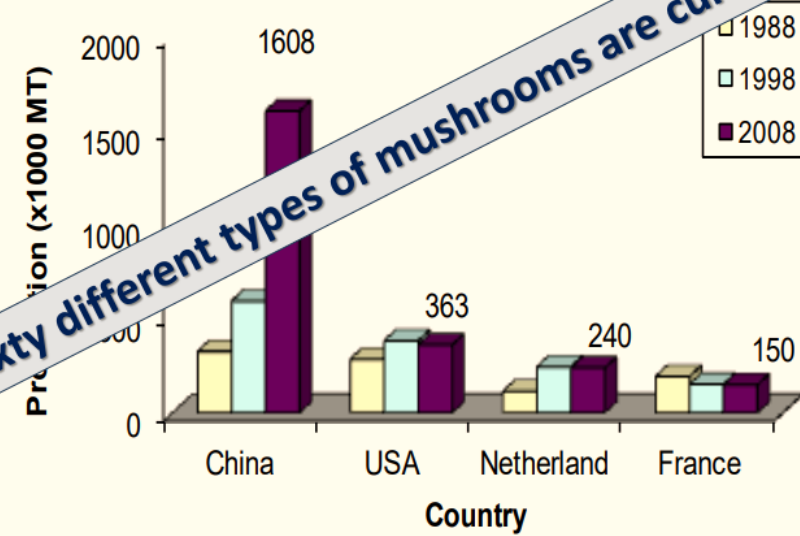
- Scientific studies on lion's mane began In 2000.
- Major areas of interest are:
  - Immune system: **Immune-modulation**
  - Nervous system:
    - Nerve growth factor
    - Neuro-regeneration
    - Neuroprotection
    - **Cognition**
    - Nerve injury
  - Cardiovascular system:
    - Blood pressure
    - Lipids and cholesterol
  - Neoplasm: **anti-cancer**



**World Mushroom Production (Million Tonne)**  
(Estimates - All mushrooms)



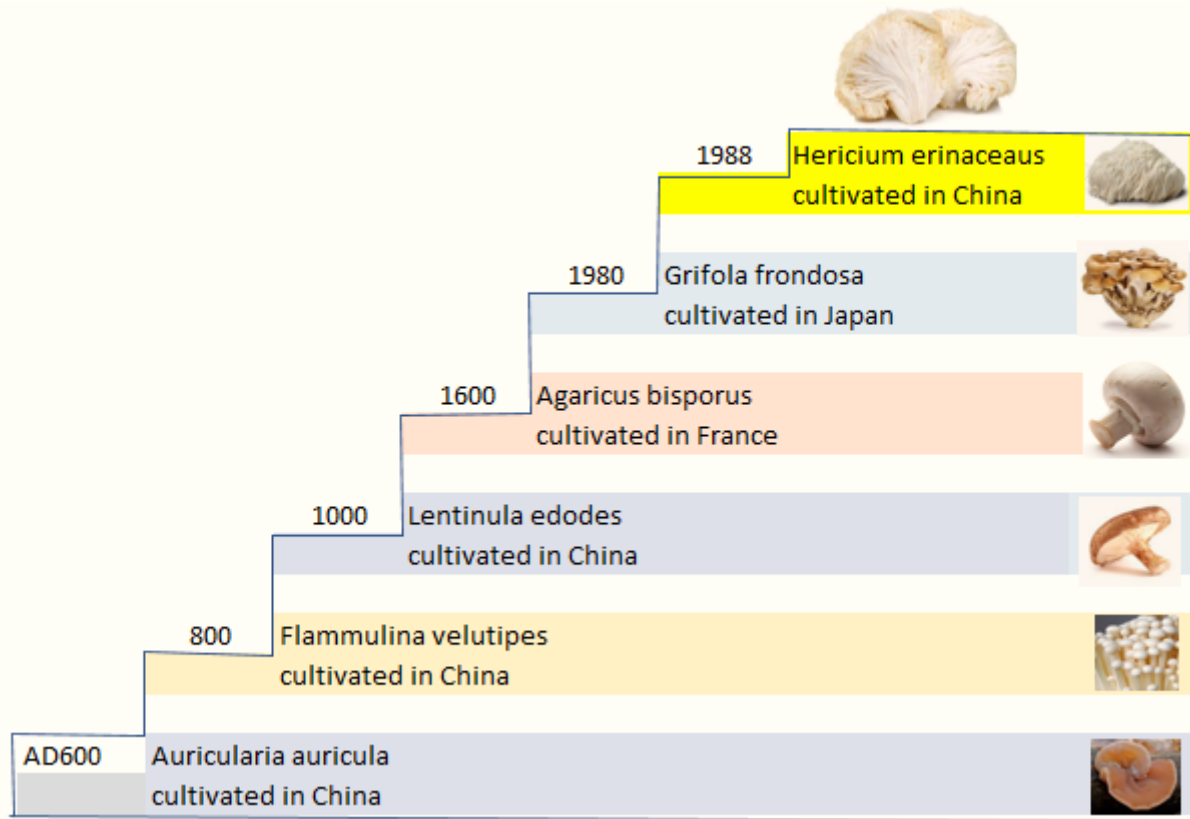
**Mushroom production in major mushroom growing countries in last three decades**



**Sixty different types of mushrooms are cultivated in China**



# Cultivation of Lion's mane (*Hericium erinaceus*) mushroom



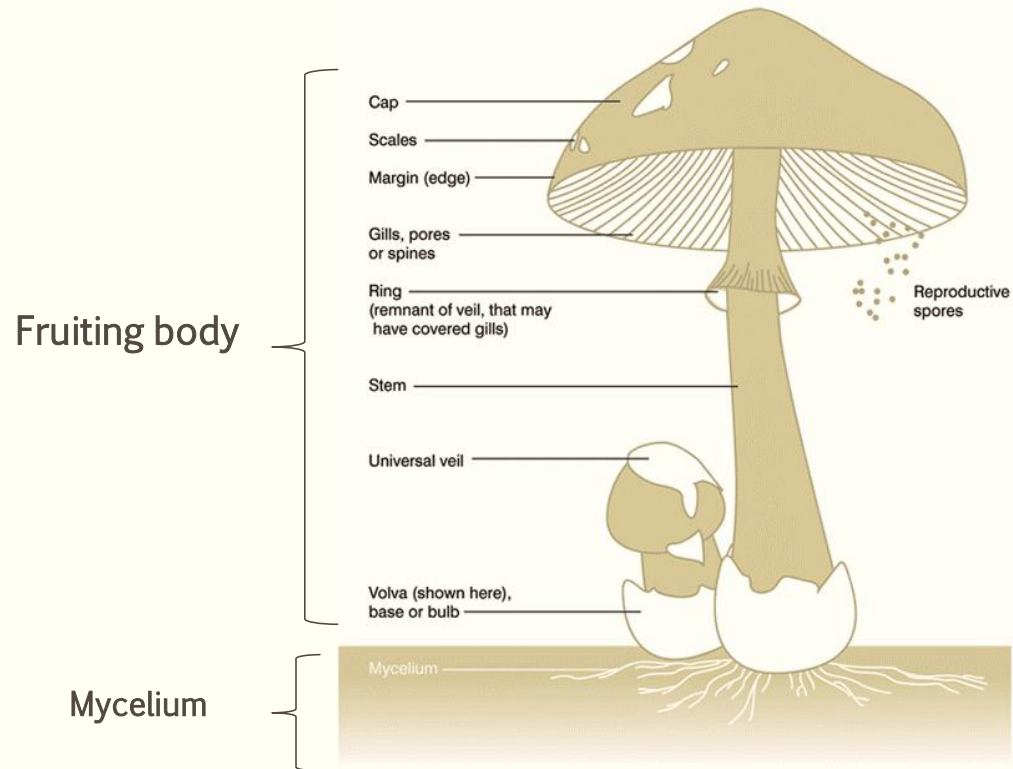
# Scientific classification of Lion's Mane (*Hericium erinaceus*)

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Kingdom	Fungi
Division	Basidiomycota
Class	Agaricomycetes
Order	Russulales
Family	Hericeae
Genus	Hericium
Species	H. erinaceus



# Anatomy of a typical mushroom vs lion's mane mushroom



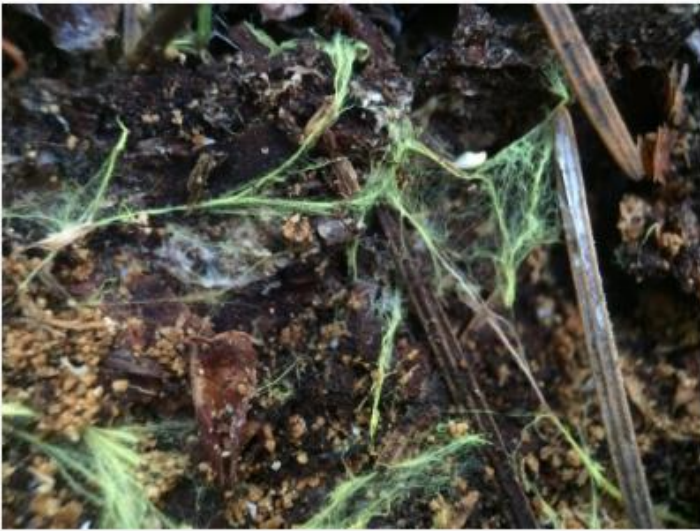
Fruiting body

spore-bearing spines



# Mycelium of a mushroom

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# Life cycle of a mushroom

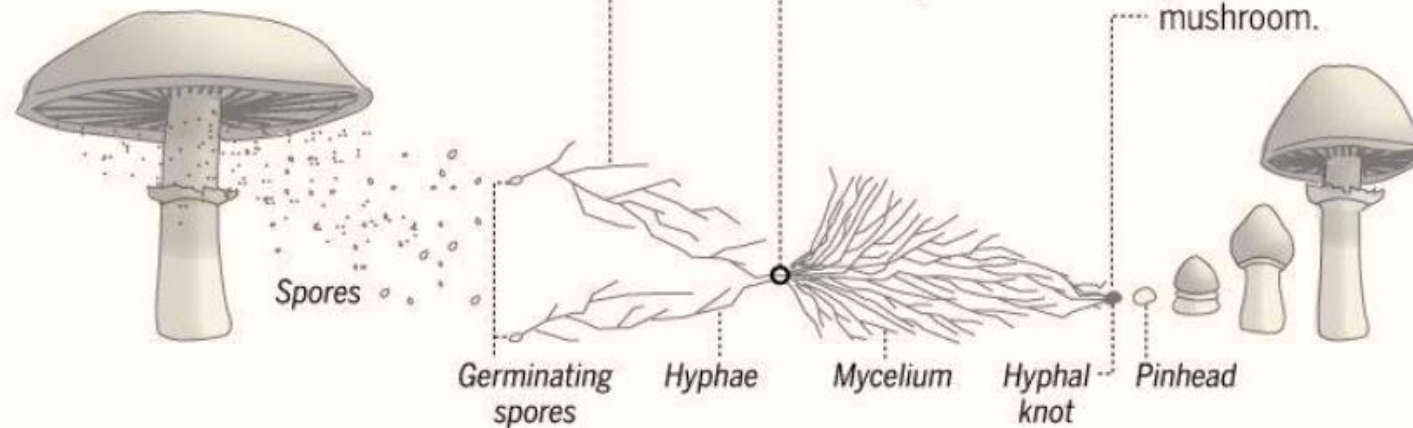
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A mushroom releases millions of tiny spores into the air, each one with half the genetic code necessary for a new mushroom.

In the right conditions, a spore germinates, growing thread-like structures, called hyphae, through the soil.

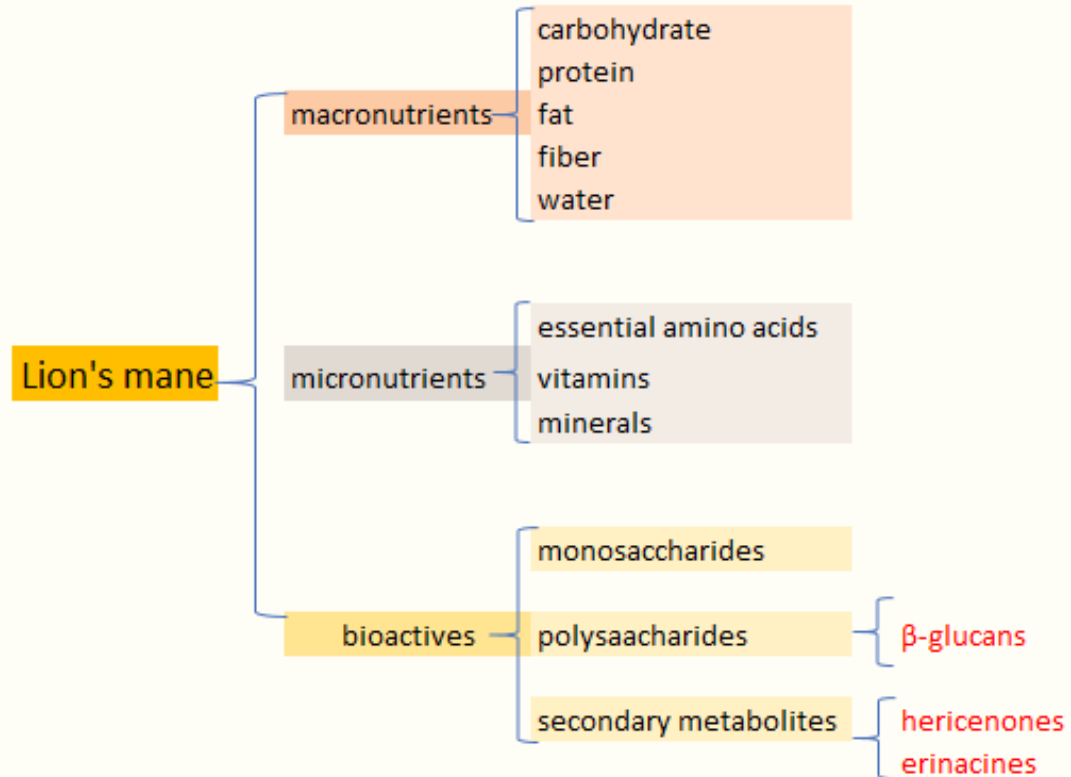
The hyphae fuse with hyphae from a compatible spore to form a thread with a complete genetic code called mycelium.

The fused hyphae eventually form a hyphal knot that develops into a pinhead, then sprouts and grows into a new mushroom.



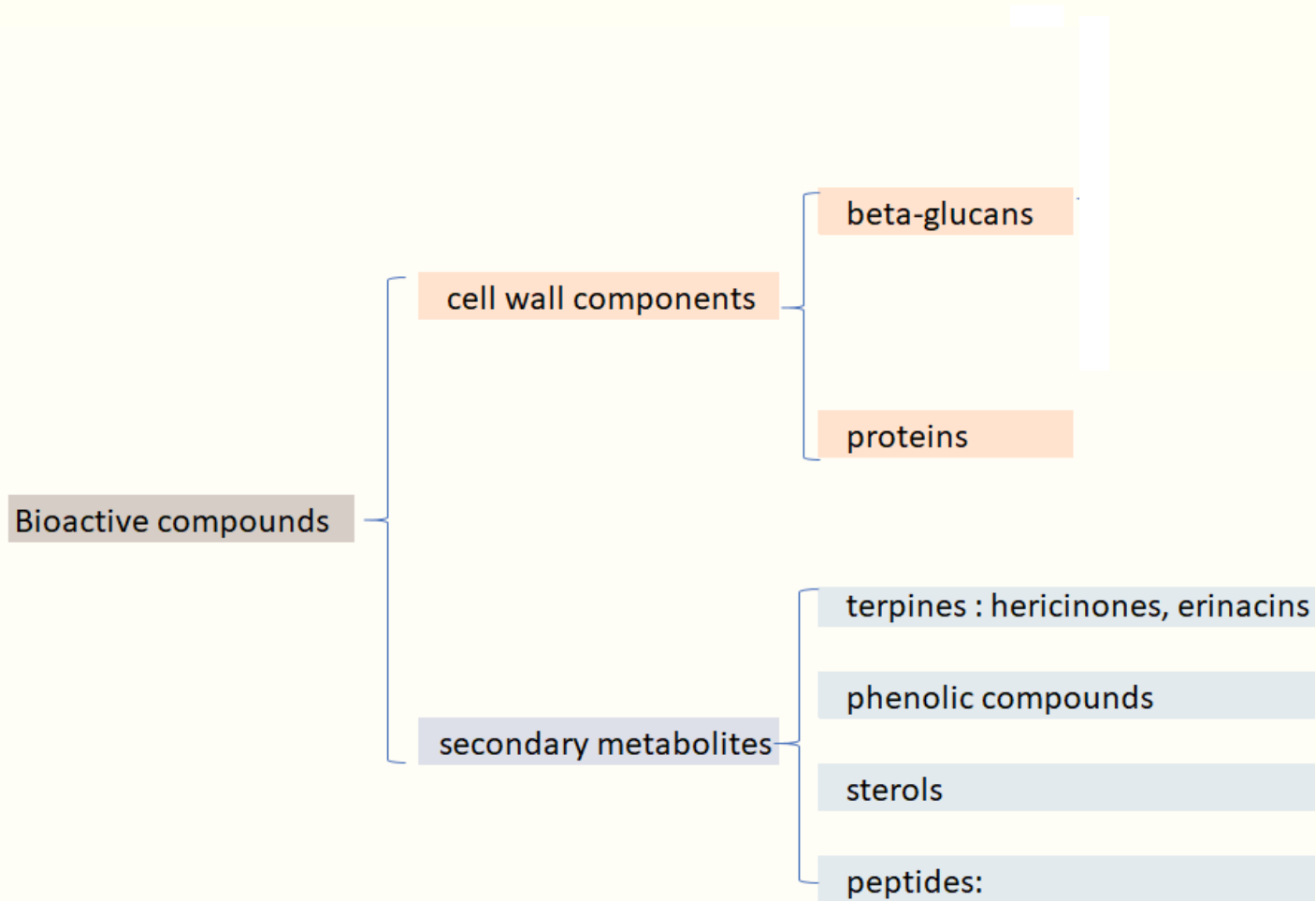
# Nutrient composition of Lion's mane (*Hericium erinaceus*)

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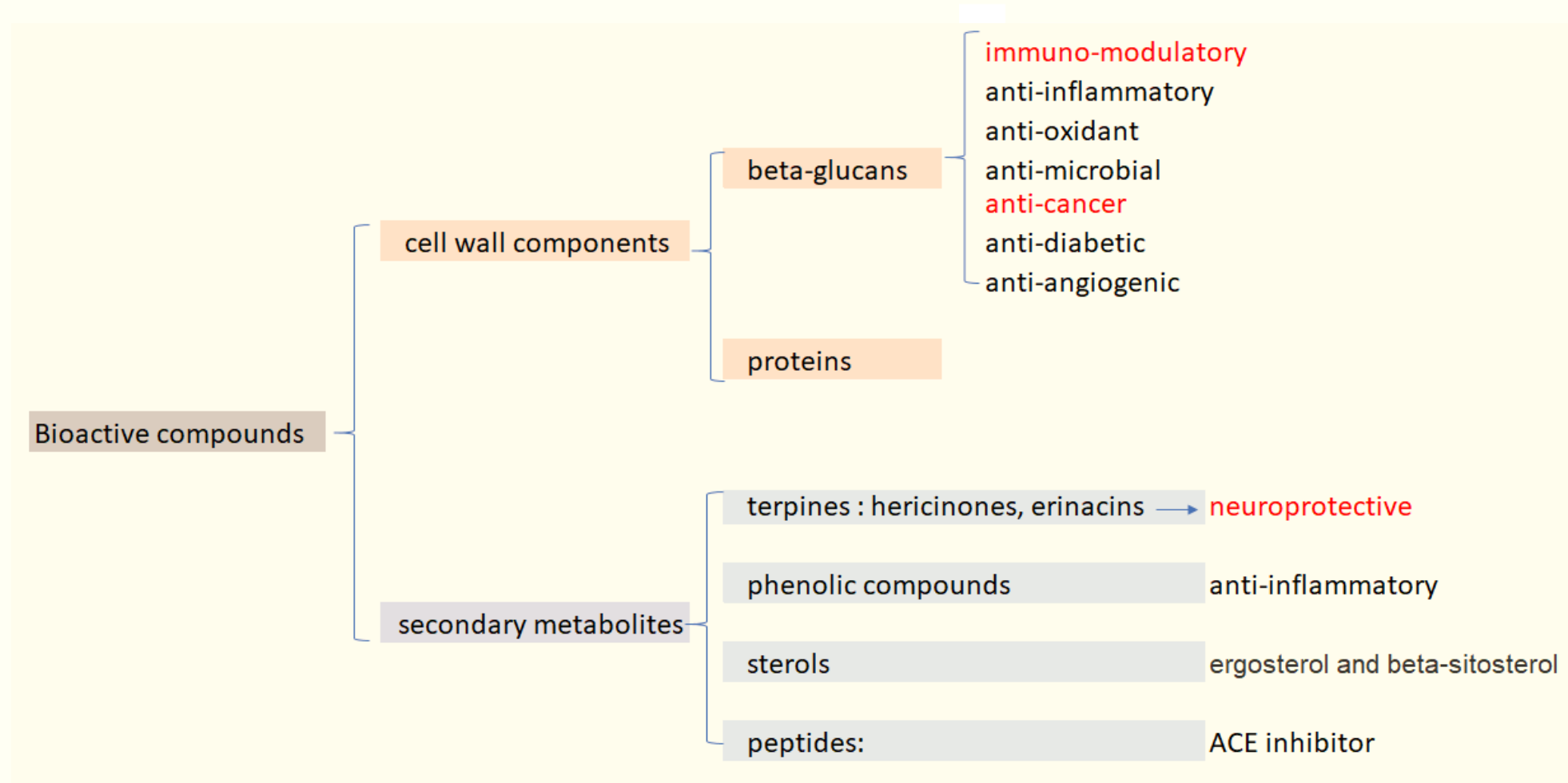
# Bioactive compounds of Lion's Mane (*Hericium erinaceus*)

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# Bioactive compounds & functions of Lion's Mane (*Hericium erinaceus*)

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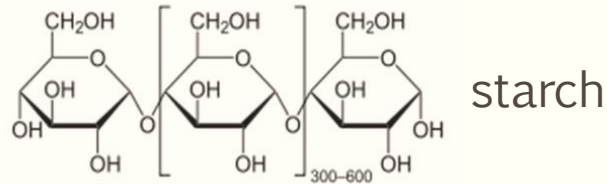




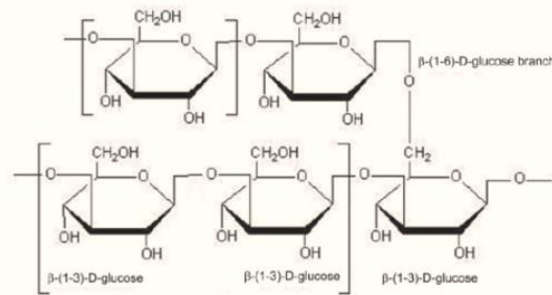
# What is a polysaccharide?

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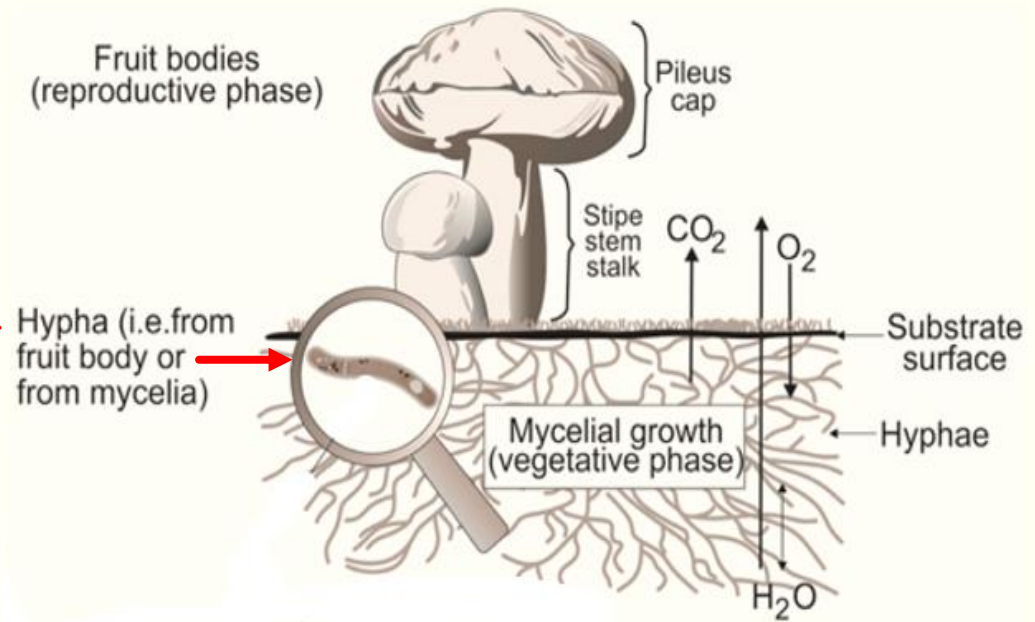
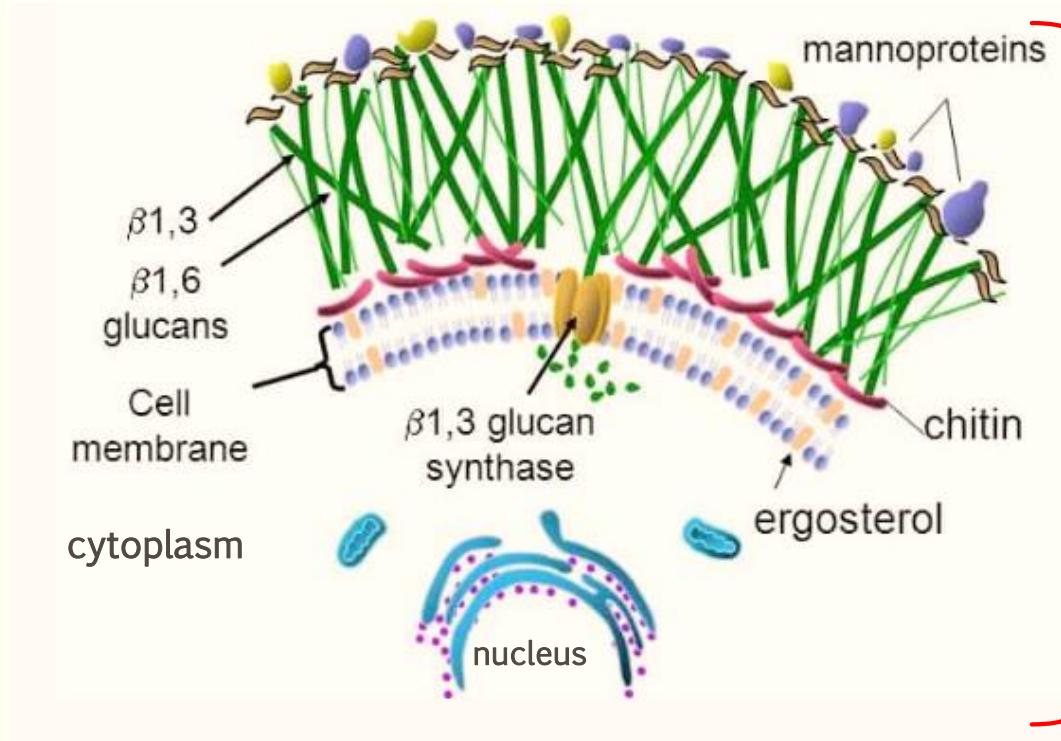
- A long chain of carbohydrate consisting of a number of sugar molecules bonded together, e.g. starch, cellulose or glycogen.



- The polysaccharide from lion's mane mushroom (hericium mane) is called beta-glucan.



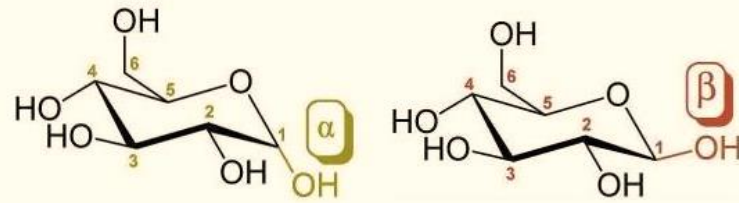
# Location of $\beta$ -glucans in mushroom cell wall



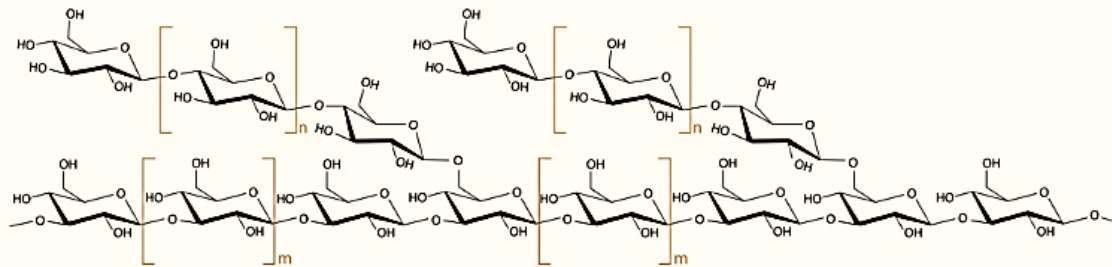
Adapted from <https://www.sciencedirect.com/science/article/pii/S2405805X16300230>  
<http://www.nammex.com/redefining-medicinal-mushrooms/>

# What is a beta-glucan?

- Beta ( $\beta$ ) refers to the orientation of the linkage bond.



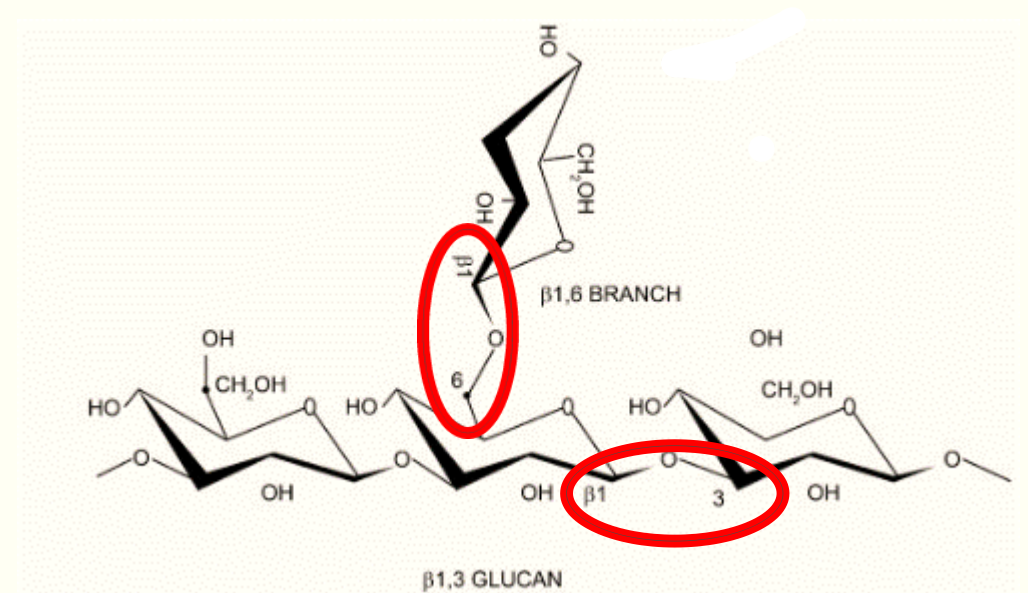
- Glucan molecule is a polysaccharide of D-glucose monomers, linked by glycosidic bonds.



# What is a Beta-1, 3 and Beta-1,6 Glucan?

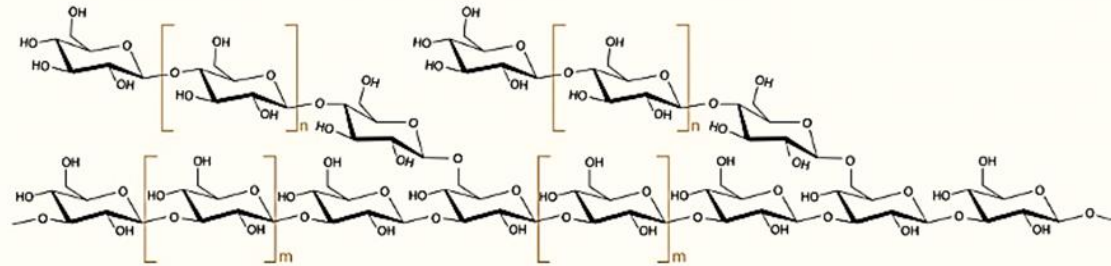
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- **Beta** refers to the structural configuration of the molecule.
- **Glucan** refers to a polysaccharide of D-glucose monomers, linked by glycosidic bonds
- The number **1,3** and **1,6** refers to the glycosidic linkage and bonding of the glucose molecule



# What is the main function of $\beta$ -glucan

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Beta-1, 3 and Beta-1,6 Glucan

- Immune System Booster or
- Biological Response Modifier

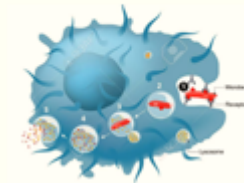


# Effects of $\beta$ -glucans on the Immune System

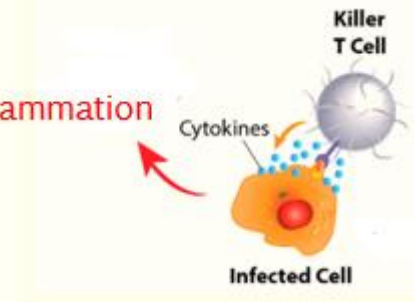
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- Removal of dead cells by phagocytosis.
- Destruction of cancer cells by lysis.
- Generation and release of cytokines.
- Communication with immune cells.
- Protection from fungi, bacteria and virus.

Phagocytosis

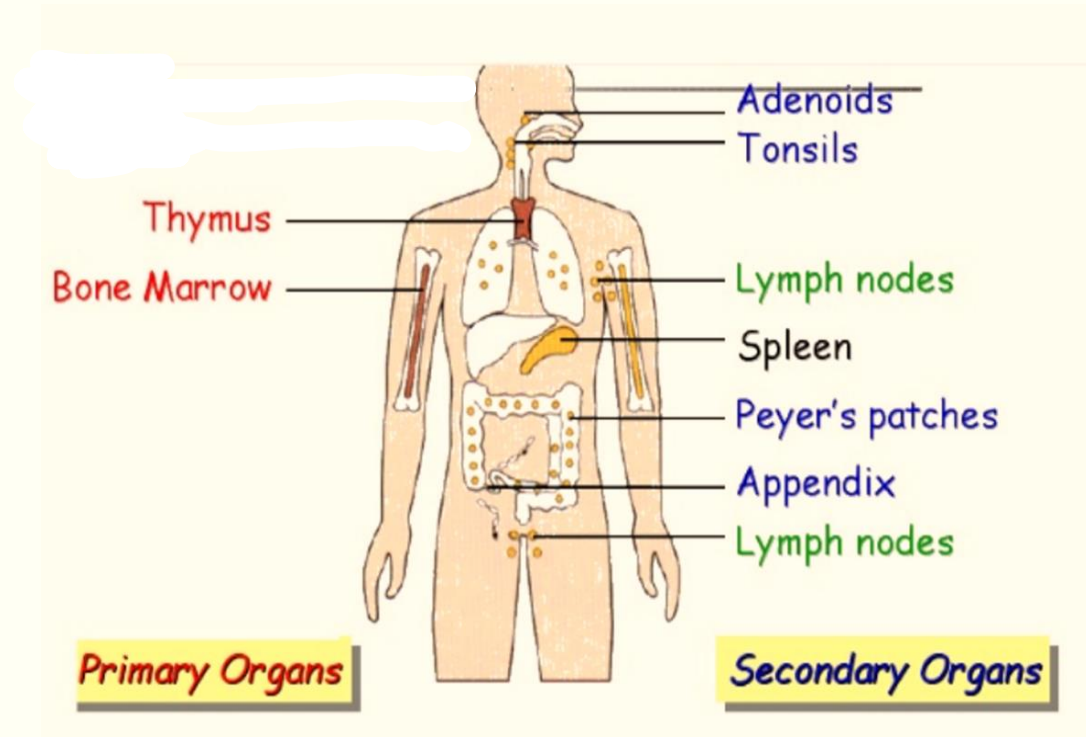
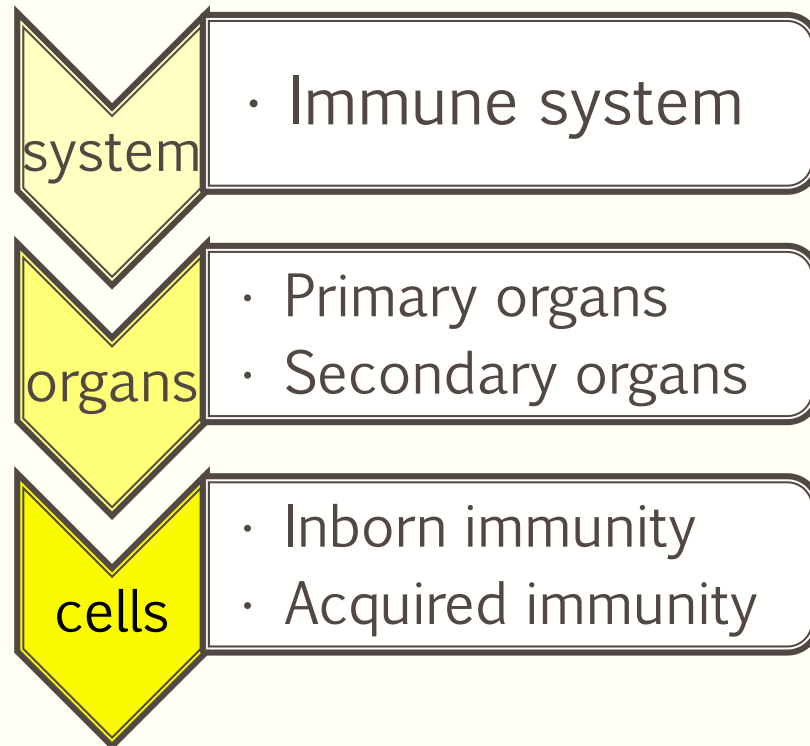


Inflammation



# What is the Immune System?

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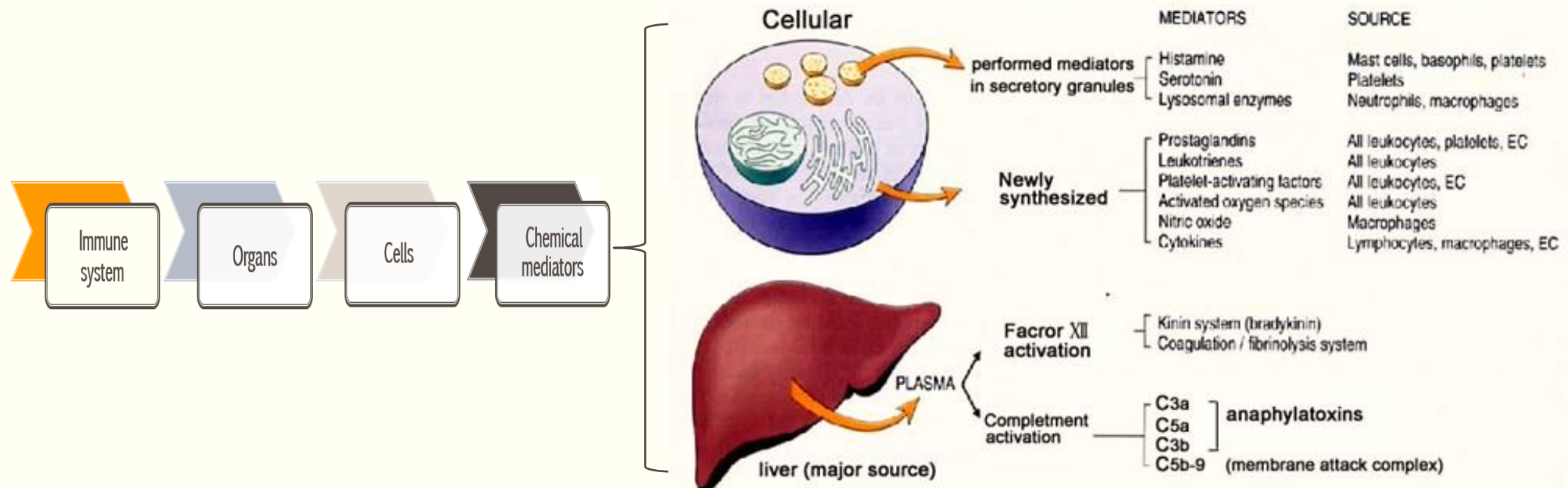
# Components of the immune system

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# The components of the immune system:

## Cell derived and plasma derived chemical mediators



# Components of the immune system

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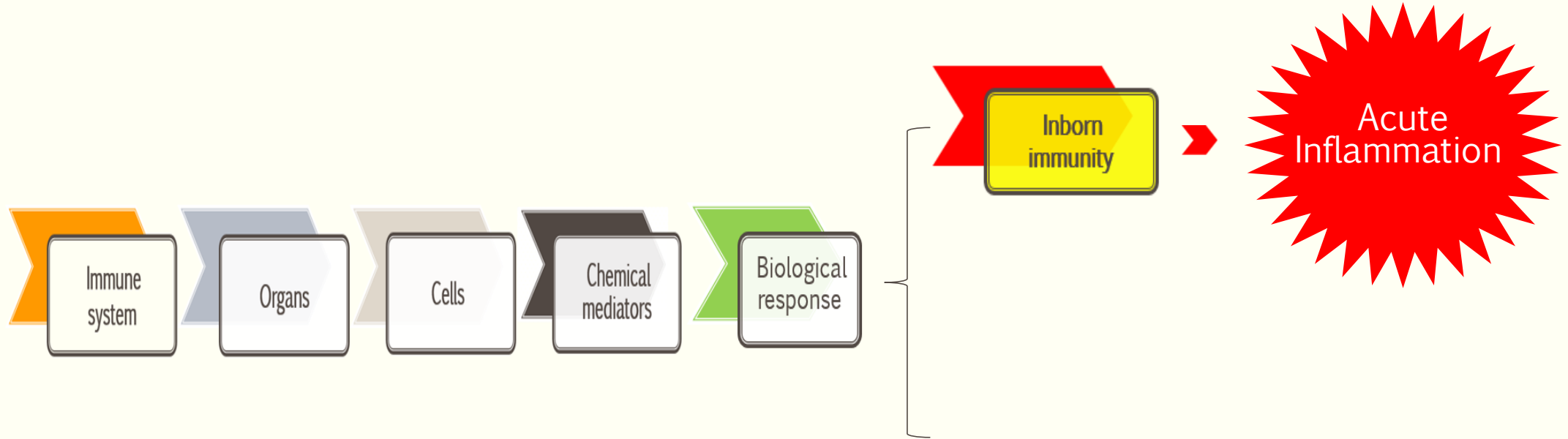




# Functions of the immune system:

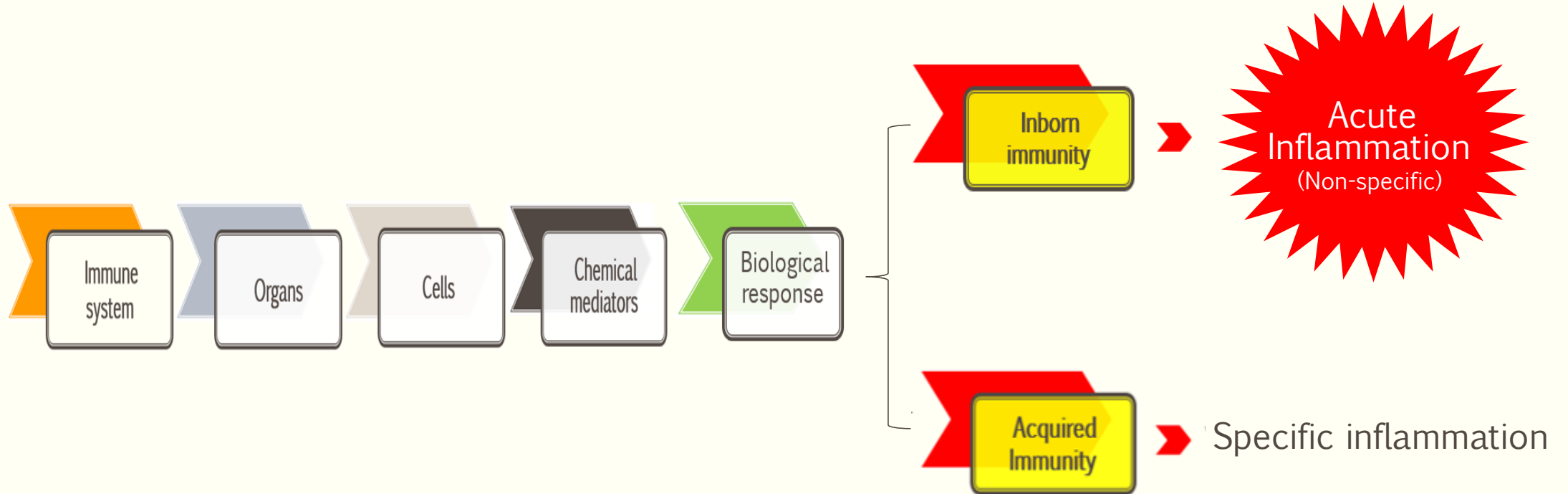
## Biologic response

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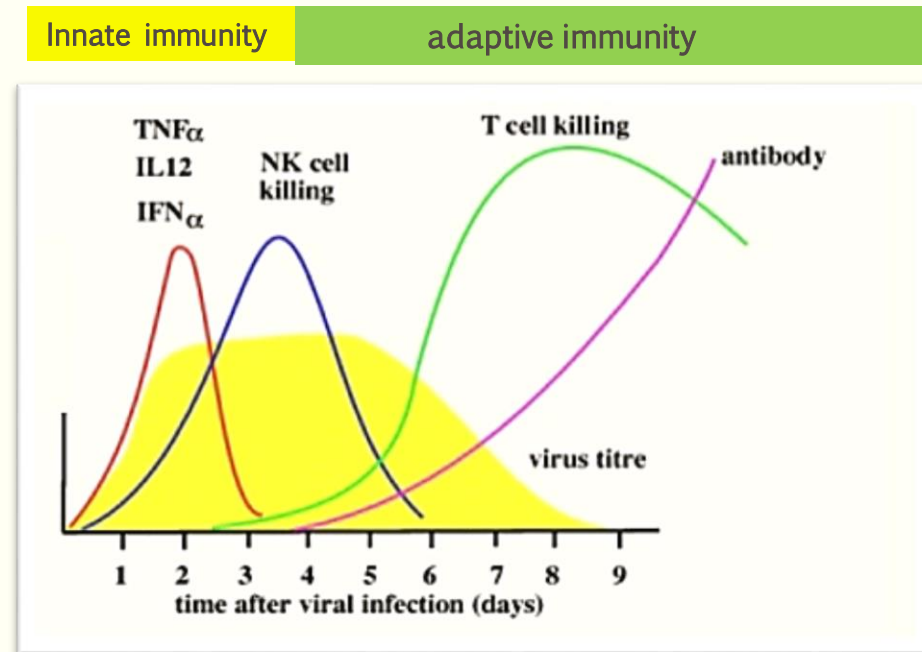
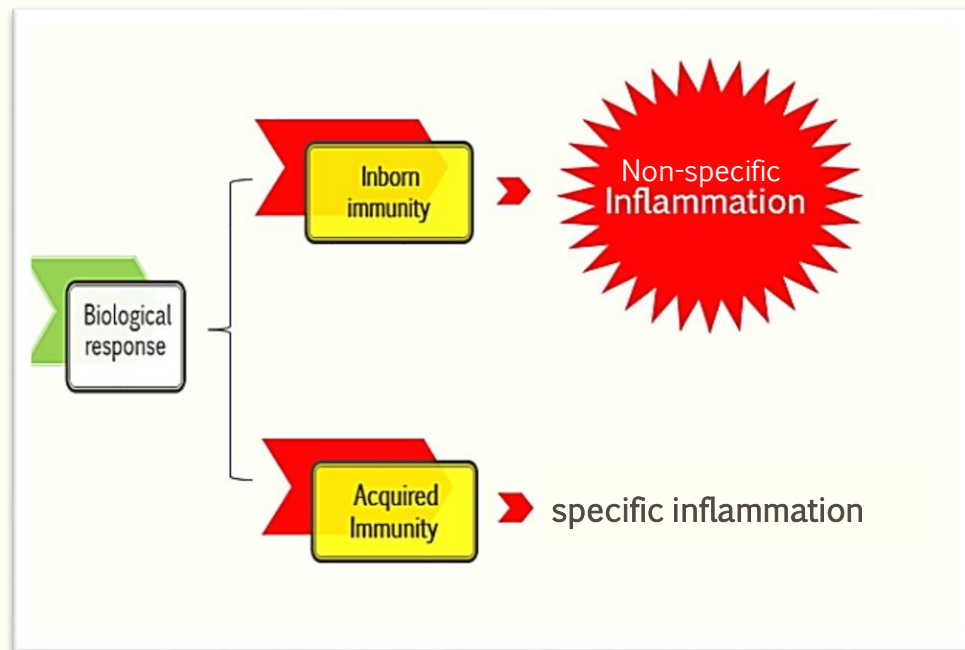


# Functions of the immune system

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# Timeline in evolution of Inborn (innate) and Acquired (adaptive) immunity



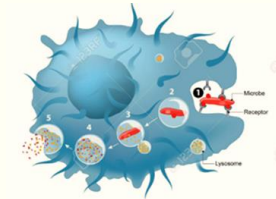
# $\beta$ -glucans: immuno-modulatory actions of lion's mane mushrooms

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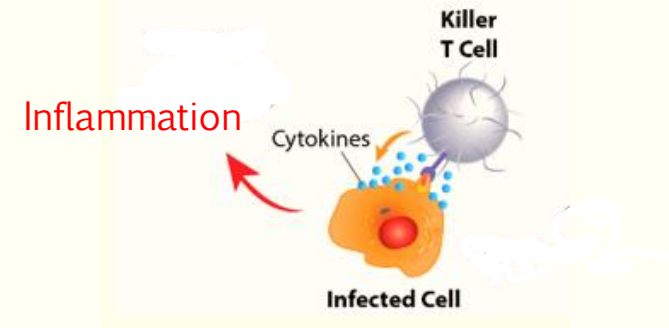
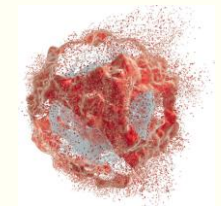
Lion's mane mushrooms strengthen the immune system by enhancing the

- actions of white blood cells:
  - Neutrophils
  - Macrophages
  - NK cells
- and reducing the release of inflammatory cytokines e.g.
  - $\text{TNF-}\alpha$
  - $\text{iL-1}\beta$

Phagocytosis



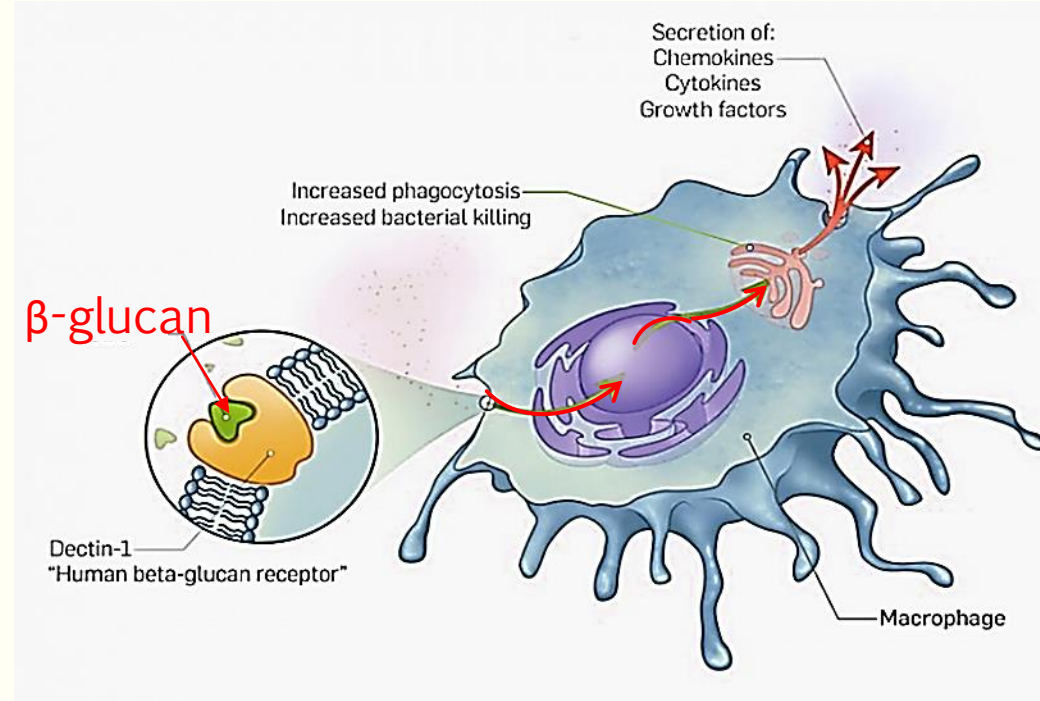
Lysis



# The human beta-glucan receptor is widely expressed in immune cells

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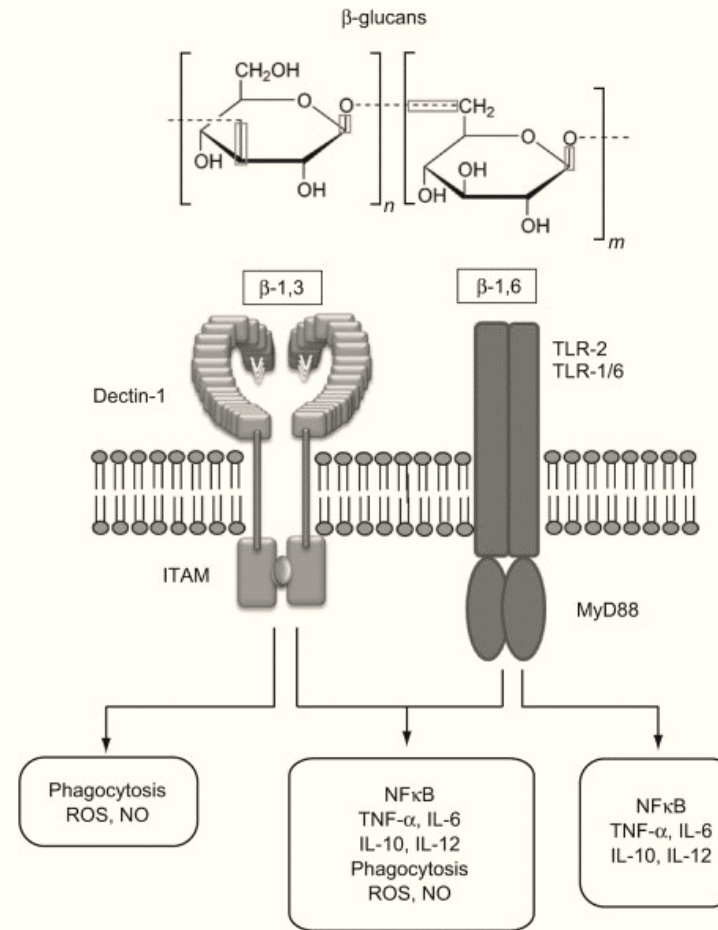
- Monocyte
- Macrophage
- Dendritic cells
- Neutrophils
- Eosinophils
- B cells
- Subpopulation T cells



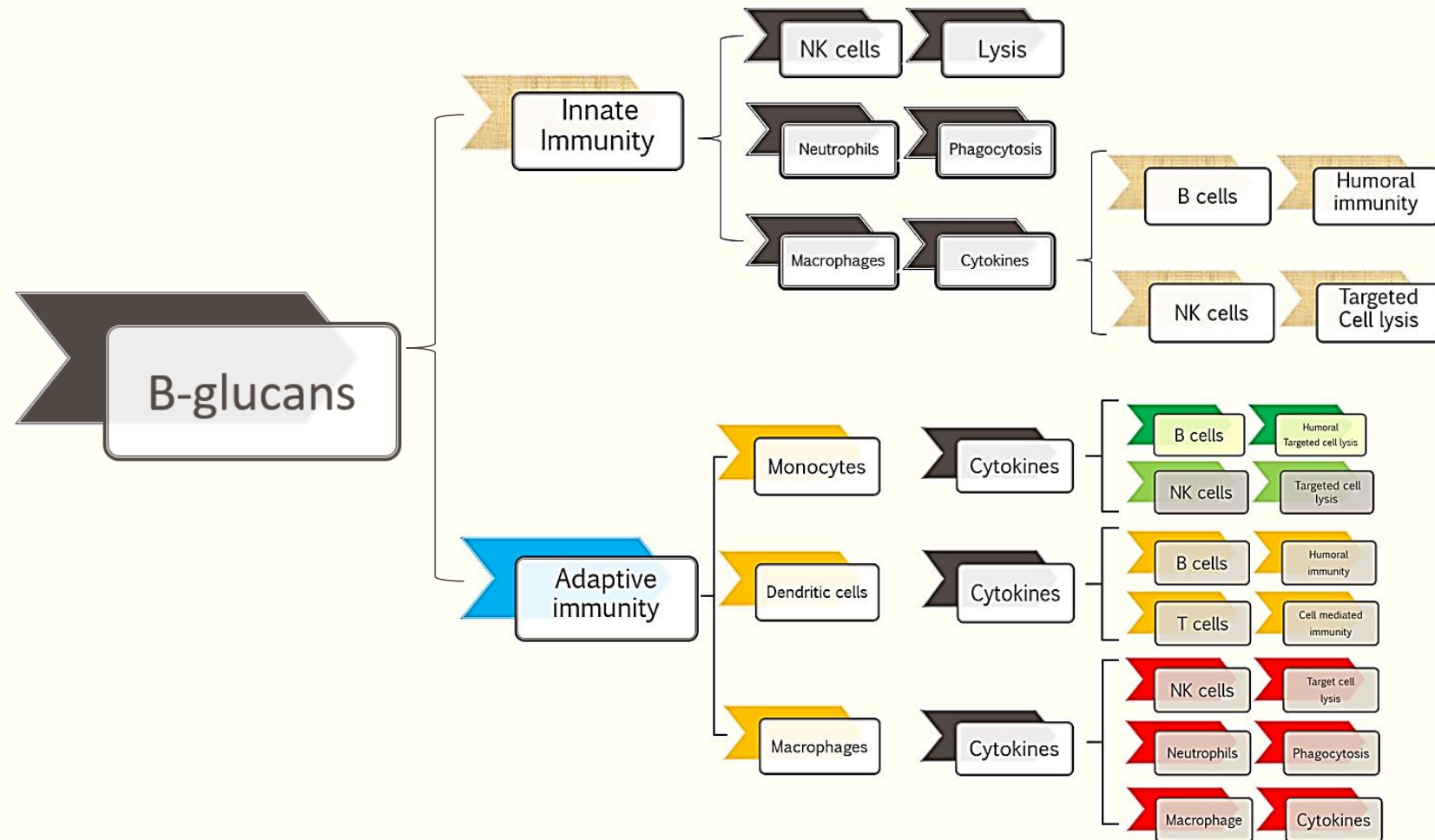


# Conceptual model for the interaction between $\beta$ -glucans and receptors of the innate immune system (macrophages)

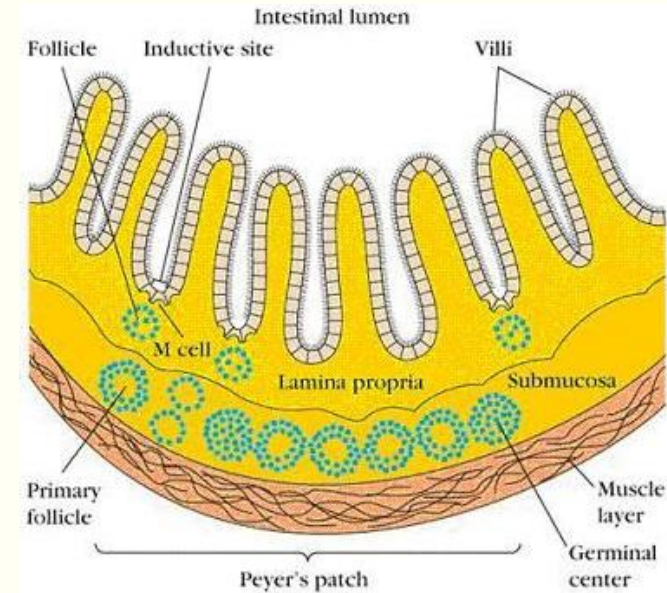
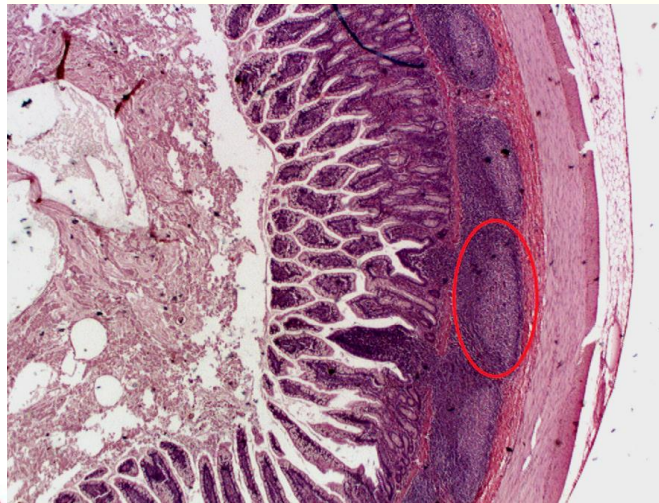
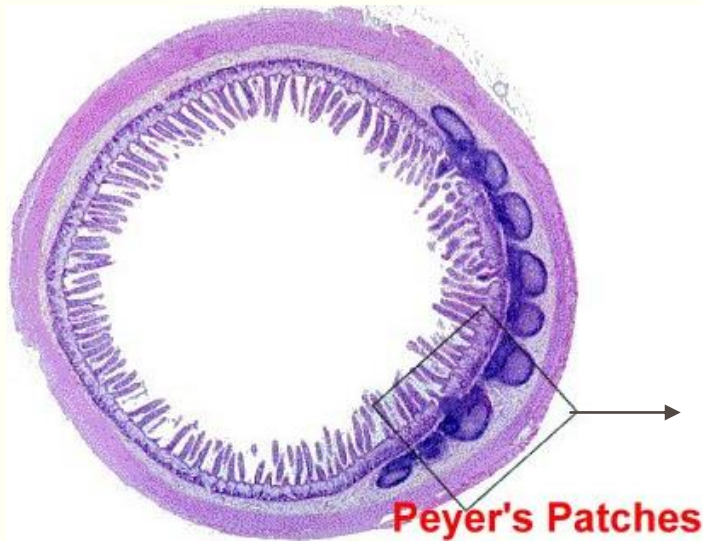
Interaction between Dectin-1 and toll-like receptors (TLRs) results in synergistic effects. ROS, reactive oxygen species.



# Cellular and hormonal effects of $\beta$ -Glucans on the immune system



# Absorption of soluble $\beta$ -glucans in the intestine

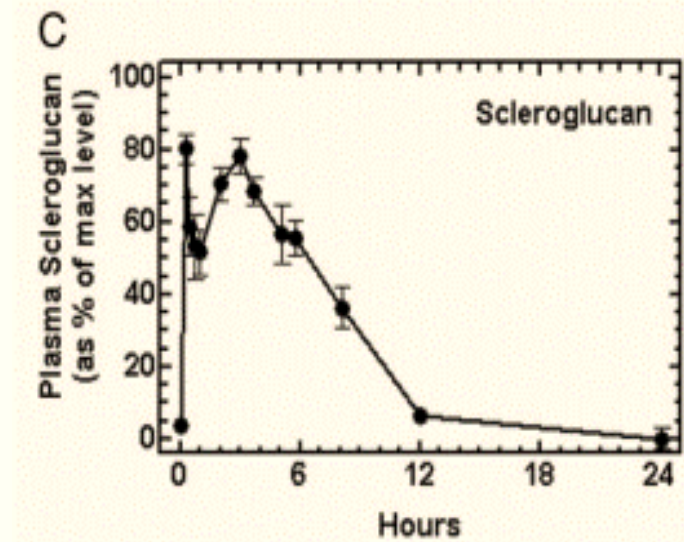
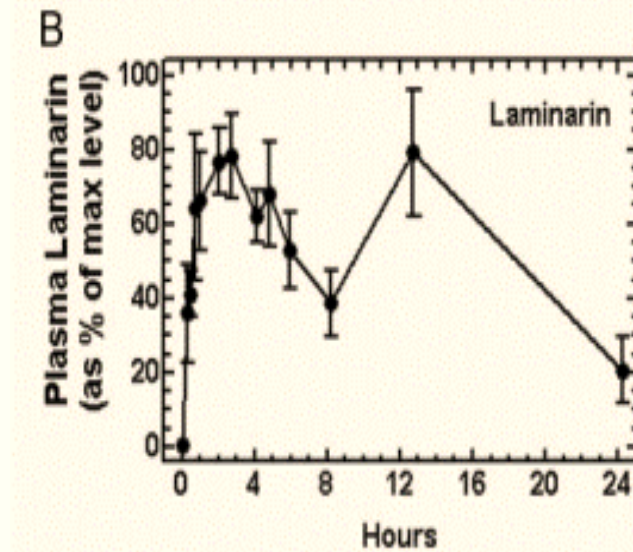
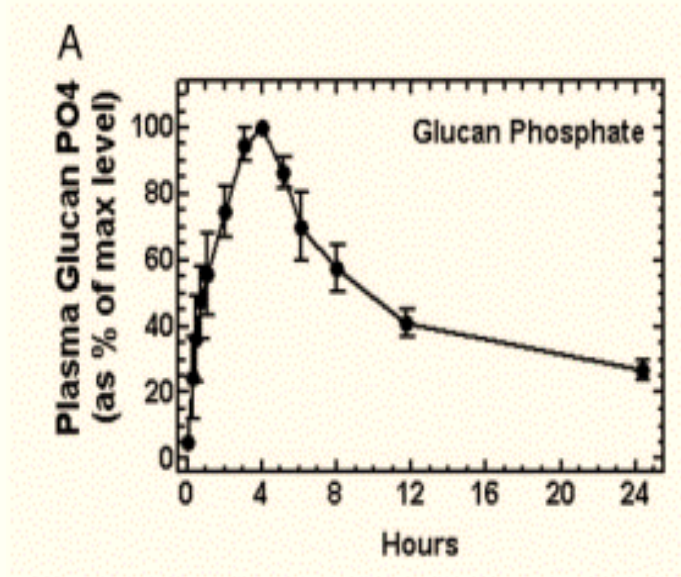


<https://vet.uga.edu/ivcvm/courses/vpat5215/digestive/week04/diarrhea/diarr4.htm>

[https://en.wikipedia.org/wiki/Peyer%27s\\_patch](https://en.wikipedia.org/wiki/Peyer%27s_patch)

<https://www.pinterest.com/pin/354165958170035412/>

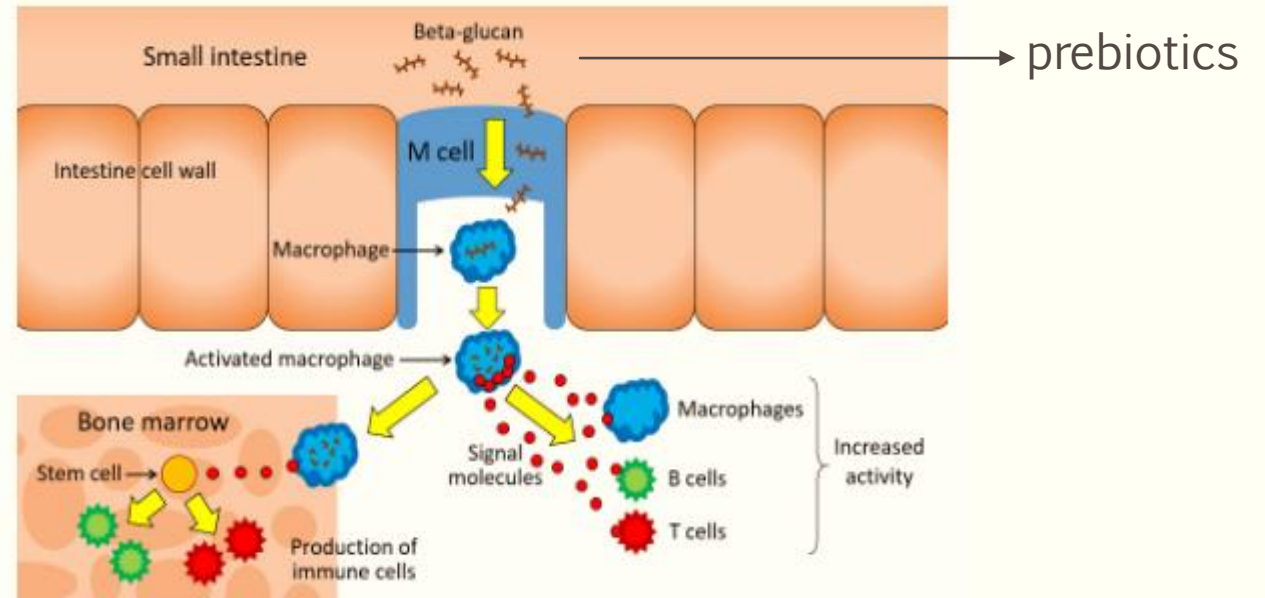
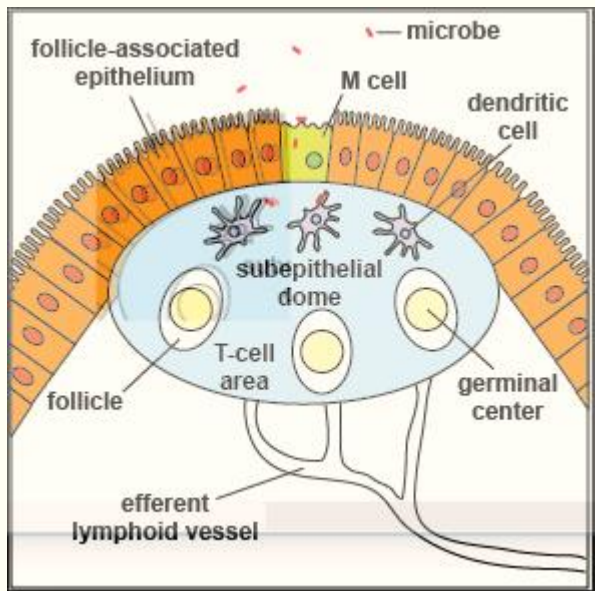
# Oral delivery and absorption of single dose of soluble glucans in intestinal tract of rats





# Uptake of Beta 1,3/1,6 Glucan in the intestinal tract

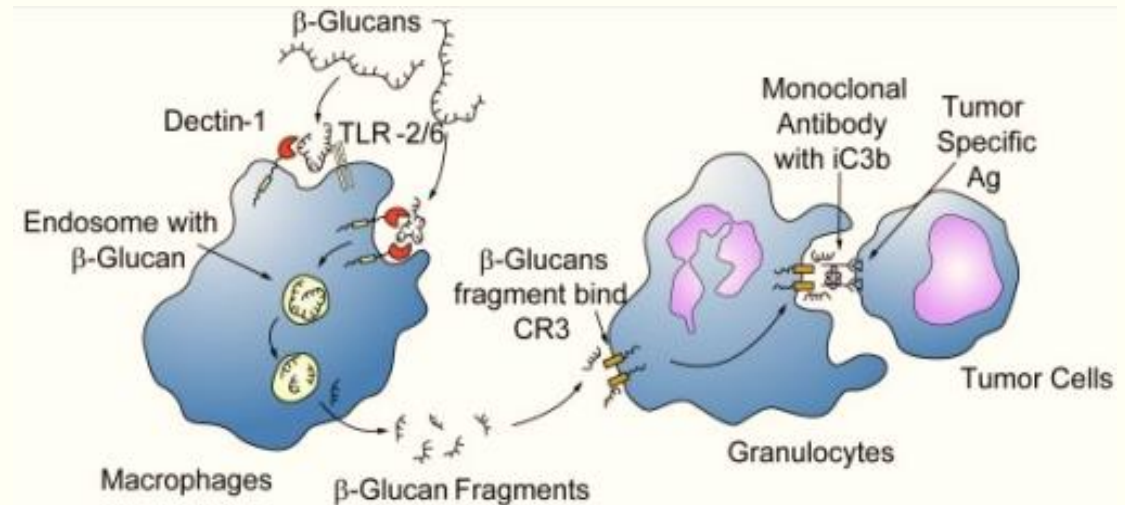
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<https://www.action-inter.net/beta-1316-glucan-and-the-immune-system.html>

# The uptake and fate of insoluble $\beta$ -glucan in immune cells

- 1 • **insoluble  $\beta$ -glucans** in small intestine
- 2 • macrophage
- 3 • bone marrow  
• mononuclear phagocytes
- 4 • **conversion of insoluble  $\beta$ -glucan to soluble fragments**
- 5 • circulating Immune cells: granulocytes, monocytes
- 6 • **anti-inflammation**  
• **anti-cancer**





# Bioavailability of $\beta$ -glucans

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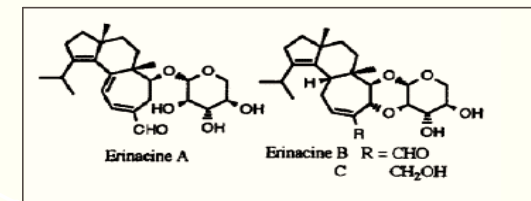
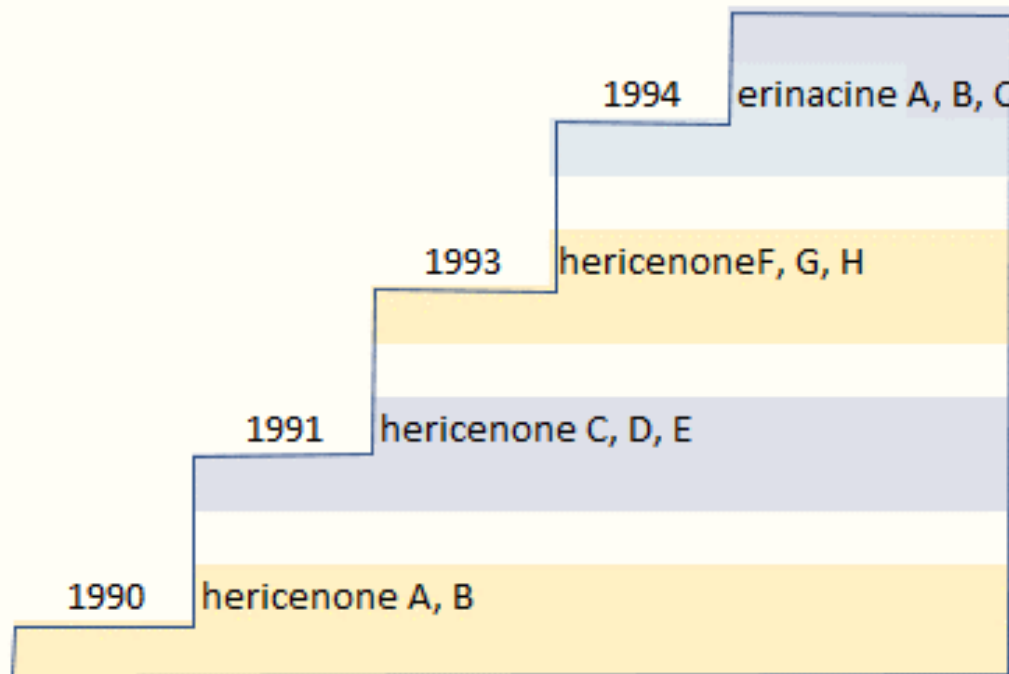
- Bioavailability of  $\beta$ -glucans has not been clearly established.
- Intravenously administered (1,3)- $\beta$ -glucans have similar half-lives
- 70% of (1,3)- $\beta$ -glucans are deposited in the liver and spleen
- Glucan derived from *Grifola frondosa* is reported to have a  $T_{1/2}$  of 6.4 h following systemic administration in normal mice.
- In rabbits, intravenous administration of a 92-kDa radio labelled (1,3)- $\beta$ -glucan isolated from *Candida albicans* showed a distribution  $T_{1/2}$  of less than 5 min.
- Most of the radio labelled (1,3)- $\beta$ -glucan (>97%) was associated with cell-free plasma, while radioactivity associated with blood cells was initially found in platelets and later (2 h) distributed to polymorphonuclear leukocytes and red blood cells.

# What are hericenones and erinacines in lion's mane (*Hericum erinaceus*) ?

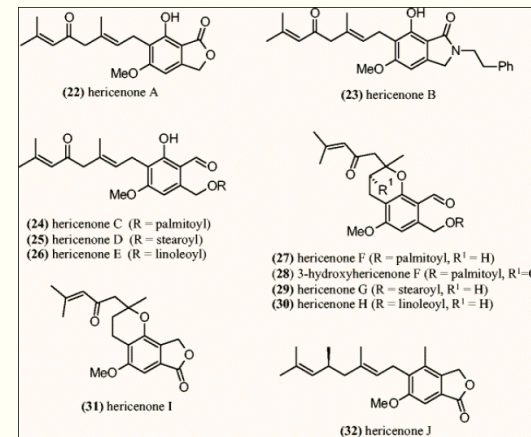
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- They are terpenoid compounds derived from lion's mane mushroom.
- Hericenones are derived from the fruiting bodies of the mushroom. They are volatile, and numbered from 1 to 17.
- Erinacines are derived from the mycelium of the mushroom. They are non-volatile and numbered from 18 to 39.
- The molecular weight of hericenones vary from 300 to 600 g/mol.
- The molecular weight of erinacines vary from 400 to 500 g/mol.
- Hericenones number 3, 4, 5, 8 are nerve growth factor stimulators.
- Erinacines number 18, 19, 20, 33, 34, 35, 36 are nerve growth factor stimulators.

# Milestones in the discovery of hericenones and erinacines from fruiting bodies and mycelium of lion's mane mushroom



mycelium



fruit bodies

# Number of hericenones from fruiting body of lion's mane mushroom

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	name	Number	NGF sythesis stimulators
Fruit body	hericenones	1-8	3, 4, 5, 8
	hericenones	9-12	
	erinacerin	13-14	
	3-hydroxyhericenone	15	
	hericenones	16-17	



# Number of erinacines from mycelia of lion's mane mushroom

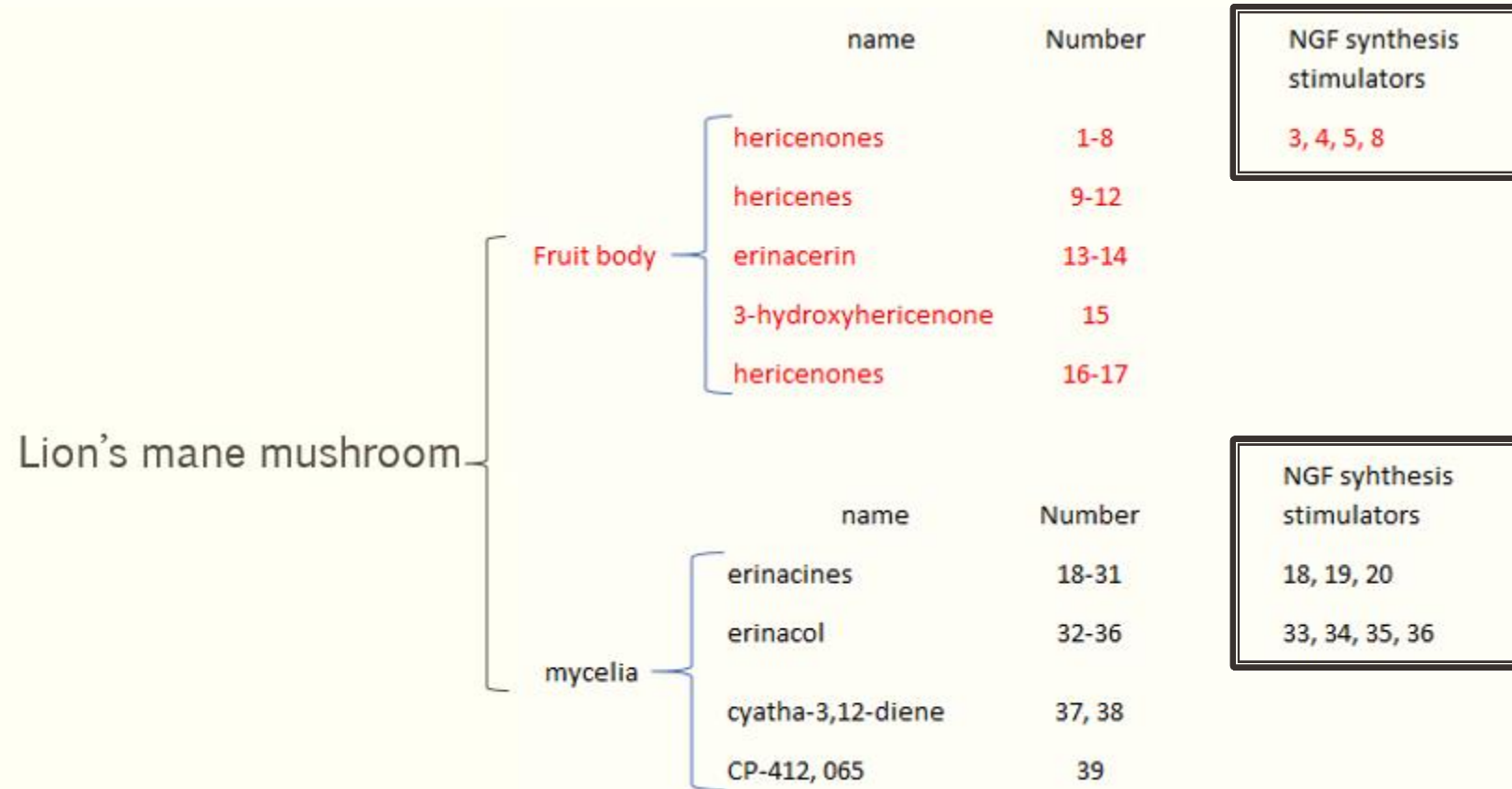
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	name	Number	NGF syththesis stimulators
mycelia	erinacines	18-31	18, 19, 20
	erinacol	32-36	33, 34, 35, 36
	cyatha-3,12-diene	37, 38	
	CP-412, 065	39	



# Number of NGF (nerve growth factor) stimulators in lion's mane mushroom

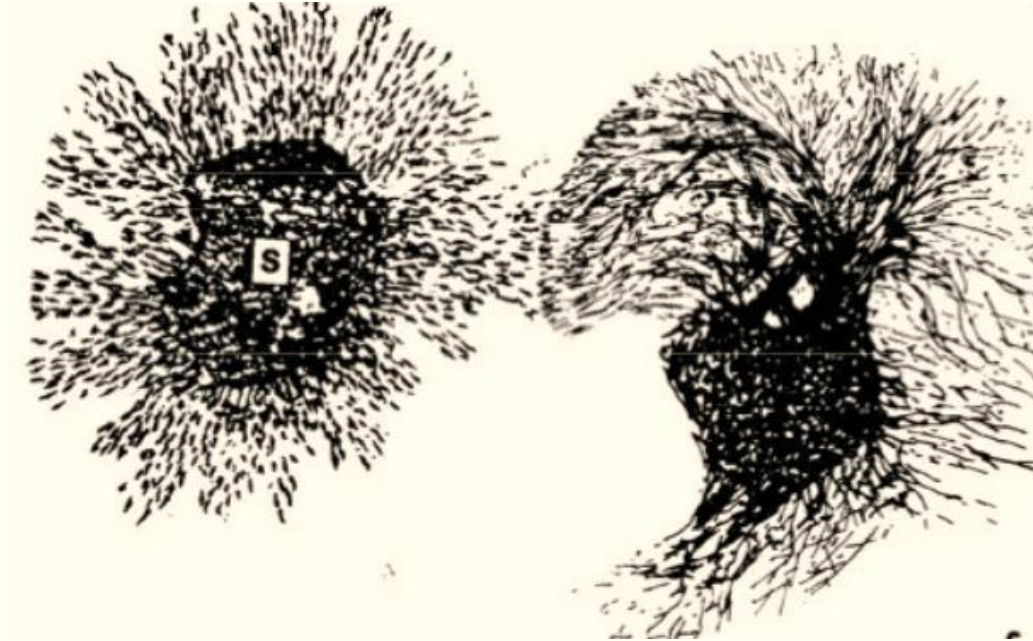
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# Discovery of Nerve Growth Factor during 1950s

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mouse tumor cells

sensory ganglion



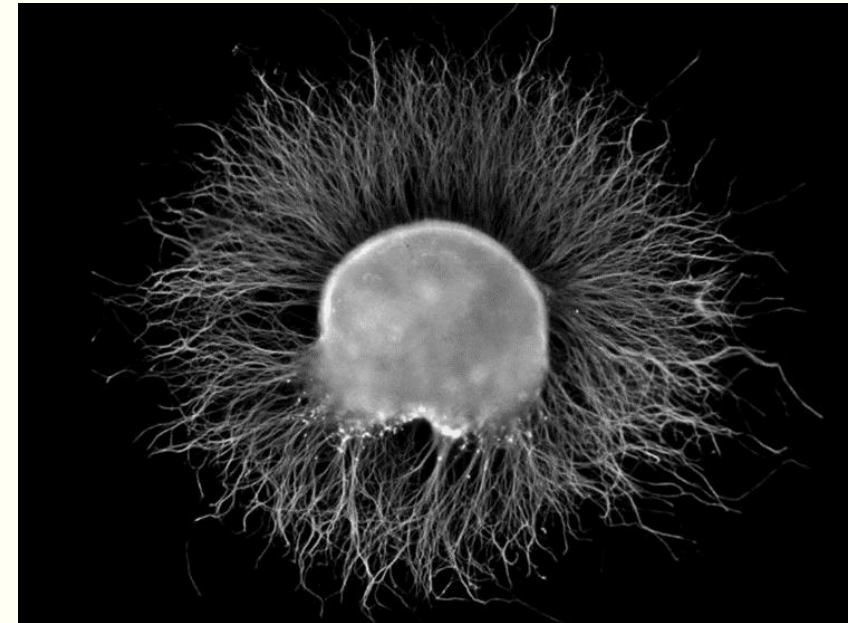
Nobel laureate 1986

Rita Levi-Montalcini in 2009, at her 100th birthday party.

# What is a Nerve Growth Factor (NGF) ?

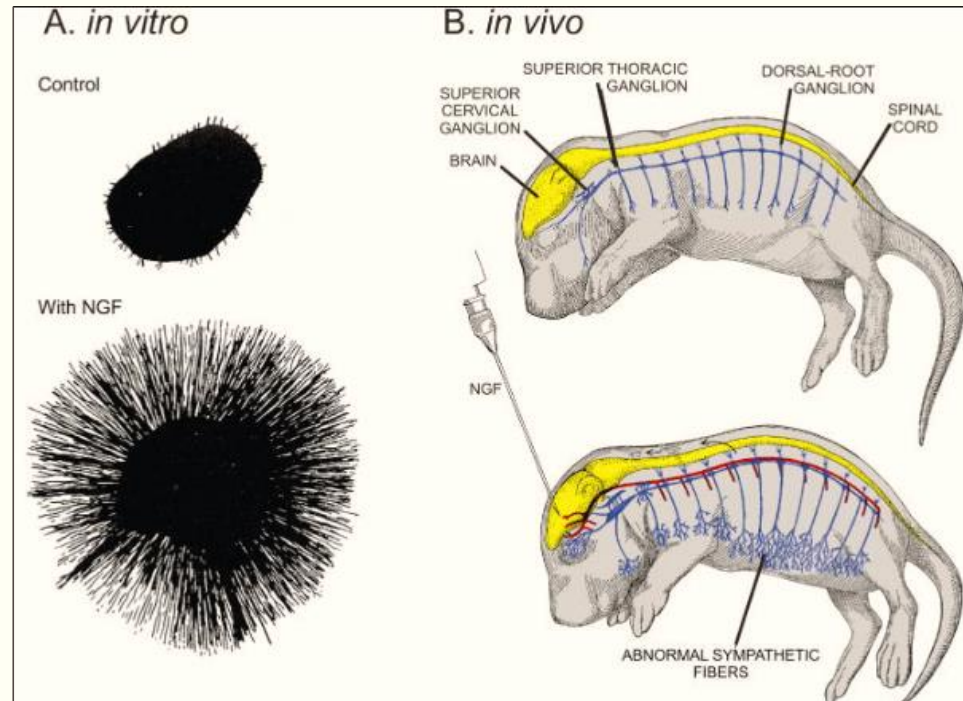
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- Protein
- 118 amino acids
- Molecular weight 26,959 Da
- Sources
  - neuron
  - leukocytes: mast cells, eosinophils
  - bone marrow stromal cells
  - thymus
  - salivary gland
  - oral keratinocytes
  - endothelial cells
  - fibroblasts



# Nerve growth factor (NGF) promotes neurite outgrowth in vitro and axon outgrowth in vivo

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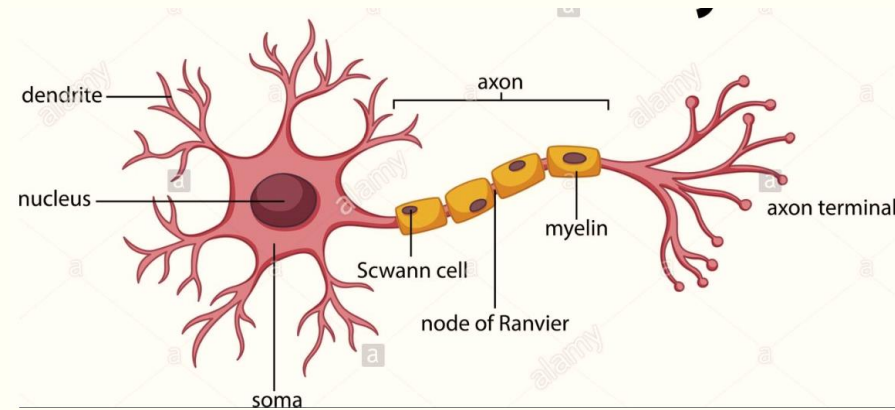
chick dorsal root ganglia

rat sympathetic nerve fibers

# What are the functions of Nerve Growth factor (NGF)

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- Growth of neurons
- Development of neurons
- Differentiation of neurons
- Survival of neurons
- Formation of myelin sheath in sensory neurons
- Neurotrophic modulation of synaptic transmission
- Function as immune-modulator in inflammation
- Function as nootropics
- NGF synthesis declines with age



# Comparison of Hericenones, Erinacines and Beta-glucans in lion's mane

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## Hericenone and erinacine

- Hericenones are from fruiting bodies of lion's mane
- Erinacines are from mycelium of lion's mane
- Both are water soluble
- Molecular weight of
  - hericenone A: 330.38 g/mol
  - hericenone C: 570.811 g/mol
  - Hericenone F: 570.811 g/m
- Molecular weight of
  - erinacine E: 432.557
- Erinacines A, B and C are strong nerve growth factor (NGF) synthesis stimulators

## Beta-glucans

- $\beta$ -glucans are from cell wall of lion's mane
- Lion's mane  $\beta$ -glucans are insoluble in water
- Molecular weights range 35-650 K daltons
- Uptake in intestine by macrophages
- Stimulate innate and adaptive immunity:
- May act as prebiotic

# Effects of bioactive compounds from *hericium erinaceus* *in vitro* and *in vivo*

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## In vitro

- inhibit LDL oxidation
- inhibit HMG Co-A reductase
- anti-inflammatory
- neuronal survival
- **neurotrophic**
- induce apoptosis

## Animals

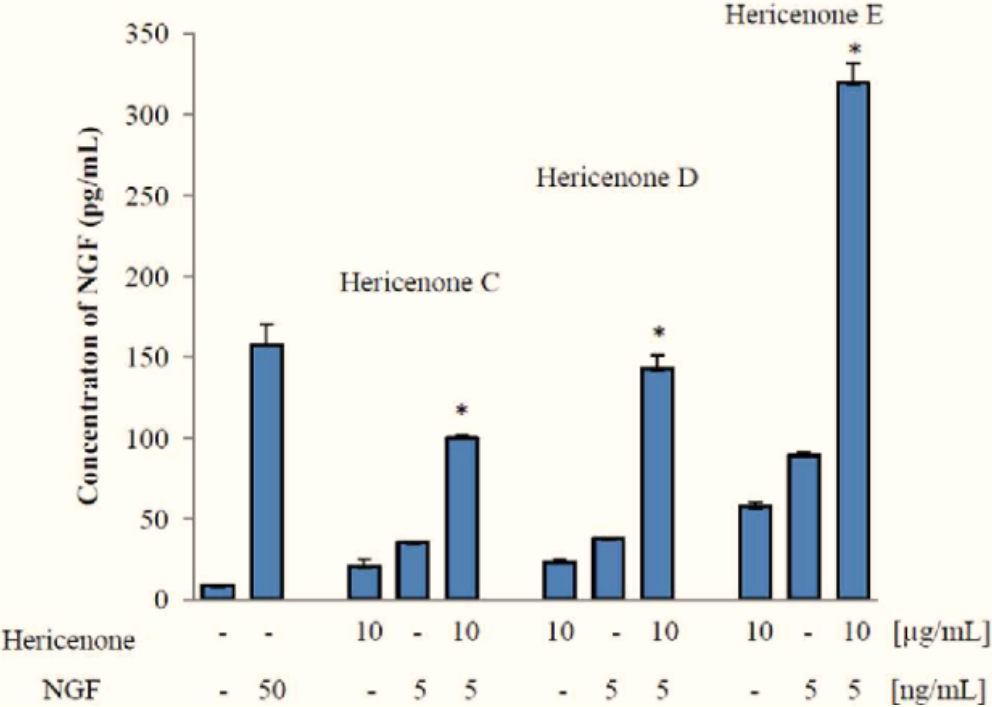
- anti-gastric ulcer
- anti-ulcerative colitis
- anti-hyperlipidemic
- anti-fatigue
- restore nerve injury
- anti-cancer
- anti-metastasis

## Human

- **improve cognitive function**
- improve depression and anxiety



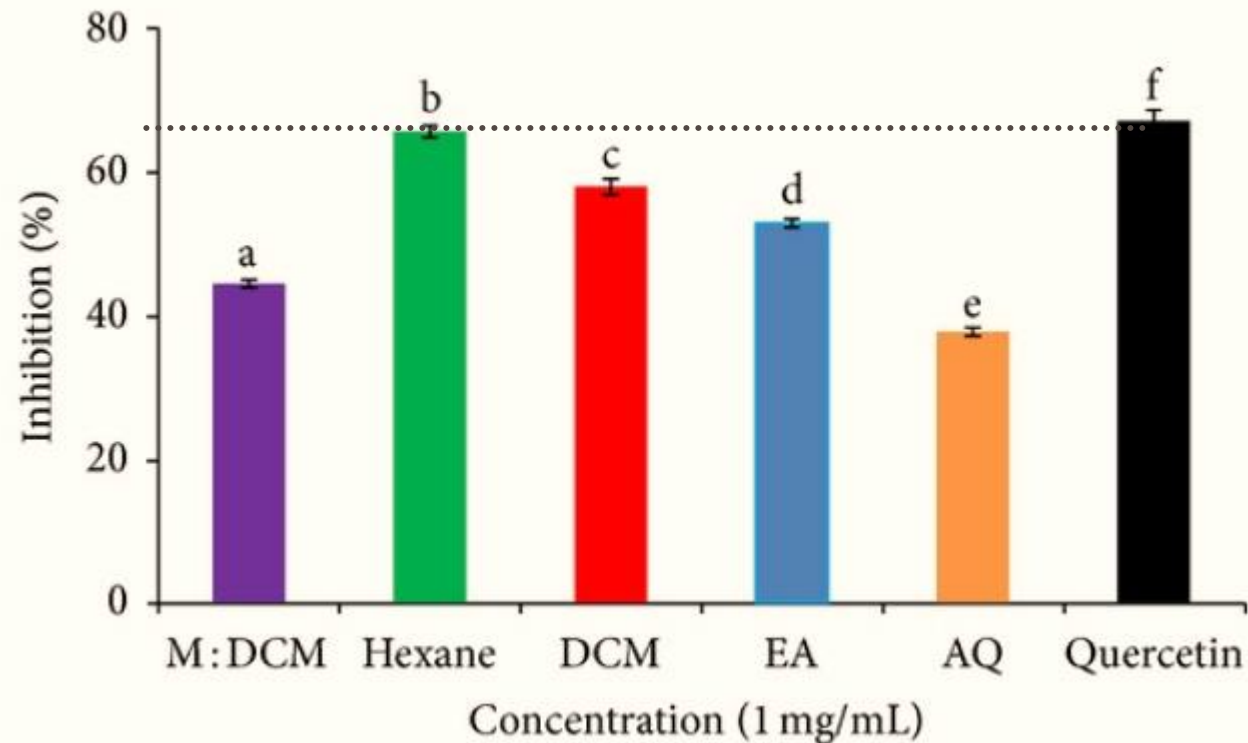
# Effects of hericenone C, D, and E on the stimulation of NGF secretion by neurite-bearing PC12 cells in the presence or absence of NGF





# Effect of *H. erinaceus* solvent-solvent fractions on inhibiting the oxidation of human LDL molecules (2014)

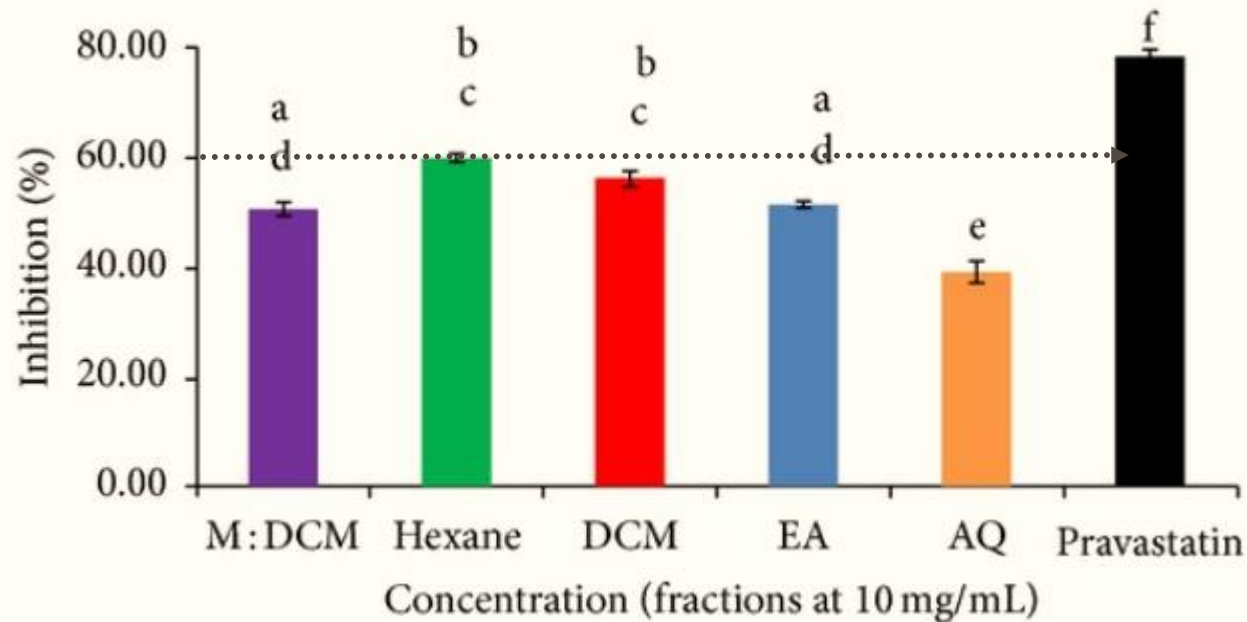
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methanol : dichloromethane (M : DCM),  
hexane (HEX),  
dichloromethane (DCM),  
ethyl acetate (EA), and  
aqueous residue (AQ).

# Effect of *H. erinaceus* solvent-solvent fractions on inhibiting the activity of HMG Co-A reductase (2014)

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methanol : dichloromethane (M : DCM),  
hexane (HEX),  
dichloromethane (DCM),  
ethyl acetate (EA), and  
aqueous residue (AQ).

# Anti-Inflammatory Effects of Ethanol Extract of Lion's Mane Medicinal Mushroom, *Hericium erinaceus* (Agaricomycetes), in Mice with Ulcerative Colitis. 2016

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## Abstract

This study investigated the anti-inflammatory activity of ethanol extracts of *Hericium erinaceus* in the inflammatory bowel disease (IBD) model. Twenty C57BL/6 mice were divided into four groups: control, ulcerative colitis (UC), and two groups receiving different doses of ethanol extract of *Hericium erinaceus* (HEEE). Orally administered HEEE improved body weight, reduced colon inflammation, and protected the mucosal epithelium. HEEE markedly reduced eosinophilic infiltration, suppressed the production of inflammatory mediators: tumor necrosis factor- $\alpha$ , interleukin (IL)-1 $\beta$ , and IL-6 in colon tissues, and increased superoxide dismutase in serum to suppress the oxidative stress. These results suggest that HEEE can be applied as a protective agent in the treatment of IBDs.

<https://www.ncbi.nlm.nih.gov/pubmed/27481156>

# Anti-Gastric Ulcer Activity of Polysaccharide Fraction Isolated from Mycelium Culture of Lion's Mane Medicinal Mushroom, *Hericium erinaceus* (Higher Basidiomycetes). 2015

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## Abstract

*Hericium erinaceus* is a culinary-medicinal mushroom that is used in traditional medicine, in folk medicine, and as medicinal cuisine in Asian countries such as China, Japan, and Korea. *H. erinaceus* exhibits various pharmacological properties, such as anti-cancer, immunomodulation, anti-dementia, and anti-ulcer. The polysaccharide fraction of the mycelium culture of *H. erinaceus* was isolated and its anti-ulcer activity was evaluated. The polysaccharide fraction significantly decreased the ulcerated area compared with the control group. The active principle in the polysaccharide fraction was identified as a triterpene compound, with anti-gastric ulcer activity. The polysaccharide fraction was also active in reducing the ulcerated area using an ethanol-induced ulcer model in mice and with an 3-[4,5-dimethylthiazol-2-yl]-2,5-diphenyltetrazolium bromide assay using MC cell lines. The results suggest that the polysaccharide fraction can significantly decrease the ulcerated area compared with the control group and the effect is fairly dose dependent, irrespective of animal or cell experiments. These results indicate that the polysaccharide fraction is the active component of the *H. erinaceus* mycelium culture, which protects against gastric ulcers.

<https://www.ncbi.nlm.nih.gov/pubmed/26853960>

# Neurotrophic properties of the Lion's mane medicinal mushroom, *Hericium erinaceus* from Malaysia. 2013

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## Abstract

Neurotrophic factors are important in promoting the growth and differentiation of neurons. Nerve growth factor (NGF) is essential for the maintenance of the basal forebrain cholinergic system. Hericenones and erinacines isolated from the medicinal mushroom *Hericium erinaceus* can induce NGF synthesis in nerve cells. In this study, we evaluated the synergistic interaction between *H. erinaceus* aqueous extract and exogenous NGF on the

**aqueous extract of *H. erinaceus* contained neuroactive compounds which induced NGF-synthesis and promoted neurite outgrowth**

compounds that induced the secretion of extracellular NGF in NG108-15 cells, thereby promoting neurite outgrowth activity. However, the *H. erinaceus* extract failed to protect NG108-15 cells subjected to oxidative stress when applied in pre-treatment and co-treatment modes. In conclusion, the aqueous extract of *H. erinaceus* contained neuroactive compounds which induced NGF-synthesis and promoted neurite outgrowth in NG108-15 cells. The extract also enhanced the neurite outgrowth stimulation activity of NGF when applied in combination. The aqueous preparation of *H. erinaceus* had neurotrophic but not neuroprotective activities.

# Neuroregenerative potential of lion's mane mushroom, *Hericium erinaceus* in the treatment of peripheral nerve injury (2012)

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## Abstract

We present a model case study of the activity of aqueous extract of *Hericium erinaceus* fresh fruit bodies in promoting functional recovery following crush injury to the peroneal nerve in adult female Sprague-Dawley rats. The aim was to explore the possible use of this mushroom in nerve repair. The activities of aqueous extract were compared to activities exhibited by mecobalamin (vitamin B12), which has been widely used in the treatment of

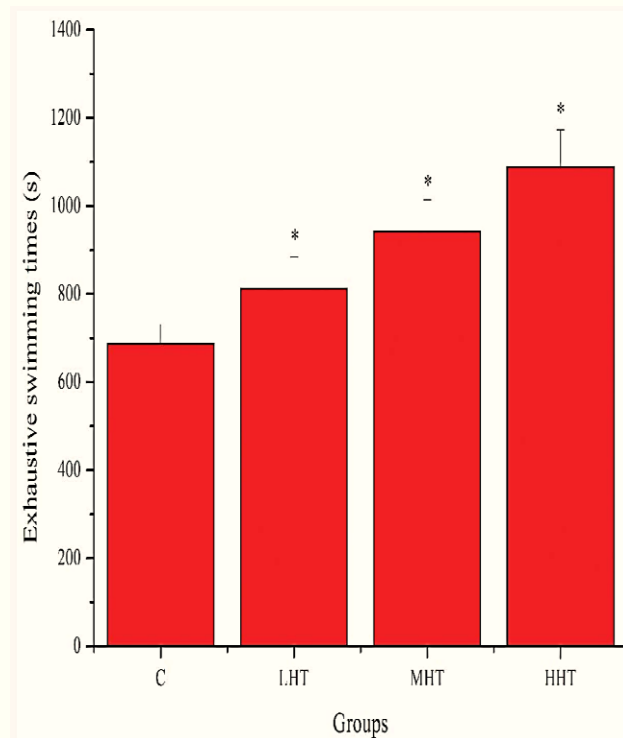
**Regeneration of axons and reinnervation of motor endplates/neuromuscular junction in extensor digitorum longus muscle of rats in treated groups developed better than in the negative control group**

with ER signaling pathways as well as c-Jun and c-Fos genes compared to the negative control group. Akt cascade plays a major role in mediating neurotrophin-promoted cell survival, while MAPK cascade is involved in mediating neurite outgrowth. Immediate early gene expression was also involved in the cascade of events leading to regeneration. Local axonal protein synthetic machinery was also enhanced in the distal segments of crushed nerves in treated groups. Therefore, daily oral administration of *H. erinaceus* could promote the regeneration of injured rat peroneal nerve in the early stage of recovery.

<https://www.ncbi.nlm.nih.gov/pubmed/23510212>

# Effects of polysaccharide extracts from lion's mane mushroom (*Hericium erinaceus*) in swimming times of rats (2014)

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Effects of *Hericium erinaceus* on exhaustive swimming times. Values are expressed as the means  $\pm$  SD. \* $P < 0.05$ , compared with the C group.

- C, control;
- LHT, low-dose HEP-treated group;
- MHT, moderate-dose HEP-treated group;
- HHT, high-dose HEP-treated group.



# *Hericium erinaceus* (Lion's Mane) mushroom extracts inhibit metastasis of cancer cells to the lung in CT-26 colon cancer-transplanted mice. (2013)

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## Abstract

This study investigated the antimetastatic activity of four *Hericium erinaceus* edible mushroom extracts using CT-26 murine colon carcinoma cells as an indicator of inhibition of cell migration to the lung. Hot water (HWE) and microwaved 50% ethanol (MWE) extracts of *H. erinaceus* strongly elicited cancer cell death through the expression of matrix metalloproteinases (MMPs) and another extracellular matrix (ECM) component, biglycan. HWE and MWE down-regulated extracellular signal-regulated kinase (ERK) phosphorylations. The reduced phosphorylation of ERK1/2 by HWE and MWE reduced the formation of tumor nodules in the lung by about 50% and 55%, respectively. Dietary administration of HWE and MWE reduced the increases in lung weight caused by cancer cell metastasis. These results demonstrate the effectiveness of HWE and MWE as beneficial antimetastatic agents, targeting their upstream signaling molecules for mediating the expression of the ECM-degrading proteinases. Acidic and alkaline extracts were not bioactive. Bioactivity seems to be related to composition. *H. erinaceus* edible mushrooms have the potential to serve as a health-promoting functional food.

# High molecular weight of polysaccharides from *Hericium erinaceus* against amyloid beta-induced neurotoxicity (2016)

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## Abstract

**BACKGROUND:** *Hericium erinaceus* (HE) is a well-known mushroom in traditional Chinese food and medicine. HE extracts from the fruiting body and mycelia not only exhibit immunomodulatory, antimutagenic and antitumor activity but also have neuroprotective properties. Here, we purified HE polysaccharides (HEPS), composed of two high molecular weight polysaccharides ( $1.7 \times 10^5$  Da and  $1.1 \times 10^5$  Da), and evaluated their protective effects.

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**HEPS exhibit antioxidant and neuroprotective effects on A $\beta$ -induced neurotoxicity in neurons.**

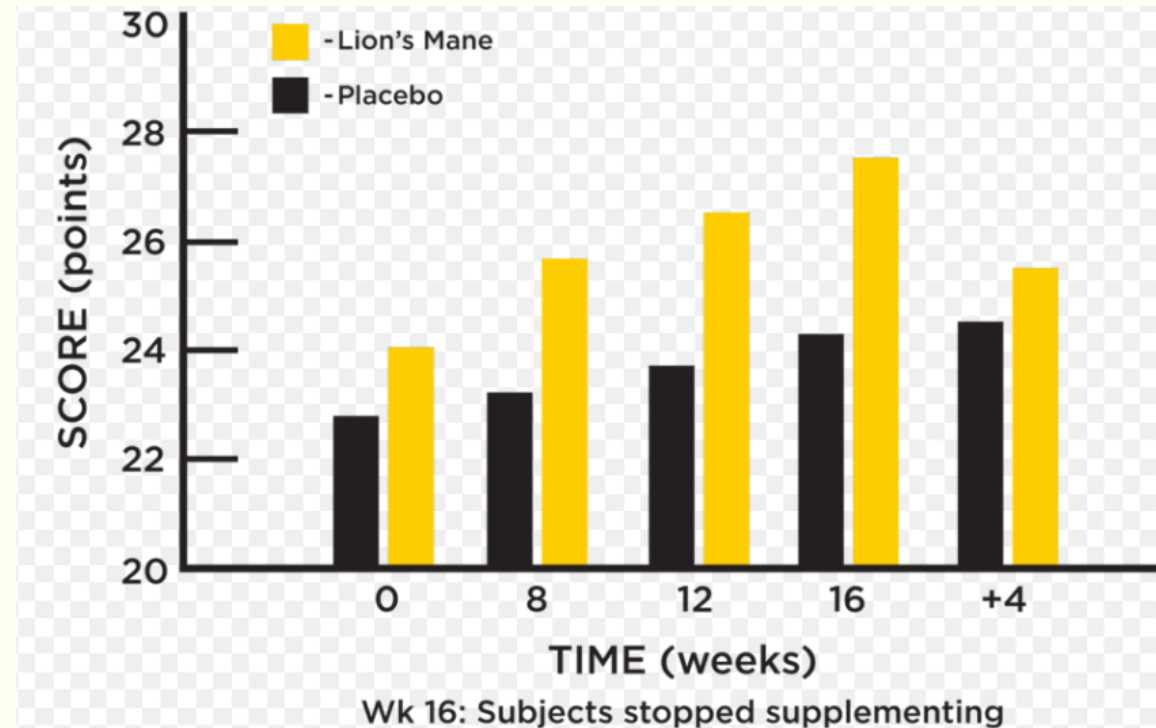
**RESULT:** Our results showed that 250  $\mu$ g/ml HEPS was harmless and promoted cell viability with 1.2  $\mu$ M A $\beta$  treatment. We observed that the free radical scavenging rate exceeded 90 % when the concentration of HEPS was higher than 1 mg/mL in cells. The HEPS decreased the production of ROS from 80 to 58 % in a dose-dependent manner. Cell pretreatment with 250  $\mu$ g/mL HEPS significantly reduced A $\beta$ -induced high MMPs from 74 to 51 % and 94 to 62 % at 24 and 48 h, respectively. Finally, 250  $\mu$ g/mL of HEPS prevented A $\beta$ -induced cell shrinkage and nuclear degradation of PC12 cells.

**CONCLUSION:** Our results demonstrate that HEPS exhibit antioxidant and neuroprotective effects on A $\beta$ -induced neurotoxicity in neurons.

<https://www.ncbi.nlm.nih.gov/pubmed/27266872>

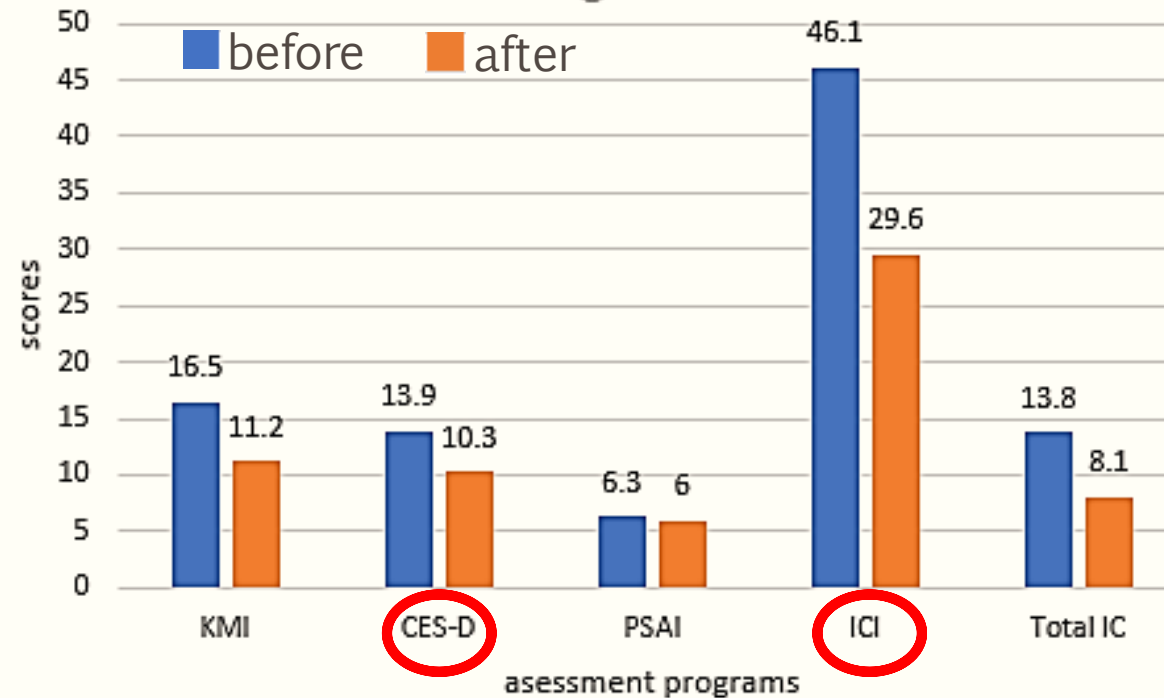
Improving effects of the mushroom Yamabushitake (*Hericium erinaceus*) on mild cognitive impairment:  
a double-blind placebo-controlled clinical trial based on the Revised Hasegawa Dementia Scale (HDS-R).

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# Effects of maitake mushroom (*Hericium erinaceus*) on depression and anxiety among 30 subjects in a 4-week double blind placebo control trial (2010).

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- KMI: Kupperman Menopausal Index
- CES-D: Center for Epidemiologic Studies Depression
- PSQI: Pittsburgh Sleep Quality Index,
- ICI: Indefinite Complaints Index

Adapted from [https://www.jstage.jst.go.jp/article/biomedres/31/4/31\\_4\\_231/\\_pdf](https://www.jstage.jst.go.jp/article/biomedres/31/4/31_4_231/_pdf)

# Side effects, interactions, dosage

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- No adverse reaction has been reported on the use of lion's mane as a food.
- No adverse reaction has been reported on the use of lion's mane supplements.
- No information is available on the interaction of lion's mane with drugs.
- There is not enough scientific information to recommend the appropriate dosage.

# Lion's mane mushroom: commercial products

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## Products

- Raw lion's mane
- Powder
- Extract
- Capsules
- Dietary supplement

## Advertised health benefits

- Immune function
- Anxiety and depression
- Cognitive health
- Digestive health
- High cholesterol
- Diabetes
- Wound healing
- Cancer

# Examples of lion's mane mushroom extracts

elixir

Supplement Facts	
Serving Size: 1 mL (~45 drops)	
Servings Per Container: 30	
Amount Per Serving	
Proprietary Blend	1 mL †
Fresh Lion's Mane ( <i>Hericium erinaceus</i> ) mycelium extract ‡	
Dried Lion's Mane ( <i>Hericium erinaceus</i> ) fruitbody extract ‡	
†Daily value not established	
‡Certified Organic	
Other ingredients: water, alcohol ‡ (alcohol content: 30–40%), myceliated brown rice ‡	

capsule

Supplement Facts		
Serving Size: 1000mg	Amount Per Serving	%DV**
Servings Per Jar: 30		
Lion's Mane Mushroom	1000mg	*
*No Daily Value Established		
**Based on 2,000 Calorie Diet		
<b>Suggested Use:</b> As a dietary supplement, take 1000mg once daily.		
<b>Warning:</b> Keep out of reach of children. Do not take this or any other supplement if under the age of 18, pregnant or nursing a baby, or if you have any known or suspected medical conditions, and/or taking prescription drug(s) or OTC medication(s).		
Storage: Store in a cool and dry place. Keep away from direct sunlight and heat.		
Manufactured for Nootropics Depot 8380 S. Kyrene Rd. Ste. 110 Tempe, AZ 85284 Support@NootropicsDepot.com		

Mixture of extracts

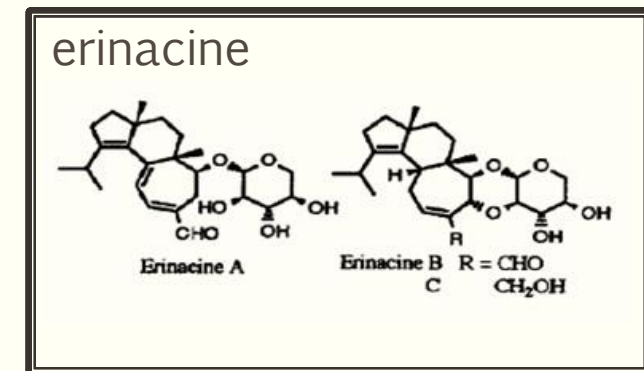
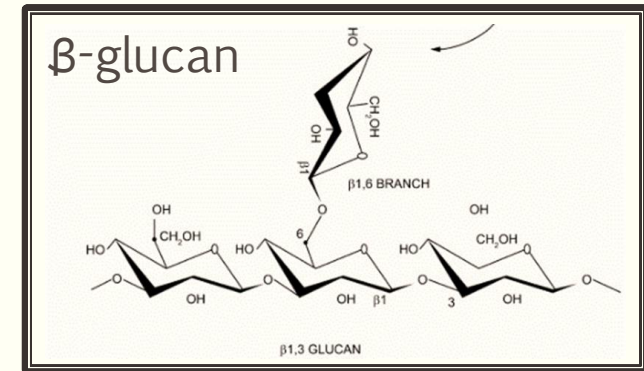
Supplement Facts		
Serving Size: 1000mg / 2 Capsules • Servings Per Container: 45		
	Amount Per Serving	% Daily Value
Reishi Mushroom Extract**		
(Ganoderma lucidum) .....	200mg	†
Chaga Mushroom Extract** (Inonotus obliquus) .....	200mg	†
Shiitake Mushroom Extract** (Lentinula edodes) .....	200mg	†
Maitake Mushroom Extract** (Grifola frondosa) .....	200mg	†
Turkey Tail Mushroom Extract**		
(Trametes versicolor) .....	200mg	†
Beta-D-Glucans .....	>30%	†
Starch .....	<3%	†
<b>Other ingredients:</b> Tapioca (Plantcap® vegetable capsule)		
**All ingredients are Certified Organic. † Daily Value not established		



# Buyers beware (*caveat emptor*) in buying dietary supplements

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- Nootropics are smart or cognitive enhancers.
- Beta-glucans are not nootropics.
- Beta-glucans are biological response modifiers.
- Some hericenones and erinacines are nootropics.
- The pharmacological properties of beta-glucans, hericenones and erinacines in lion's mane mushroom have yet to be defined.



# Some delicious lion's mane mushroom cuisine

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Lion's Mane Mushrooms and Garlic – E...



Sparta Lion's Mane Mushroom Salad



Pan-Fried Lion-Mane Mushr...



Poached Lion's Mane Mushroom



Mane and Oyster Mushroom Pasta Recipe ...



Stir fry Lion's Mane Mushroom - Pict...

# Summary

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- Lion's mane mushroom is scientifically known as *Hericium erinaceus*.
- Investigations of its health benefits began in the year 2000.
- Besides macro and micronutrients, beneficial bioactive compounds have been analyzed and studied.
- The bioactive compounds consist of polysaccharides and secondary metabolites
- $\beta$ -glucans in polysaccharides are immuno-modulatory and anti-cancer.
- The important metabolites are hericenones and erinacines. Several of them are strong stimulators of nerve growth factor (NGF) synthesis.
- Lion's mane mushroom is a safe and delicious mushroom. No adverse reactions have been reported.



# ANY QUESTION?

Please contact

Kevin KF Ng, MD, PhD

Email: [kevinng68@gmail.com](mailto:kevinng68@gmail.com)