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The discoveries of mechanisms for autophagy and its function

What is autophagy

In Greek words auto-, meaning “self”, and phagein, meaning “to eat”. Thus, autophagy denotes “self eating”. It is a natural process which is a fundamental process for degrading and recycling cellular components.

During autophagy, a cell will break down unnecessary components within a cell for fuel and to build or maintain cells.

It plays the role of cleaning up the “junk” components which free cell space so that the cell can work properly. It can also destroy bacteria, viruses and cancer cells that can harm cells. After that, it can rapidly provide fuel and building blocks for the new parts of the cell, which makes the response of starvation and other kinds of discomfort from the cell important.

This article will describe the discoveries of mechanisms for autophagy and its function. During the 1960’s, researchers first found that the cell could destroy its own components by forming sack-like vesicles enclosed with membranes which were transferred and fused with the recycling compartment, the *lysosome*, for degradation.

In early 1990, Yoshinori Ohsumi published papers showing identify genes essential for autophagy, used baker’s yeast with a series of brilliant experiments. He elucidated the underlying mechanisms for autophagy in yeast as well as in our cells.

How Autophagy Works

Autophagy takes place in the cytoplasm, the gelatinous liquid that fills the inside of a cell. It occurs when cells are either damaged or needed energy. It is a process of cells recycling uncalled parts of itself to create new parts and provide energy to survive.

This process involves four steps in total: (1) Sequestration, (2)Transfer, (3)Degradation, and (4)Utilization. When a cell’s dysfunctional component is surrounded by a phagophore, sequestration will happen. The second part happens after the broken part, which is also called autophagosome, is fused to lysosome. Then the lysosome will release enzymes to break down the damaged part to amino acids. The amino acids will eventually be used as fuel source (ATP) and synthesized to build or maintain the cell.

Benefits of Autophagy

Within the cell, autophagy can help:

- Decreasing the free radicals which are the unstable molecules led Oxidative stress causing cell damage.

- Maintain genomic stability
- Prevent cells from the premature deterioration and aging
- Improve nutrients and energy conversion
- Improve cell elimination of junks
- Eliminate bacteria, virus and other pathogens or other foreign materials within cells

Outside of the cell,

- Autophagy can help anti- inflammation
- improve brain nerve signals transmission
- Maintain health and functional of the systems

How to Trigger Autophagy?

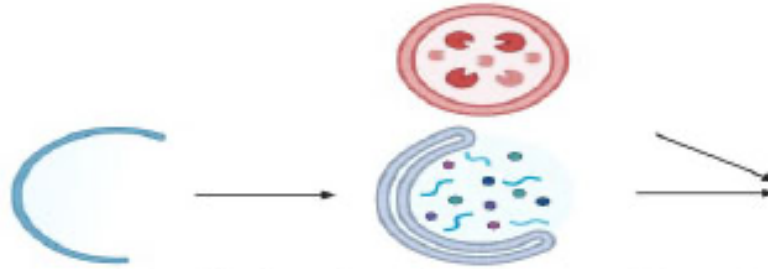
Autophagy is typically triggered when cells lack nutrition. There's several ways to trigger it manually: fasting(deprives the body of nutrition), exercising(burns glucose), restricting calories(loss and fewer nutrients), and switching to a keto diet(force your body to burn fat).

This is mainly targeted to keep the body in homeostasis instead of keeping yourself healthier, and it also needs to be a steady action in order to be beneficial to people.

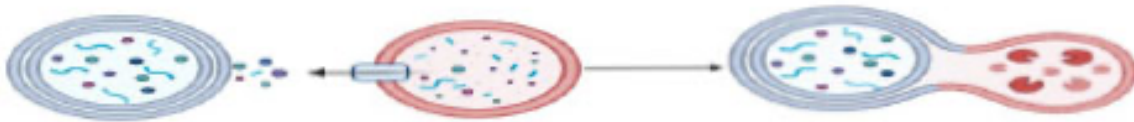
Disrupted autophagy has been linked to several kinds of problems, such as Parkinson's disease, type 2 diabetes and other disorders that appear in the elderly. Other kinds of problems include mutations in autophagy which cause genetic disease, and the disturbances in the autophagic machinery have also been linked to cancer. While scientists are hoping to find ways to treat those diseases by using autophagy, the research still remains in its infancy. Not only because there's no evidence about successfully altering or preventing those diseases by autophagy, but also because triggering autophagy now is only a way of keeping healthy and wellness.

Summary

It has been over 50 years since autophagy was found. However, not until 2016 did Yoshinori Ohsumi let the public recognize the importance of this behaviour. Autophagy is a process that keeps your cells in proper balance. It will take away old or damaged components of the cell and recycle them. Those components will turn into amino acids which can be used as fuel or a new part of the protein. It can be triggered due to exercise, calorie restriction, fasting, or keto diet. Even though scientists are still trying to use autophagy to treat diseases such as cancer, there's no evidence that autophagy will be able to do that with diet or exercise. Exercising or keeping a good diet might be helpful to us, but we can't expect it to prevent diseases because of autophagy.



Step1 Sequestration, dysfunctional component of a cell is surrounded by a double-membrane structure called a phagophore. The encased component is called an autophagosom



Step 2&3. Transfer: This takes place when the autophagosome is fused to a specialized structure in the cytoplasm, called a lysosome. Lysosomes contain enzymes that degrade dysfunctional

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Step 4 Degraded and utilizing



Figure 1: During cell stress, A vesicle called autophagosome was generated in the cells. The autophagosome engulfs cell's junk (damaged proteins and organelles) and fuses with the lysosome. Lysosome contains enzymes for digestion of cellular “junk”contents. Inside the lysosome the contents are degraded into smaller constituents by enzymes. In last step, autophagy provides nutrients and new building blocks for cell renewal.