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Literature Survey: Turritopsis Dohrnii, the Immortal Jellyfish. Regeneration: Process, Concept and Implications

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ABSTRACT:

This paper is an overview of fascinating research on the perspectives that jellyfish offer as a model organism in understanding the aging and regeneration of animal tissues. The specific breed of jellyfish which we will be discussing in this paper is the Turritopsis dohrnii. They are small, bell shaped and unique organisms that have a remarkable ability to transform their mature cells back into young cells. They have the biological clock to reset their body into their juvenile state after reaching maturity. The process through which this is accomplished is called trans differentiation. This is the closest concept to immortality seen on this planet .

We will further explore the mechanisms behind the regeneration of the cells in the immortal jellyfish. We will understand the process of regeneration and learn the methods of these jellyfish. This is already being explored even in the medical fields, we can see how it can be applied for treatment of diseases and injuries, as well as in the beauty department.

By understanding the underlying processes of regeneration and trans differentiation in these turritopsis dohrnii jellyfish, we can gain valuable insights into the potential uses of these mechanisms in medical fields. This research could offer exciting possibilities for the development of new regenerative therapies that can help restore damaged tissues and organs in humans.

Introduction:

Turritopsis dohrnii was first discovered in the Mediterranean Sea, but has since spread worldwide. T. dohrnii is generally found living in temperate to tropical waters. The specific breed of jellyfish which we will be discussing in this paper is the Turritopsis dohrnii. They are small, bell shaped and unique organisms that have a remarkable ability to transform their mature cells back into young cells. We will further discuss the Concept and Process of transdifferentiation of these jellyfish and also the application of this in the medical field of human life.

i. The Concept and Process of Immortal Jellyfish

All living creatures in the world experience aging as a natural process. But from the dawn of time, one of the greatest problems facing our species has been discovering the key to eternal youth. We have sought out and continue to seek ways to slow down the aging process so that the effects of aging do not diminish our quality of life.

The average human being starts aging after we reach adulthood, that is around the age of 20. You start aging when the changes in your body are no longer growth and development. Different parts of the body ages at different times. The first sign of aging is seen on your skin at around the age of 25, The skin starts appearing dry and changes texture. The brain starts aging at around the age of 40, it starts losing neurons. Then comes your heart, lungs, kidneys and lastly your liver. The liver stays the youngest for the longest. They start aging only after 60- 70 years.

All human beings have been trying to fight the process of aging since forever. In this paper let's understand those remarkable abilities of the Turritopsis dohrnii jellyfish of reversing the clock and entering its juvenile phase repeatedly. The scientists have already started working on the applications of this in the medical field.

The Turritopsis dohrnii resets their cells and performs a life cycle reversal to prevent death brought on by any physical harm, unfavorable environmental conditions, or aging (in other stages, Cnidaria, Hydrozoa). Because of this special quality, the species is known as the "Immortal Jellyfish." T. dohrnii demonstrates another developmental stage in addition to the conventional hydrozoan life cycle, offering a fresh perspective on cellular plasticity, aging, and regeneration. An injured, old or weak jellyfish will undergo a whole-body transformation into a cluster of uncharacterized tissue (cyst stage) after which they will metamorphose back into an earlier life cycle stage, the polyp. **The underlying cellular processes** that allows the jellyfish to achieve a reverse development is called **transdifferentiation,** a mechanism in which a fully mature and differentiated cell can switch into a new cell type.

ii. Application of compounds of the turritopsis dohrnii in the medical industry

The application of jellyfish into the medical industry is being explored to great extents. Since the process of transdifferentiation is repairing old and damaged cells, research is being made to cure neurodegenerative diseases like cancer with the help of these compounds.

Doing a study on Turritopsis dohrnii is beneficial for multiple reasons:

1. Understanding the biology of immortality: The turritopsis dohrnii is the only animal in the animal kingdom which is immortal. Studying and understanding the biology of these creatures can help gain insights into the mechanisms that allow for such extreme longevity and potentially apply this knowledge to improve human health and increase lifespan.
2. Environmental monitoring: Turritopsis dohrnii are said to be capable of surviving various changes in the climate. They are known as indicator species, which means that their presence or absence can give you an insight on the climate changes or pollution triggers etc.
3. Biomedical research: They have many unique properties which make them an ideal model for biomedical research. To state an example, their remarkable ability to regenerate its entire body from one small fragment could help understand tissue regeneration.

In this paper we will do a literature study on the turritopsis dohrnii process of regeneration and their application. The objectives of this research paper is to

i. Understand the concept of regeneration of these jellyfish

ii. Understand the process of regeneration

iii. Application of these creatures in the medical field

The Concept of Regeneration

Regeneration is the ability of an organism to regrow or replace damaged or lost tissues and parts of their body. Many organisms have the ability to regenerate certain parts of their body from plants and bacteria to certain animals such as starfish and even some mammals. This process appears differently on different organisms. Some of them have the ability to regenerate organs and limbs by the process called epimorphosis, where new tissues are formed from existing tissues at the site of an injury. Flatworms have the ability of regenerating their entire body from a small fragment. Human beings have the ability to regenerate only upto a certain extent. They can regenerate their liver tissues.

The fact that a flatworm can regenerate their entire body may create a doubt about the difference in regeneration between them and the *turritopsis dohrnii*. Although worms and other species have the astonishing ability to regenerate, this does not equate to immortality. In actuality, certain worm species and other animals with the ability to regenerate live relatively brief lives and do not significantly outlive other creatures of a similar size. The majority of species use neoblasts, a type of stem cell that is present throughout the body, to carry out this feat of regeneration. Undifferentiated cells called neoblasts have the ability to differentiate into any type of cell required for regeneration. Neoblasts are activated and start to divide and differentiate into the numerous cell types required to restore the missing tissues and organs when a flatworm is damaged or sliced into pieces. The newly formed cells develop and differentiate into the distinct types of cells required for the regeneration of each tissue and organ as they are produced. Many signaling networks and gene expression programmes control the maturation and differentiation process.

The *Turritopsis dohrnii* jellyfish's regeneration is special because it may go back to a previous developmental stage, basically resuming its life cycle. The jellyfish can convert its mature cells into immature ones through a process known as transdifferentiation, which allows them to later evolve into all the different cell types required to reconstruct the entire body.

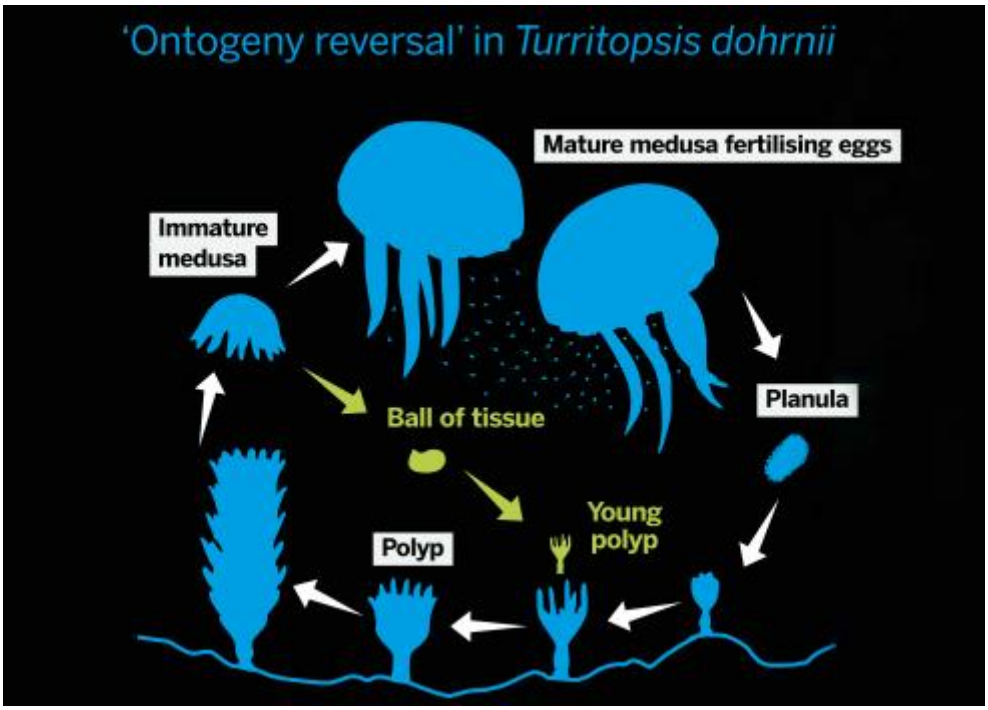
The Turritopsis dohrnii jellyfish has the capacity for immortality due to this mechanism of regressing to an earlier developmental stage. The jellyfish can effectively avoid the consequences of ageing and continue to renew its body indefinitely by turning back the hands of its biological clock. In contrast, the majority of other creatures have a predetermined lifespan that is influenced by things like

Process of Regeneration in the jellyfish *Turritopsis Dohrnii*

Turritopsis dohrnii, like all jellyfish, begins life as a larva called a planula that grows from a fertilised egg. A planula begins its life as a swimmer before landing on the ocean floor and growing into a cylindrical colony of polyps. These eventually give birth to free-swimming, genetically identical medusae, or the creatures we know as jellyfish, which mature in a matter of weeks. *Turritopsis dohrnii*, when fully grown, measures only 4.5 mm (0.18 inches) across, or approximately the size of a pinky nail. Its clear bell is surrounded by up to 90 white tentacles, and in the center is a bright-red stomach. They regress in their development and turn back into polyps in reaction to physical harm or even famine. The reborn polyp colony eventually blooms and releases medusae that are genetically identical to the damaged adult, in a process that remarkably resembles immortality. In fact, the species has earned the moniker "the eternal jellyfish" since this behavior was first noted in the 1990s.

The biological mechanism underlying it, a rare process called **transdifferentiation**, is of special interest to researchers because it may have medical uses. An adult cell that is specialised for a specific tissue might transform into a completely different kind of specialised cell by going through transdifferentiation. It is a productive method of cell recycling and a crucial topic of investigation in stem cell research that could aid in the replacement of disease-damaged cells.

This process of regeneration can happen an infinite number of times. These jellyfish will in turn never die of old age.



Study made to identify the immortality of the jellyfish

There is a new study that compares the *T.dohrnii* and the *T.ruba* which are related jellyfish but the *T.ruba* is mortal. From the research done, it was found that the "immortal jellyfish" has double the amount of genes that repair and protect DNA. This information was given to us by Jason P. Dinh. This allows *T. dohrnii* to produce more restorative proteins.

The authors also found differences in several other genes, including those associated with replication and stem cell population. "Immortal jellyfish" had mutations that preserved telomeres, or DNA sequences that protect the end of a chromosome and typically shorten with age, *New Scientist* writes. These have been factors that contribute greatly to the jellyfish's immortality.

Medical application of the *turritopsis dohrnii*

There are so many potential uses of the *turritopsis dohrnii* in the medical field. Scientists have been researching on these creatures for a while now and these are somethings they have come up with

1. Anti-Aging:

The ability of the *turritopsis dohrnii* to revert back into its juvenile stage has led some researchers to investigate its potential use in anti aging. A group of researchers from the University of Oveido reveal that the genetic sequence of the jellyfish reveals "key molecular mechanisms behind rejuvenation of *T. dohrnii*," the scientists write. Researchers say their work could help promote health for aging humans. They are still researching these topics as they have not yet found anything to prevent aging in human beings.

2. Regenerating tissues: It is studied that the *turritopsis dohrnii* regenerate their tissues which is something that could be potentially used to make regenerating medicines. Studies on their genes and proteins are being made by researchers to see how it could be applied to help with human tissues regeneration.

3. Cancer Research: The *turritopsis dohrnii* produce the protein telomerase which are also found in the human stem cells and in many cancer cells. The telomerase is a protective cap found at the end of chromosomes. They shorten as the cells divide and age. Cancer cells are able to control their telomerase which allows them to divide and grow uncontrollably. Studying the telomerase activity in the *turritopsis dohrnii* can give us new insights in cancer treatment since they can also control their telomerase growth. *Turritopsis dohrnii* is not directly used for cancer research but they're unique properties, cellular mechanisms could potentially aid in understanding cellular aging and regeneration.

Conclusion

The *turritopsis dohrnii* has many potential uses in the medical field. A lot of scientists are trying to conduct research on these creatures. Their gene development, DNA etc. The biggest research going on right now is to find a cure to cancer by understanding the functions of *turritopsis dohrnii* and implying it to human beings. No conclusive uses have been found of *T. dohrnii* but there is a lot of potential identified and a lot of studying to do.

They also make model organisms to study tissue regeneration, wound healing and studying the effects of drugs on neural functions because of their transparent bodies.

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