# BIOKEMI

April 2023

# The Essence of Life

## Fifth Edition

Department of Biochemistry
Shivaji College
University of Delhi

# BIOKEMI 2023

## Fifth Edition

## Departmental Scientific Magazine


**DEPARTMENT OF BIOCHEMISTRY**

**SHIVAJI COLLEGE**

**UNIVERSITY OF DELHI**

**The black holes of nature are the most perfect macroscopic objects there are in the universe: the only elements in their construction are our concepts of space and time.**

*Subrahmanyan Chandrasekhar*

## MESSAGE FROM THE PRINCIPAL

**The whole art of teaching is only the art of awakening the natural curiosity of young minds for the purpose of satisfying it afterwards.**
*Anatole France*

*It gives me immense pleasure to note that the Department of Biochemistry of Shivaji College is bringing out the fifth edition of its annual departmental magazine: BIOKEMI 2023. The motto of Shivaji College Amritam tu vidya (knowledge is eternal) and it is our constant endeavour to transcend knowledge beyond books and classroom.*

*In sync with this motto, I believe that BIOKEMI provides the students with a priceless opportunity to traverse beyond their textbook-based curriculum and study and write about the scientific phenomena of their interest. It also provides a means to nurture and hone their writing skills and to integrate those skills with art and photography. These experiences not only contribute to their holistic development as students of science but also prepare them better for continuing their quest for knowledge.*

*I congratulate the editorial board of BIOKEMI 2023 consisting of faculty members and students of the Biochemistry Department, for marching ahead on this journey of enhancing the scientific aptitude of students. I wish you all the very best for all future ventures.*

**Prof. Shiv Kumar Sahdev**
Principal, Shivaji College

## MESSAGE FROM EMINENT SCIENTIST

***The art and science of asking questions is the source of all knowledge.***
*Thomas Berger*

*It is my great pleasure to have been invited to write this message for "BIOKEMI 2023", the departmental scientific magazine of the Department of Biochemistry, Shivaji College, University of Delhi. I am sure that this initiative will be a great learning experience for the students of the department, as it will give them the opportunity to think beyond the boundaries of the ordinary, in the field of science. This will help the students develop a scientific temperament and motivate them toward research and development.*

*I believe that the art of scientific writing plays an important role in enabling researchers to present their works in the form of treatises and publications. It is important to not only make discoveries in the field of science but also lucidly explain the findings through oration and publication. Endeavours like BIOKEMI can facilitate the students in developing these skills and preparing them to contribute meaningfully to the frontiers of scientific research.*

*I congratulate the Department of Biochemistry on the release of the fifth edition of their annual departmental magazine BIOKEMI. I also wish the college great success in all its ventures.*

**Dr. Aniruddha Roy**
Associate Professor, Department of Pharmacy
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## MESSAGE FROM THE EDITOR'S DESK

**The ignited minds of the youth is the most powerful resource.**
*Dr. A.P.J Abdul Kalam*

*It gives me great pleasure in presenting to you the fifth edition of the departmental scientific magazine -* ***Biokemi 2023****. This magazine was conceptualized as a platform for the students to ignite their minds and express their interests in the field of science. It encourages them to look for topics that pique their scientific curiosity beyond the confines of their curriculum, and come up with their own interpretations. Biokemi also helps train the students in conducting review of scientific literature, writing of original articles and appropriately referencing them. The student editors of Biokemi gain an experience of scientific writing and editing, which would expand their horizons in expressing scientific work. It is always amazing to see the interesting scientific topic that the students choose and explore.*

*It is the fruit of dedicated efforts of the editorial team of faculty members and students that we have been able to release the fifth edition of our departmental magazine. I thank all my Biokemi 2023 editorial team colleagues for the team effort that made this magazine possible. The students' editorial board deserves a special mention as they led this project with dedication, hard work and enthusiasm. I would also like to acknowledge all our authors, for submitting interesting scientific articles and other content. As this was the first time for many authors in writing an original scientific article, their efforts are all the more commendable. I would like to take this opportunity to thank our Principal, Prof. Shiv Kumar Sahdev, for always supporting and motivating us to reach greater heights.*

*I hope you enjoy reading this magazine as much as we enjoyed creating it. We look forward to continuing the legacy of BIOKEMI for the years to come.*

**Dr. Jayita Thakur**
Editor-in-Chief, Biokemi
Department of Biochemistry
Shivaji College

**Nothing in life is to be feared, it is only to be understood.**
**Now is the time to understand more, so that we may fear less.**
*Marie Curie*

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**If you cannot do great things, do small things in a great way.**

*Napoleon Hill*

# A. ARTICLES SECTION

## 1. OILS: QUALITY AND THEIR STRUGGLE TO BECOME GOOD

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Imagine making food without the use of oils is near to impossible which makes them an integral part of our diet. Oils can be of various types like cooking oil, edible oil, vegetable oil, etc. that are obtained from various sources such as plant seeds, crude oil, etc.
In our households, the selection of the oils depends on their quality i.e., whether they are good for health or bad which basically depends on the types of fatty acids present in it. The oil extracted from different plant species may have different chemical compositions but all oils contain fatty acids (1). Fatty acids are essential macronutrients that provide energy to the body and play a crucial role in various physiological processes. Fatty Acids are long-chain carboxylic acids with hydrocarbon chains ranging from 4 to 36 carbons long (C4 to C36) (2). The structure of fatty acids can vary, and they can be saturated or unsaturated. Unsaturated fatty acids are considered to be healthier than saturated ones, as they can lower the levels of LDL (bad) cholesterol and reduce the risk of heart diseases.


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**Figure 1.** Types of Unsaturated Fatty Acids

The difference in structure between cis and trans-fatty acids influences their physical properties (Figure 1.). Trans-fatty acids have a higher melting point and are more solid at room temperature, while cis-fatty acids have a lower melting point and are more liquid. This property is due to the tight packing of trans-fatty acids, which results from the linear arrangement of their carbon chains. In contrast, cis-fatty acids have a kinked structure that prevents tight packing, resulting in a more fluid consistency (Figure 2).
Consuming a diet high in trans-fatty acids can increase the risk of heart diseases, as they can increase LDL cholesterol levels and decrease HDL (good) cholesterol levels. Therefore, it is recommended to limit the consumption of trans-fatty acids in the diet. It is also important to note that during the refining process, some cis-fatty acids may be converted into trans-fatty acids, leading to an increased intake of trans-fatty acids (2).

**Refining:** Refining is a long and complex process that takes place in multiple steps. If we take crude oil, there are 2 types of impurities in it – (a) Fat-Soluble Impurities and (b) Fat Insoluble Impurities, which are rare.
This process comprises mainly 4 steps:

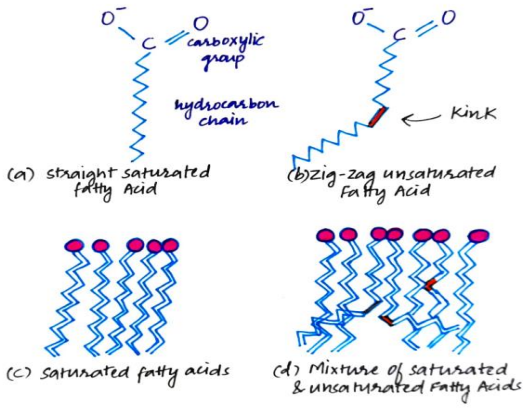


**Figure 2.** The packing of fatty acids into stable aggregates (2).

| Fatty acids | Melting point(°C) |
|---|---|
| *n*-Eicosanoic acid | 76.5 |
| *n*-Tetracosanoic acid | 86.0 |
| Elaidic acid (trans) | 45 |
| *cis*-9-Hexadecenoic acid | 1 to –0.5 |
| *cis*-, *cis*-, *cis*-9,12,15-Octadecatrienoic acid | -11 |

**Table 1.** Melting points of different types of fatty acid

1) **De-gumming:** Degumming is an essential step in the process of refining crude oils. This process involves removing phospholipids (PL) that act as emulsifying agents, which would lead to the loss of neutral oil and ultimately result in a low-quality end product (4). According to research, there are only three primary reasons to degum oil: to produce lecithin (phosphatides), to provide degummed oil for long-term storage or transport, and to prepare for physical refining (3). Degumming can be carried out using various methods, such as
   - Water Degumming
   - Acid Degumming
   - Enzymatic Degumming
   - Membrane Filter Degumming

2) **Neutralization or De-acidification:** Neutralization is the second step during the refining of crude oils, crucial for removing free fatty acids (FFA) from the crude oil. The deacidification process has the maximum economic impact on oil production because the removal of FFA from crude oil represents the most delicate and difficult stage in the refining cycle, since it determines the quality of the final product (5).
   - Chemical Deacidification
   - Physical Deacidification
   - Miscella Deacidification

3) **Bleaching or de-coloration:** Bleaching is the third step in the refining of crude oils that removes any remaining pigments from the oil. This is typically done by heating the neutralized oil and treating it with bleaching clays

that adsorb the colored pigments. The amount of bleaching clay required varies depending on the color content of the crude oil and the desired quality of the final product. Bleaching can be done by 2 ways:

- Oxidation Method
- Reduction Method

4) **Deodorization:** Deodorization is the fourth step and is considered the heart of the entire edible oil refining process (7). This process removes any odoriferous compounds from the oil using steam distillation under vacuum at temperatures ranging from 210-270°C (3). Four interrelated operating variables that influence deodorized oil quality include vacuum, temperature, stripping-steam rate, and retention time at deodorization temperatures (6). There are different types of deodorizers like
   - Batch Deodorizer
   - Semicontinuous Deodorizer
   - Continuous Deodorizer
5) **Dewaxing:** Dewaxing is performed as a fifth step. Dewaxing is not a compulsory process, but it can improve the stability and clarity of the oil. It is performed only for high wax containing oils such as Sunflower Oil, Rice Bran Oil, Corn Oil etc. (7).

Overall, the refining of crude vegetable oils is a complex process that involves several steps to produce high-quality edible oil. Each step is important and can have a significant impact on the final product's quality and shelf life.

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## 2. MITOCHONDRIAL DISEASE IN IDENTICAL TWINS


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'Science is not about the predictable process, rather it is governed by a stochastic phenomenon…….'

'Mitochondria' is a cell organelle present within both plant and animal cells. It plays a pivotal role in proper functioning of the cell as it generates most of the chemical energy required by the cell to carry out certain biochemical reactions. They are the ATP generators in a cell. They are more abundant in those organs where the energy demand is very high for example heart, brain, muscles etc. As the name suggests, Mitochondrial

diseases are those diseases that have a detrimental impact on the normal functioning of mitochondria hence disrupting all the processes directly associated with this organelle (1). Depending upon the site of disruption different symptoms may be observed which includes a wide array of them like fatigue, metabolic strokes, seizures, cardiomyopathy, impairment of kidney, liver and heart functions, cognitive disabilities and much more. These symptoms can be present at any time right from infancy to adulthood depending upon the extent of disruption. When either number or function of mitochondria in a cell are disrupted then there is a great decrease in energy produced which ultimately leads to organ dysfunction. In a rare event, as a result of the extensive investigations led by the researchers at Massachusetts General Hospital (MGH) and Children's Hospital Philadelphia (CHOP) a rare mitochondrial disease has been identified in identical twins (2).

This discovery and the disease are considered to be rare because it didn't follow a general trend rather it was quite abnormal or away from normal. It has been identified that a pair of identical twins were showing a series of unusual symptoms despite being provided normal conditions and all the prerequisites which were necessary. As per the report of New England Journal of Medicine, despite consuming more calories than the requirement, substantial loss of weight was seen when the twins were 2 months old (3). Slowly they started presenting with other health issues like pulmonary malfunctioning and a high body temperature was also recorded. Further research along with Exome sequencing (method that involves sequencing the coding regions of the genome that enables the researchers to focus on the genes that are most likely to affect the phenotype, thus proves to be cost effective and a great time saver compared to the tedious process of sequencing the whole genome) revealed a mutation in an enzyme called the Mitochondrial ATP Synthase, which is required by the cells for generating the energy storage molecule ATP(Adenosine Triphosphate) (4, 5).

Via Post Exome sequencing, it was further found that this mutation leads to "leaky" or mitochondrion that dissipates all the energy generated. This process of energy dissipation is called Mitochondrial uncoupling (4).
So according to Peter Mitchell's Chemiosmotic theory, the electron transfer in mitochondria is accompanied by proton flux and is coupled through several redox proton pumps which are mediated by different complexes named as complexes 1,3,5. This electron transfer generates electrochemical potential that is finally used by F1-F0 ATP Synthase to generate ATP (Figure 1). However not all the potential energy is converted into ATP by mitochondrial rotor due to presence of mitochondrial uncoupling to some extent. This incomplete process can be due to several reasons like basal proton leak, electron leak, electron slip (7). Researchers proposed the name "MITOCHONDRIAL UNCOUPLING SYNDROME" which comprises uncoupled mitochondria which is otherwise hyperactive along with hypermetabolism (1, 3).

This entire process was a rare finding as said by senior author Dr Vamsi Mootha, a professor of Systems Biology and Medicine at Massachusetts General Hospital (MGH). As stated by him there are more than 300 rare genetic mitochondrial diseases and nearly all of them involve disruption of mitochondrial activity. By studying the possible mutations in the ATP synthase, itself can pave a way for further discoveries in the field of mitochondrial diseases (7).

**Conclusion:**

Hence, we conclude that mitochondrial diseases can be of many types and that the type of disease caused in identical twins is solely due to Mitochondrial Uncoupling in spite of having hyperactive mitochondria and hypermetabolism.

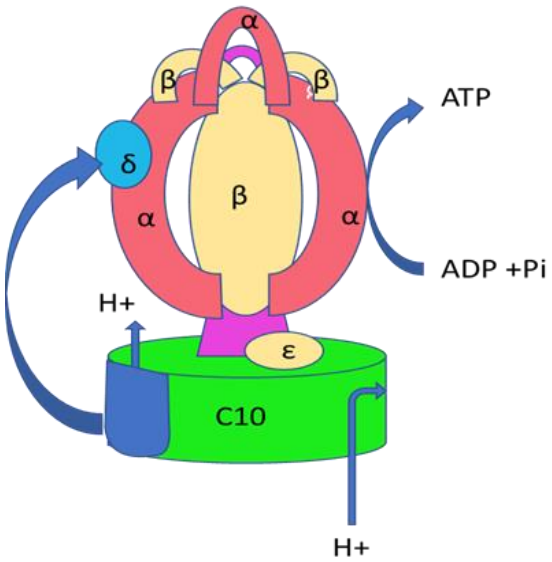


**Figure 1.** Structure of ATP synthase

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## 3. HOW ANTS CARRY THIS MUCH WEIGHT

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Ants are known for their incredible strength and ability to carry objects many times their own weight. This is due to their small size, strong muscles, and cooperative behavior. Ants have a hard exoskeleton and strong muscles that allow them to generate a lot of force. They also work together in large groups to move heavy objects, communicating with each other through chemical signals. When an ant finds a piece of prey, it tries to move it on its own and, if successful, recruits nestmates directly or by leaving trails. Certain species of ants may

recruit specialized workers with large mandibles to chop the prey into smaller pieces if a group of ants is still unable to transport the prey item after a particular amount of time. Thus mandibles play a major role in transport in ants.

Ant mandibles are specialized mouthparts used for a variety of tasks, such as feeding, nest construction, and defense. They are highly adapted to their particular lifestyles and exhibit a wide range of shapes and sizes depending on the species. Their primary function is to capture and manipulate food, such as seeds, insects, and other small prey. Some species of ants, such as leaf-cutter ants, have highly specialized mandibles that are adapted for cutting and transporting plant material. Ant mandibles are also used in nest construction, with some species of ants using their mandibles to dig tunnels or manipulate soil (Figure 1). In addition, some ant species use their mandibles to cut and shape plant material or other materials to construct their nests. Another important function of ant mandibles is defense. Many ant species have highly developed mandibles that are used to fend off predators or other ants. Some species of ants, such as army ants, use their mandibles to form a defensive wall around the colony, protecting the queen and young from attackers (1-3).

**Figure. 1** Mandible are a pair of appendages near the insect's mouth
**(**Source: https://www.rawpixel.com/image/8719984/photo-image-public-domain-animal)

**Organization phase in ants**

Ants use a combination of chemical communication, tactile cues, and visual cues to coordinate their behavior to achieve collective goals. Pheromones can be used to signal the presence of food, mark trails leading to food sources, and indicate the location of the nest or other important areas. Tactile cues such as antennation and touching each other with their legs can convey information about the location and quality of food sources, as well as the identity of other members of the colony. Visual cues such as the position of the sun or landmarks in the environment can also be used to navigate and coordinate their behavior. The study of ant organization and collective behavior has important implications for fields such as robotics, where researchers are exploring ways to replicate the cooperative behavior of ants in the development of swarm robotics and other technologies (Figure 2).

Ants are highly social insects that have evolved a sophisticated system of communication and cooperation to work together to achieve common goals, such as moving heavy objects. Here is a brief overview of how ants work together to carry something (2):

- Identification of the object: Ants identify an object to move, and if it is too heavy for a single ant to carry, they recruit more ants to help.

- Communication: Ants communicate with each other using chemical signals called pheromones. The leading ant will leave a trail of pheromones that other ants can follow to the object.
- Positioning: The ants position themselves around the object in a way that distributes the weight evenly. They use their strong mandibles to grip onto the object.
- Lifting: Once the ants are in position, they simultaneously lift the object, using their strong muscles to generate force. They move the object by walking together in a coordinated manner.
- Navigation: The leading ant continuously leaves a trail of pheromones for the other ants to follow to the final destination. Once they arrive, they deposit the object and stop laying pheromones.
- Through this coordinated effort, ants are able to carry objects that are much larger and heavier than their individual weight. The cooperation and communication between ants is a remarkable example of social behavior in the animal kingdom.

**Figure 2.** Ants work together as one unit
**(**Source: https://www.rawpixel.com/image/3578658/free-photo-image-ant-animal-cc0)

**How load-carrying ants don't fall over**

Load-carrying ants have evolved several strategies to avoid falling over when carrying heavy objects. These strategies include (1):

- Lowering the center of gravity: Ants lower their center of gravity by bending their bodies and aligning their legs with the direction of the load. This makes them more stable and less likely to tip over.
- Increasing leg area: Ants also increase the area of their legs in contact with the ground, which helps to distribute the weight of the load more evenly and improves stability.
- Using adhesive pads: Some ants have adhesive pads on their feet that allow them to grip onto surfaces and prevent slipping.
- Working together: Ants work together to move heavy objects, which allows them to distribute the weight across multiple ants and reduce the load on each individual ant.
- Adjusting their gait: Ants adjust their gait to compensate for the weight of the load, taking smaller steps and moving more slowly to maintain stability.

  Overall, ants have evolved a combination of physical and behavioral adaptations that allow them to carry heavy loads without falling over. These adaptations have been honed over millions of years of evolution and are highly effective at allowing ants to work together to achieve complex tasks.

**The coexistence in ants**

Ants are one of the most abundant and ecologically important insect groups on the planet, and their coexistence is a complex process that involves a variety of behavioral and physiological mechanisms. These mechanisms include the division of labor, the use of pheromones, physical barriers, and social behaviors. Pheromones are used for a variety of purposes, such as marking trails to food sources, identifying nestmates, and regulating the behavior of other ants. Physical barriers are used to segregate different groups within the colony, while foraging areas and waste disposal areas are located on the periphery. Social behaviors such as grooming or food sharing help to reinforce social bonds and promote cooperation within the colony (3, 4).

**Maximal load-carrying performance of ants**

Ants are known for their remarkable strength and ability to carry loads that are many times their own body weight. One study published in the Journal of Experimental Biology found that the leafcutter ant *Atta colombica* was able to carry loads up to 308% of their body weight, which is one of the highest load-carrying capacities reported for any animal. Another study found that the Saharan silver ant *Cataglyphis bombycina* could carry loads that were up to 100 times their own weight. Ants have strong mandibles, strong leg muscles, and the ability to distribute the load of the object they are carrying across multiple workers, allowing them to carry larger loads than they would be able to carry individually. This has important implications for understanding their behavior and ecology, as well as for developing biomimetic robots and other technologies that can replicate the strength and agility of ants. Many experiments are done on different species of ants (on leaf cutting and grass cutting ants) and are observed the papers are referred below (2, 3).

**Difference between grass cutting and leaf cutting species of ants**

Grass cutting ants and leaf cutting ants are two types of ants that are known for their ability to manipulate plant materials, but they have some important differences in their behavior and ecology. Grass cutting ants primarily feed on grasses and other low-lying vegetation and use their mandibles to cut the grass into small pieces, which they then carry back to their nests to use as a substrate for growing a fungus that serves as their primary food source. Leaf cutting ants are found primarily in tropical and subtropical regions of South America and have large, complex societies and their ability to shape and manipulate the landscape around their nests. They are more specialized in their diet and habitat preferences, while grass cutting ants are more adaptable and can harvest a wider range of plant materials. Additionally, leaf cutting ants have a more generalized worker caste (4).

**Large ants do not carry their fair share**

In some ant colonies, larger ants may not carry their fair share of the workload, known as "size-based task partitioning." This is due to larger ants having a higher energy cost of locomotion and may tire more quickly, while smaller ants may have more specialized anatomical features that make them better suited for specific tasks. To address this issue, some ant colonies have evolved mechanisms for enforcing task allocation and ensuring that all ants contribute to the colony's welfare. Additionally, some species of ants have been observed to engage in aggressive behavior towards slackers or to adjust the allocation of tasks based on the needs of the colony. Overall, this phenomenon reflects the diverse abilities and roles of individual ants within a colony, and the overall productivity and success of the colony depends on the coordinated efforts of all members (3).

**Cooperative transport by ants and robots**

Cooperative transport by ants and robots is an area of research that seeks to understand and replicate the ability of ants to work together to move heavy objects. Ants have been shown to be very effective at cooperative transport, and researchers have identified key principles that underlie their success. Robots that can work together to transport heavy objects are being developed using these principles, such as swarm robotics. This research has the potential to improve our understanding of social behavior and develop new technologies for a variety of applications, such as transportation and logistics (4).

**Group size in cooperative transport in ants**

Group size plays an important role in cooperative transport in ants, with larger groups being more effective than smaller groups due to their ability to distribute the weight of the food item more evenly among the workers. However, there is a limit to how large the group can be before it becomes less effective due to more coordination and communication among the workers, and it can be more difficult for each individual to find a place in the group where it can contribute effectively to the task. The optimal group size for cooperative transport depends on a number of factors, such as the size and shape of the food items, the terrain over which it needs to be transported, and the size and strength of the ants themselves. This has important implications for the design of swarm-based robotics systems, where the size and composition of the robot swarm can have a significant impact on its effectiveness and efficiency (5)**.**

**From ants to robots and back**

From ants to robots and back refers to the process of studying the behavior and capabilities of ants and using this knowledge to design and improve robot systems, and then using the insights gained from robots to further our understanding of ant behavior. Ants have been a source of inspiration for robotics researchers for many years, due to their impressive abilities to work together in large groups to accomplish complex tasks, navigate their environment, and adapt to changing conditions. Researchers have designed robot swarms that can communicate with each other, share information, and coordinate their actions, and have also been able to test hypotheses about how ants might achieve similar tasks in their natural habitats. This iterative process of studying ants and robots and using each to inform the other has led to many advances in both fields, and has the potential to generate even more exciting discoveries in the future (4, 5).

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## 4. SKIRMISHES BETWEEN THE GENDERED BRAIN

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*"Women … represent the most inferior forms of human evolution and … are closer to Children and savages than to an adult, civilized man."* ~ Gustave Le Bon, 1895

From the eighteenth century, traits pertaining to a definite social order have been attributed to the brain. The unspoken fact has been established that there is a 'male' brain and a 'female' one.
François Poullain de la Barre, a philosopher from the seventeenth century was the first one to question this inequality. His two publications, On the Equality of the Two Sexes: a physical and moral discourse and On the Education of Women, to guide the mind in sciences and manners (1674), Poullain tries to show how women skills of embroidery and needle-work are equally challenging like those required to comprehend physics. He further appended that the skull region of the body does not exhibit any differences between men and women according to the majority of trustworthy anatomical studies (Figure 1). The brains of women and men are anatomically same, he concluded (1).

In 2015, Dalphna Joel at Tel Aviv University with his colleagues analyzed brain scans from more than 1,400 people. They found 10 regions showing differences, but each of these regions on further study expressed that very few individuals showed an extreme 'male' or 'female' brain rather a pattern of values was revealed with overlapping zones. This suggests that each individual's brain is a mosaic of masculinized and feminized regions, hence we should not expect biologically sex driven differences in behavior (2).

**Figure 1.** There is no anatomical differences in the brain of a male and female (Source:https://images.rawpixel.com/image_png_600/czNmcy1wcml2YXRlL3Jhd3BpeGVsX2ltYWdlcy93ZWJzaXRlX2NvbnRlbnQvam9iNjY5LTA5Mi1wLWwxYWR2YTUyLnBuZw.png)

**Brain Plasticity**

The nervous system's capacity to change its behavior in response to internal or external stimuli is known as neuroplasticity or brain plasticity. Synaptic plasticity, the ability of neurons to change the intensity and accuracy of synaptic activity through a variety of activity-dependent mechanisms, is a key characteristic of neurons. Yet, it is still unclear how precisely plasticity affects the morphology and physiology of the brain despite extensive research into the processes driving synaptic plasticity. Studying the brains of singers, judo practitioners, golfers, etc. provides additional support for this. The demands of their unique expertise could readily be explained by the structural variations in their brains compared to those of ordinary mortals — the left-hand motor coordination area was larger in string players, the right-hand one in keyboard player.

Neuroscientist Maryjane Wraga works at Smith College, US. She did an experiment on spatial ability tasks. When primed with a favourable gender stereotype as opposed to a negative stereotype, women performed better on tasks requiring mental rotation. This effect is called stereotype lift (1).

**Shattering the Neurotrash**

Our plastic brain tries to align and accustom itself to this gendered world, a world that has treated the genders differently for ages. Questions are being asked on the sex differences of the brain.

“If there are sex differences, where do they come from? And what do they mean for the brain’s owner?”(1).

We can now observe the development and disintegration of neural networks as well as the maturation of an adult human. The development of ourselves as social beings is undoubtedly the greatest notable achievement of the brain's evolution, social cognitive neuroscience teaches us. Knowing about the social brain could provide us with a very useful lens to explore how a gendered world can result in a gendered brain, as well as how gender stereotypes are a very real hazard to the brain that can prevent brains from reaching the conclusion they deserve (1, 2).

Lucy Foulkes and Sarah-Jayne Blakemore, cognitive neuroscientists, advised us to consider individual variances, while writing about the adolescent brain. Several factors such as socio-economic status, culture and ‘peer environment' factor have significant impact on brain activity. However, there is no denying that sex differences might matter. Diseases like autism and Alzheimer’s disease do portray gender imbalances. To be

cognizant of these gender imbalances we should not assume that just focussing on biological sex will provide the answers (1).
Deets and data on 'mosaic brains' and dimensionality in behavioural measures reveals that using sex as a catch-all category may miss key valuable influences and paint a misleading picture (2).

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## 5. WHERE HAVE I SEEN THIS BEFORE? WHY DO WE EXPERIENCE Déjà Vu?

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Most people have experienced that strange feeling of seeing something entirely new yet also being quite familiar with the setting - known as déjà vu (from French déjà - already vu- seen). Déjà vu is described as a dissociative phenomenon wherein an impression of familiarity that is subjectively inappropriate has been created between the present and the past. While déjà vu experiences have been linked to memory loss, seizure disorder and various other psychological phenomena, the exact cause of such episodes is still unknown (1). The research exploring the reasons behind this phenomenon is broadly classified into experimental and observational. The observational research mainly involves observing the subject and their experience. Experimental research involves artificially inducing a familiar sensation in order to make the subject experience déjà vu. Both of which are quite tough to do (2).

**What Causes it?**

Various scientists have conducted different experiments and formed their own hypothesis as to why déjà vu occurs. There exist a few theories as to why we experience déjà vu, but the most common of these theories links déjà vu to Temporal lobe epilepsy.

**Temporal Lobe Epilepsy**

One of the most common theories as to why we experience déjà vu involves Temporal Lobe Epilepsy. Epilepsy is a neurological disorder marked by seizures the occurrence of which varies from one individual to the other. This is due to hyperexcitability of neurons in the brain. In Temporal lobe epilepsy the seizures originate in the temporal lobe, the part of the brain responsible for memory (3). People with temporal lobe epilepsy report experiencing déjà vu just before a seizure. This led scientists to speculate that déjà vu could be associated with the temporal lobe. In people who do not have TLE, a déjà vu could be termed as a small seizure, one that does not require medical attention. The strong feeling of familiarity is identified by the temporal lobe and omitted by the rest of the brain (Figure 1) (2).

**Three Possible Mechanisms**

Alan S. Brown, Elizabeth J. Marsh came up with three possible mechanisms that could trigger déjà vu:

- ➢ Split Perception - A mere glance at a scene before a completely fully aware look. Therefore, the perception is split into 2 and seems familiar.
- ➢ Implicit memory - The scene is experienced before but stored in a discrete way and when experienced again that appears to be weirdly familiar.
- ➢ Gestalt familiarity- The current setting is very similar to a setting that has been experienced before (4).

**Familiarity Based Recognition**

A recent report by Colorado State University psychologist Anne M. Cleary links the human recognition memory and déjà vu by pointing out the similarities that exist between them. The report puts emphasis on the importance of familiarity in causing this phenomenon. Recognition memory is that memory that aids the brain in establishing a relation between something we experienced before and something we are experiencing in the present. —M Cleary. Recognition memory is characterized majorly into two that is recollection based and familiarity based recognition. Déjà vu seems to be associated with the latter, according to Cleary. Recollection based recognition is when one can point to the exact instant that an event occurred. Familiarity based recognition is when a situation feels familiar (1, 4).

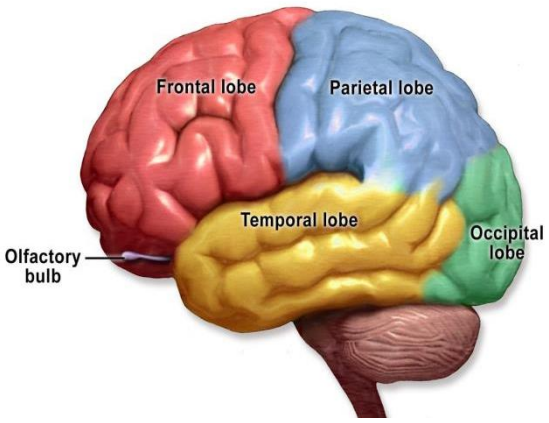


**Figure 1.** Different lobes of human brain

(Source: Blausen.com staff (2014). "Medical gallery of Blausen Medical 2014". WikiJournal of Medicine 1 (2). DOI:10.15347/wjm/2014.010. ISSN 2002-4436)

Cleary conducted an experiment in which the participants were given a list of celebrity names and later given photographs of celebrities, some of which corresponded to the names on the list. The results showed that even when the subjects couldn't identify the celebrities, they were familiar with the names they'd read. This backs the hypothesis that déjà vu may occur when certain details of the current situation resemble that of a situation that has occurred previously.

Cleary's experiments support the idea that déjà vu occurs when certain parts of the current scenario resemble certain parts of a previous experience. The more the overlap the stronger the feeling of familiarity (5).

**Recollection based Familiarity**

The cognitive research points toward disruption or misinformation of the familiarity-based recognition, the hypothesis that Cleary based her experiments on.

Some advancements are also based on the dual-process theory as well. It differentiates recollection and familiarity-based recognition. Some research that takes recollection-based recognition into account suggests that to be able to experience déjà vu, one needs to have solid recollection. This concept is supported by the TLE theory (5).

In an experiment conducted by Martin C. B., Mirsattari S. M., Pruessner J. C. and others in 2012, they took two groups of people with TLE. Some of them did experience déjà vu frequently and some did not. It was found that patients experiencing déjà vu had a familiarity disorder. But, the two groups could not be differentiated on the basis of familiarity. It was a recollection that could do so. From there the inference was drawn that recollection is also required to recognize a familiarity (6). Another study conducted by Brazdil et al attempted at correlating brian morphology with déjà vu experiences. He prepared a questionnaire and measured the grey matter volume of the individual. It was found that people with higher frequency of déjà vu had lower grey matter in areas associated with memory (7, 8).

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# 6. PSYCHEDELIC RENAISSANCE

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The word 'Drug' has a stigma attached to it in our society. You must have come across some horrific headlines in the newspaper like, 'AMERICA MAY LOSE A GENERATION DUE TO DRUGS', 'INDIAN STUDENTS DIED OF HEART ATTACK DUE TO DRUG OVERDOSE', 'TWO BROTHERS DIE DUE TO DRUG ADDICTION', haven't you? But no matter how dark the forecast, every cloud has a silver lining. Certain psychotomimetic drugs also called 'Psychedelics' have the ability to rewire a depressed, anxious mind. The history of psychedelics is far-reaching: the ritual concoction soma, a beverage which has been talked about in the religious texts like the Vedas, is thought to have been a psychedelic. It was probably a plant extract that increased awareness and imparted mystical experiences. A new wave of research has made these hallucinogens or psychedelics a pinnacle of neuroscience. Antidepressants that include selective serotonin reuptake inhibitors, typically work by increasing the amount of serotonin between the brain and the cells. It has been found by experiments that even though serotonin can bind easily to the receptors present on the surface of brain cells, it cannot pass efficiently through the outer membranes of the cells to reach the receptors within. On the other hand, it has also been found that psychedelics, being less polar than the antidepressants, can more easily slip in through the membranes (1). Some examples of the classical psychedelic drugs include Lysergic acid diethylamide (LSD), psilocybin and Dimethyltryptamine (DMT). Entactogens like 3,4-methylenedioxymethamphetamine (MDMA) produce the same psychotropic effect but do not have the same mechanism of action as psychedelics. The mechanism of action of hallucinogens is quite complex. They work by interacting with the 5-hydroxytryptamine (5-HT) system, in simple words, the serotonin receptors (Figure 1). The main receptors (and their subtypes) of the 5-HT system that have been identified include: 5-HTI (5-HT1A, 5-HT1B, 5-HTID, 5-HTIE and 5-HT1F), 5-HT2 (5-HT2A, 5-HT2B and 5-HT2C), 5-HT3, 5-HT4, 5-HT5 (5-HT5A, 5-HT5B), 5-HT6 and 5-HT7. These receptors are present in high concentrations in the cerebral cortex and can be found both on the surface of brain cells as well as inside them. Psychedelics are agonists of the 5-HT2A receptor.

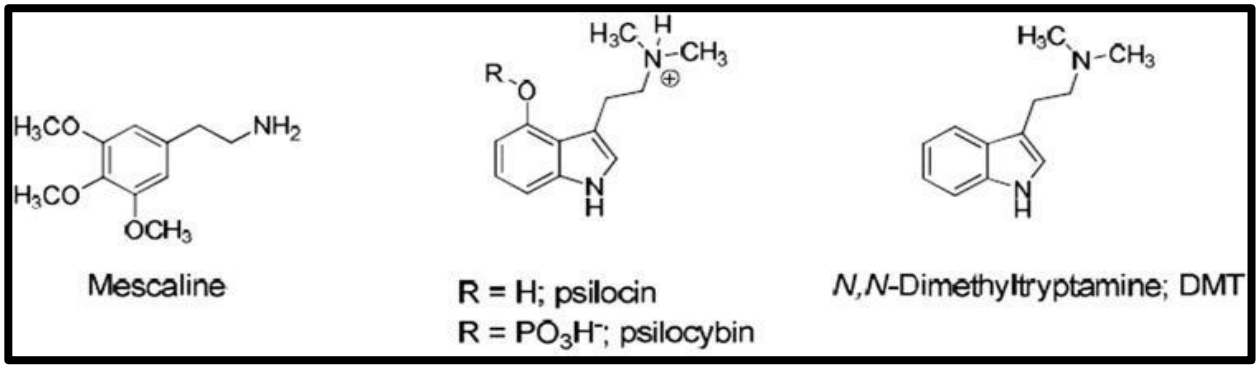


**Figure 1.** Chemical structures of classic psychedelics
Source by: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4813425/

Ever wondered that mushrooms could be magical for mental health? Well, magic mushrooms are. They are a polyphyletic group of fungi that contain psilocybin which acts on the serotonin receptors particularly 5-HT2A whose activation mediates perception, emotional regulation and attention. Studies have shown that psilocybin assisted therapies can lead to improvements in mood and anxiety. The time of action of psilocybin is very less compared to other antidepressants which take weeks to show the maximum effect. In a trial, psilocybin was administered to 233 patients who had treatment resistant depression. After receiving the drug, the patients entered a walking dream-like state but this dose of psilocybin triggered a reduction of levels of depression. Some research suggests that it acts by the deactivation of the medial prefrontal cortex that is very active in the patients suffering from depression. Other studies suggest that it attenuates the activation of amygdala an almond shaped mass of gray matter in each cerebral hemisphere involved in experiencing emotions) in response to treat related visual stimuli (2). Another drug LSD activates the serotonergic and dopaminergic activity in the dorsal raphe nucleus (located in midbrain and pons) and VTA (Ventral Tegmental Area) which influences several biological and neurological processes like anxiety and mood. Dopaminergic system also plays an important role here as studies have revealed that in rodents the behavioral effects of LSD involve first the 5-HT2A receptors followed by the second phase which needs the dopamine $D_2$ receptor.

There is a general perception that psychedelic drugs are very dangerous but from a physiologic point of view, they are one of the safest CNS drugs known (3). The good part is that they do not cause addiction and no overdose deaths have occurred after the ingestion of typical doses of psilocybin or LSD. An adverse effect of hallucinogen use, particularly the use of LSD, is hallucinogen persisting perception disorder (HPPD) (3). In this disorder, patients experience perceptual distortions or ‘flashbacks’ even after the complete cessation of the use of hallucinogen. Nevertheless, the incidence of this disorder is very rare. The research on psychedelic medicine is promising but it should be noted that these studies involved the administration of these drugs under the supervision of doctors. Psychotherapy also plays a very important role which includes preparing the patient about what will happen after the medication is taken. Therefore, it is easy to believe that psychedelics are game changers for mental health but more research and time will provide an answer about their effects on the human brain.

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# 7. AYURVEDA: SELF-HEALING MECHANISM

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We all have basic Ayurveda FAQs like where does it come from? How does it work? Can Ayurveda cure disease? Is Ayurveda a field in the making? etc. Ayurveda is such a vast and interesting discipline where you will connect with traditional healing methods. Here I give a brief overview of Ayurveda and its importance.

**What is Ayurveda?**

"AYU" means life, and "VEDA" means knowledge. Ayurveda was first recorded in the Vedas, the oldest surviving document. Ayurveda is the science of daily life, a body of knowledge that evolved from the practices, philosophies and religious initiations of "rishis" (1).

**Ayurveda, Tantra, Yoga (as mentioned in the vedas and upanishads scriptures)**

Yoga is the science of the union of God and truth. Tantra, the most direct method of energy control, which creates the ultimate union of truth and falsehood. The aim of every practice is to achieve longevity, rejuvenation and self-realization in the individual (Figure 1).

- Panchmahabhutas key concepts that are central to Ayurveda:
  Ether (space), air, water, fire, earth are the five most important elements of all matter. Man is a microcosm of nature and is also made up of five elements. Ether is the first element, and there are many empty spaces (ether) in our body, such as the digestive tract, esophagus, etc. Air is the second element, which exists in the form of heartbeat, contraction and expansion of lungs, etc. Fire is the third element. In the human body, the source of fire is metabolism, such as the digestive system and the gray matter of brain cells. Water is the fourth element involved in the secretion of digestive juice and salivary glands into human mucosa, plasma and cytoplasm. Earth is the fifth and final element that houses all living and non-living matter on a solid surface. In the human body, earth is present in the form of cartilage, bones, nails, tendons, skin and hair (2,6). In the poster above, the formation of panchmahabhutas is clearly shown.

- Tridoshas
  The five elements also embody the functioning of the five sense organs. These five elements exist as three elements called Tridoshas in our body. These three elements are vata (wind), pitta (bile), kapha (phlegm) (6). Involves the psychological, physiological and biological functions of body, mind and spirit. As stated above, all locations of Tridoshas mention their respective functions. In the image above you can also see how the creation of the five elements took place. If one of these Tridoshas is out of balance, we can heal it through another dosha by balancing the respective faulty doshas (4).

Balance is the key to perfect health

✓Vatta- Principles of Movement

✓Pitta- Principles of Metabolism

✓Kapha- Principles of Structure

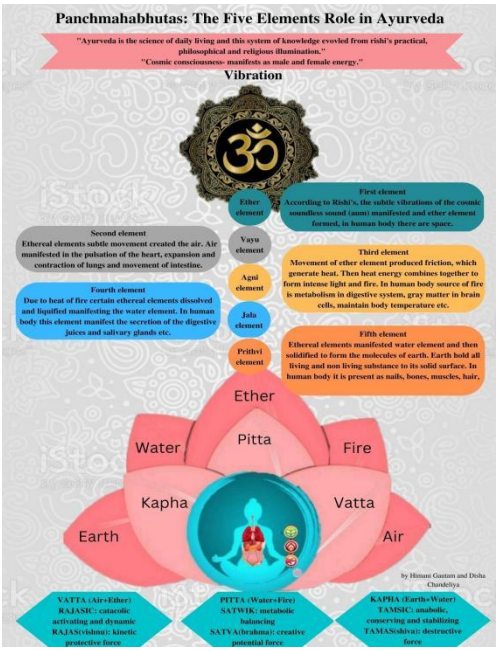


**Figure 1.** Poster on Ayurveda: The self-healing mechanism

When this balance is disturbed, health problems arise. For example, Qi can ignite the bodily fire, but water is needed to control the fire, otherwise the bodily fire will burn the tissues. All tridoshas balance each other through their respective functions (1,4). Ayurvedic research and methods. They are the oldest medical systems, consisting of a thousand hypothetical medical concepts (3,5). Vata means (space + air) it regulates all body movements and is also responsible for breathing, eye blinking, heart rate etc. If you belong to vata prakruti, then for your vata prakruti keep colors bright and soothing and their combinations gold, blue, green, orange, white and use sweet, warm and soothing scents, cultivate peace, fearlessness, your tutor. Get support there. Pitta means (Water + Fire), a Pitta person will have a strong build, mean face and hardworking, the person will face skin related issues like acne and stomach related issues. These people should not eat foods that are too heavy or too light. It should be rich in sweetness, bitterness and spice, moderate exercise, meditation, listening to soft and cool music. A Kapha (Earth + Water) person must express their creativity, avoid coffee, go to bed early and exercise moderately to balance these energies. The image above briefly explains all these doshas and panchmahabhutas.

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## 8. TRANSPOSONS: THE JUMPING GENES

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Transposons or transposable elements (TEs) are the sequence of DNA that are mobile. In a genome, these sequences can move from one position to another, and therefore are termed as **Jumping genes.** Transposons are present in almost all eukaryotes and prokaryotes and in higher proportion. They make up nearly 12% of the genome of *C. elegans* (1), 37% of mice, 45% percent of humans and more than 80% in plants like maize (2). **Barbara McClintock** in the 1940s first discovered the transposons in corn, and later received the nobel prize in medicine for her discovery (Figure 1) (3).

**Classification of transposons**

In 1989, Finnegan first introduced the classification system for transposons based on whether they require reverse transcriptase or not for their transposition mechanism. These include class I transposons (retrotransposons) and class II transposons (DNA transposons) (5).

**CLASS I TRANSPOSONS (retrotransposons)**

Retrotransposons constitute a major portion of the eukaryotic genome. Transposomal elements falling in this category require a RNA intermediary to transpose and they function through a copy and paste mechanism. They form a copy of DNA sequence, leaving behind the original sequence undisturbed and the copied sequence is inserted at a new site. During transcription, DNA is copied to RNA, which jumps to another site within the genome. Enzyme reverse transcriptase catalyses the reverse transcription of RNA intermediate so that it enters the genomic site it has moved to.

Retrotransposons can be categorized as LTRs (retrotransposons having Long Terminal Repeats) on both ends and non-LTRs. LINEs (Long Interspersed Nuclear Elements) and SINEs (Short Interspersed Nuclear Elements) constitute the non-LTRs. L1, a LINE having length of nearly 6 Kb and Alu element, a SINE of length of only a few hundred nucleotides are the leftover class of active TEs present in humans.

**Figure 1**. Maize Demonstrating Transposition and Chromosome Dissociation. Studied by Barbara (4)
(Source: https://www.cell.com/cell/fulltext/S0092-8674(17)30998-4)

**CLASS II TRANSPOSONS (DNA transposons)**

DNA transposons contain a transposase gene having TIRs (Terminal Inverted Repeats) at both the ends, which is recognised by enzyme transposase. They function through a cut and paste mechanism. Transposase catalyses the cleavage of DNA sequence from the start point (cut) and this cleaved sequence jumps to another site within the genome to get inserted (paste). The enzyme also cleaves the target site for insertion. The completion of this transposition mechanism is accomplished by nucleotide synthesis which fills up the gap created during cleavage by transposase. The length of DNA transposons can be 1000- 40,000 base pairs (1). Based on the whether a double strand break is created or not in the DNA while insertion, DNA transposons can be further subdivided into two class, namely subclass I that contains families like piggyBac, CACTA, mutator, Tc1/mariner, merlin and subclass II that contains helitron and maverick.

**Autonomous and Non autonomous Transposons**

TEs can be either autonomous or non-autonomous. Transposons like Ac elements of drosophila do not require the presence of other TEs for their mobilization and hence are autonomous. Non autonomous transposons lack the transposase gene or gene for reverse transcriptase, hence they need another TEs for transposition. A classical example of Non autonomous TEs are MITEs (Miniature Inverted Repeats Transposable Elements) that are 80 to 500 bp long, present particularly in plants (6).

**Transposons present in human genome**

1. LINEs (Long Interspersed Nuclear Elements)
   It is the only transposable element that continues to transform the human genome. Rest of the transposable elements have become inactive due to mutations. LINEs or L1, constitutes nearly 21 percent of the human genome. The length of L1 elements is about 6 kilo base pairs. L1 contains a single 5’ UTR (untranslated region), two open reading frames (ORFs) and a 3’ Untranslated region. In humans, ORF1p protein necessary for L1 retrotransposition is coded by ORF1. ORF2p protein is coded by ORF2.
2. SINEs (Short Interspersed Nuclear Elements)
   The length of these elements is nearly 100 to 600 bp. They have a 5’ terminal head, a 3’ terminal tail and body. The head is much similar to RNAs synthesized by polymerase III. Many SINEs do not contain bodies, and only terminal heads and tails are present. Such SINEs are called simple SINEs. Simple SINEs are different from pseudogenes of RNAs due to the substitution of specific nucleotides.

**Regulation of transposition**

Transposition is often deleterious to both host and the transposons. Thus, to minimize the effect of transposition and to improve fitness of the host, few transposition control mechanisms are present.

1. Inhibition of overproduction of transposons (OPI)

When transposase concentration exceeds the threshold value, it acts as an inhibitor. This was first observed in Tc1/mariner element (7). However, the exact nature of the mechanism is not understood, but suggestions have been made that transposase monomers form oligomers that are less active, thereby lowering the transposition activity (7).

2. Vertical Inactivation
   Many TEs harbor mutations that inactivate them. This occurs due to selective pressure to minimize damage to the genome of the host. Moreover, these nonfunctional TEs produce inactive enzymes which hinders the transposition process by initiating OPI, or through competition for TIRs with the enzymes that are active. For effective transposition, two transposases are needed. Thus, nonfunctional transposase protein acts as an inhibitor of transposition. At the other end, active transposases are recruited by elements that are inactive and have active TIRs.

The host can also formulate other mechanics to regulate the activity of transposons. One such mechanism includes the DNA methylation to shut down the Tc1/mariner element by preventing its transcription. Post transcription methods are also often used.

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# 9. *DROSOPHILA* AS A MODEL FOR KIDNEY DISEASE

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The human kidneys play an essential role in the body's life processes. It purifies the blood and removes the toxic substance which can be proven lethal if retention occurs. Along with the excretion, it also checks the water balance by regulating the water loss. Defective kidney and malfunction can cause end-stage renal disease (ESRD) and chronic kidney disease (CKD). For kidney disease the main cure we have is either dialysis, or kidney transplantation, both the ways are not only highly expensive but affects one's life and families. Therapeutic and medicinal treatment is a limited option (1). *Drosophila melanogaster* is an excellent model to study kidney disease (Figure 1). Complex structure of human kidneys poses a challenge for pathological studies to be done whereas, it is clear that Drosophila is an evolutionary intermediate moving towards glomerular kidneys, special and observable cell types for different kidney functions like different cells for detoxification, filtration, absorption, reabsorption and endocytosis (1). If we talk about the excretory system of Drosophila then we have two Malpighian tubules (MT) which re analogous to renal tubules of nephrons and two nephrocytes present in cluster form in the body cavity that is analogous to podocytes in human kidneys (2). According to the ultrastructural studies, the nephrocytes form a tri-layer filter with morphological resemblance to the vertebrate podocytes (1).

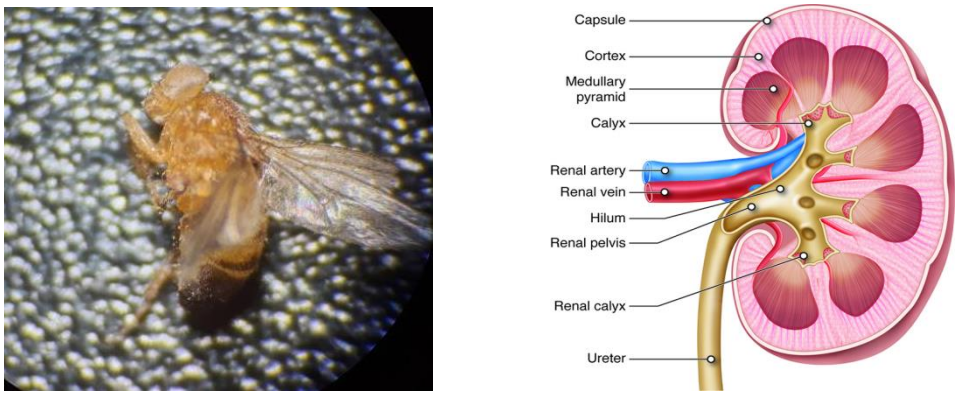


**Figure 1.** Renal tubules of human kidney and MTs of *Drosophila melanogaster* are analogous (Source: Urinary Structures and Functions – Anatomy & Physiology (ccconline.org))

**Morphology of Malpighian Tubules and its Relevance as a Model Organism**

Excretory system of Drosophila is composed of two pairs of MTs which are made up of single-layered epithelium. MTs are present between midgut and hind-gut. One is present anteriorly and the other posteriorly freely within the body cavity (2). The MT pair lying anteriorly is longer than the other pair lying posteriorly because of distinct transcriptomes. Anterior tubule pair has four different sections: initial, transitional, main, terminal. It contains two types of cells, type-I and type-II. Type-I or principal cells transport cations and organic solutes. Whereas, type-II or stellate cells are present around principal cells and have a role in flow of water and chloride ions. MTs are internally asymmetric represent spatial arrangement of gene domain which can also be seen in case of human

nephrons (3). Enhancer trap expression in MTs showed that different sections of anterior and posterior tubules are composed of different cell types performing different physiological functions. The main segment secretes water and KCl, one third portion of the lower segment performs reabsorption and its lower region preferentially reabsorbs potassium ion over water and by this it modifies the fluid (2).

Lower tubules perform acidification of the fluid by absorbing Ca+ into the lumen of the tubules. Cells present in the main segment secrete fluid in amount of its own volume in approx. 14-15 seconds, making them the fastest filtering unit or system. MTs have a very simplified development and functionally they are complex and can be compared with the human nephrons, thus playing a good role as a model for human kidneys (Figure 2) (3).

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**Figure 2.** Malpighian tubules of 3rd Instar Larvae visualized under stereo-microscope

**Polycystic Kidney Disease**

Polycystic Kidney Disease is an inherited genetic disorder, which can be autosomal dominant or recessive (rare) type. ADPKD causes the degeneration of the renal tubules (nephrons) by the uncontrolled proliferation and growth of the epithelial cells that lead to cyst formation. Cyst keeps on progressing and also damages its surrounding cells and impairs other renal tubules, both cystic and healthy ones. The cyst growth is neoplastic in nature, not just affects the structure and integrity of renal tubules but also halts renal functions which are essential for the kidney. Thus, progressively it leads to kidney failure because it is incurable. About 50% of ADPKD patients require a renal transplantation. ADPKD also disrupts metabolic procedures occurring in renal tissues. As ADPKD progresses in a patient by age, the number of cysts increases, enlargement of cyst occurs and they get filled with fluid. The major pathways affected in ADPKD are mTOR pathway or activation of mechanistic target of rapamycin. In humans it arises due to mutations in the PKD1 gene in most cases, in some cases it arises due to mutation in PKD2 gene and in the rest of the cases mutation occurs in some other loci. Studies done on murines have shown that the human PKD1 gene and its murine ortholog affect the expression of BICAUDAL C gene, which was first seen in Drosophila melanogaster ovary. BICAUDAL C gene transcribes a RNA binding protein which regulates MYC (family of proto-oncogenes) or and mTOR pathway and cause its upstream on the other hand this protein genetically downstream PKD1.BicC mutant flies were chosen because they show the features of ADPKD. Thus, due to 75% conservation in disease-causing genes and functional similarity of MTs with human nephrons, Drosophila was chosen as a model to study ADPKD. The pattern of occurrence of ADPKD in humans and BicC mutant flies were also found to be the same i.e., cyst were prominent in the intermediate and terminal tubules. PKD shows a great diversity in its phenotype and speed of progression may also vary. Human nephrons being so complex in structure are not easily dissected and

studied whereas Drosophila MTs are simple in structure and present freely in the body cavity, thus can be dissected and cystic index can be therefore calculated (4).

**Cyst Reduction Using Second- Mitochondria Derived Activator of Caspases(smac) Mimics**

smac is abbreviated for second-mitochondria derived activator of caspases (a family of protease enzymes) or DIABLO (Direct Inhibitor of Apoptosis-Binding growth with lOw pI). Smac mimics have been proven antineoplastic as they make the cells sensitive towards apoptosis. Smac mimics or behaves like an antineoplastic reagent by making cancer cells sensitive to apoptosis as they act on IAPs (Inhibitor of Apoptosis Proteins). IAPs are equally important for cell survival as it makes a balance between newly formed cells and cells undergoing programmed cell death and also provide innate immunity. Production of IAPs is increased in ADPKD (a type of cancer). Mammalian genes that code for IAPs are: XIAP- X linked, CIAP1-Cellular IAP1, CIAP2- Cellular IAP2. Drosophila genes that code for four IAPs are: Diap1, Diap2, dBruce and Deterin. In Drosophila three proteins act as an IAP antagonist or induce apoptosis (in mammalian cells), those are Reaper, Hid (Head involution defective) and Grim. Other than these, we have more fly IAP antagonists such as Jafrac, sickle and HtrA2. Mammalian IAP antagonists are smac/DIABLO, Omi/HtrA2, ARTS (Apoptosis-related protein in TGFβ Signaling) pathway, XAF1 (XIAP associated factor1). Reaper, Hid and Grim together form RHG protein having all three in a repeated pattern forming a motif. The action of these IAP antagonists was known by thoroughly studying human Smac/DIABLO and fly Hid protein. IAP antagonists induce a stimulus that induces the peptide cleavage of RHG proteins at the N-terminus and in this way, it exposes RHG protein to interact with IAP proteins that causes ubiquitination of IAP protein and ultimately it gets degraded. IAP degradation promotes apoptosis by two ways either by caspase activation or by TNF (Tumor Necrosis Factor) signaling.

The discovery of Smac/DIABLO N-terminus peptide H-Ala-Val-Pro-Ile-NH2 helps in understanding its role to promote apoptosis by degrading IAPs eventually. This also led to the development of more such smac mimics. The ability of prototypical H-Ala-Val-Pro-Ile-NH2 and its other derivatives or smac mimics to reduce cysts was tested in BicC flies of allelic combination BicCΔ/IIF34 and BicCΔ/YC3, cystic deformities were scored. Adult flies were fed on food media containing equal volumes of either water or an aqueous solution of peptide 1 and its analogs or smac mimics separately. Both in-vivo and ex-vivo assays were performed. After 20 days flies were taken and MTs of 27-29 days old flies were microdissected and a cystic index was calculated by counting the number of cyst in different regions separately (4).

**Conclusion**

The smac mimic affects the MTs differently. They do not show homogenous effects on MTs, instead tubular secretions respond differently to different smac mimics. Tubular regions have more improvement on administration of 1-4 smac mimics. This can be due to different ranges of metabolism and absorption of cystic cells present throughout the tubular region. The clogP values of 1-4 mimics also fall under the absorptive range (4).

**Cyst Reduction By Melatonin**

Melatonin is a neurohormone that is mainly secreted by pineal gland at night but also secreted by other brain cells, skin cells, cells of GI tract and by every other cell and is present almost everywhere. Melatonin can act by modulating receptors MT1 and MT2 and can also act without aid of any receptor. Along with maintaining the circadian cycle of the body it also releases the oxidative stress, cures pain and hypertension. Scientific studies

have also proved the oncostatic effects of melatonin and this can be an excellent agent to prevent tumor formation because it does not have any side effects as other treatment methods including chemotherapies and radiation therapy can have. Melatonin prevents cell proliferation in various types of cancers including ADPKD. Melatonin can induce apoptosis by various pathways. In ADPKD hyperproliferation of renal tubules due to activation of evolutionarily conserved pathways occurs along with this it also increases oxidative stress and causes inflammation in cells of renal tubules. Melatonin also shows very less toxicity in cells and thus can be used effectively. Drosophila BicC fly model was used to test the effect of melatonin in cyst reduction (Figure 3). Two different BicC mutant flies that were taken are BicCD/YC33 and BicCD/IIF34 flies. Adult BicC flies were fed on a food medium having equal amounts of water and melatonin separately particularly at night time. After 20 days flies were taken and MTs of 27-29 days old flies were microdissected and a cystic index was calculated by counting the number of cyst in different regions separately [5].

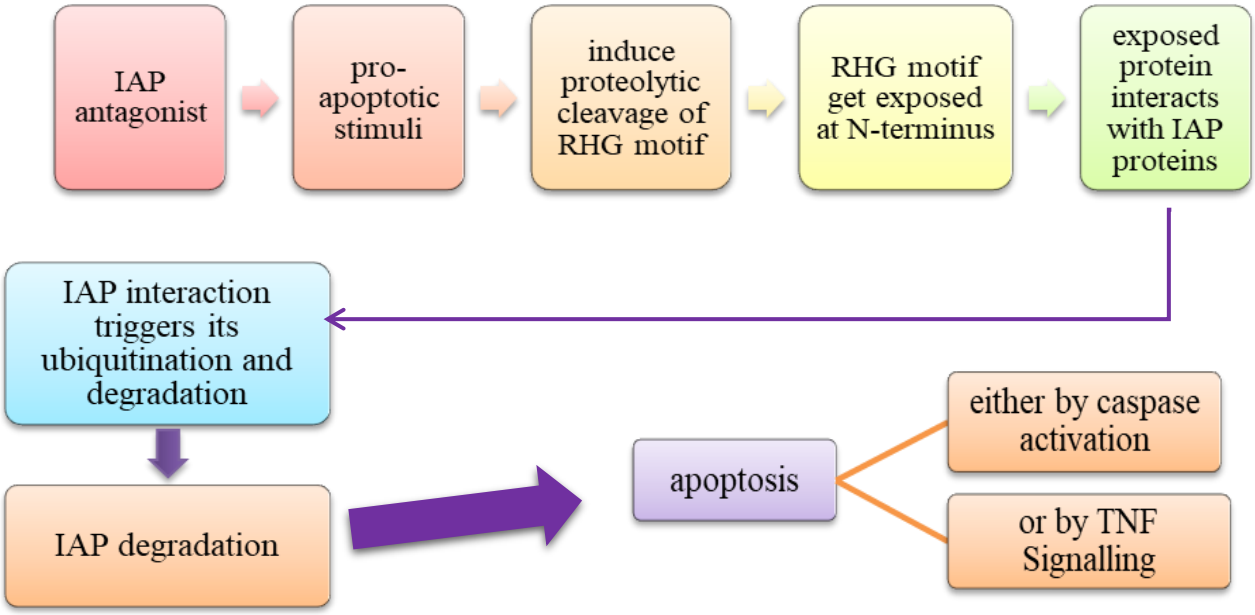


**Figure 3.** Mechanism of action of IAP antagonist against necrosis.

**Conclusion**

Melatonin treatment affects different regions of anterior and posterior tubules to a different extent in BicCD/YC33 mutant flies. Melatonin affects the anterior tubules with more efficacy than that of posterior tubules, but overall it does show cyst reduction in both the regions. Whereas, melatonin treatment affects BicCD/IIF34 mutant flies with less efficacy. Overall it does show a cyst reduction in both the anterior and posterior regions of the tubules but the clogP value was found to be more than the threshold which means that the evidence is still not strong enough for melatonin to be accepted as a way of treatment (5).

**Nephrolithiasis**

Nephrolithiasis commonly known as kidney stone disease is the agglomeration of certain salts that are supersaturated in urine. Most common salt that forms stones or calculi is calcium oxalate.Stone formation and treatment are highly conserved in humans and Drosophila melanogaster, which allow us to use Drosophila tubules as a model to screen and measure the efficacy of anti-nephrolithiasis agents (6). Genetic screening leads to identification of the new genes which give rise to kidney stones in humans as well as this technique also lead to identification of Drosophila prestin gene which is responsible for transportation of oxalate in tubules. When the prestin gene was removed or silenced it was seen that stone formation was reduced in renal tubules. In another study it was found that Drosophila mutants having gene NHERF/Sip1 show uric acid crystal stone burden. Then this gene was used to identify V-ATPase subunits in case there is a loss or reduction in naturally occurring uric acid crystals. V-ATPase subunits are responsible for forming plasma membrane proton pumps in type-I or principal cells of Drosophila tubules 1(Figure 4).

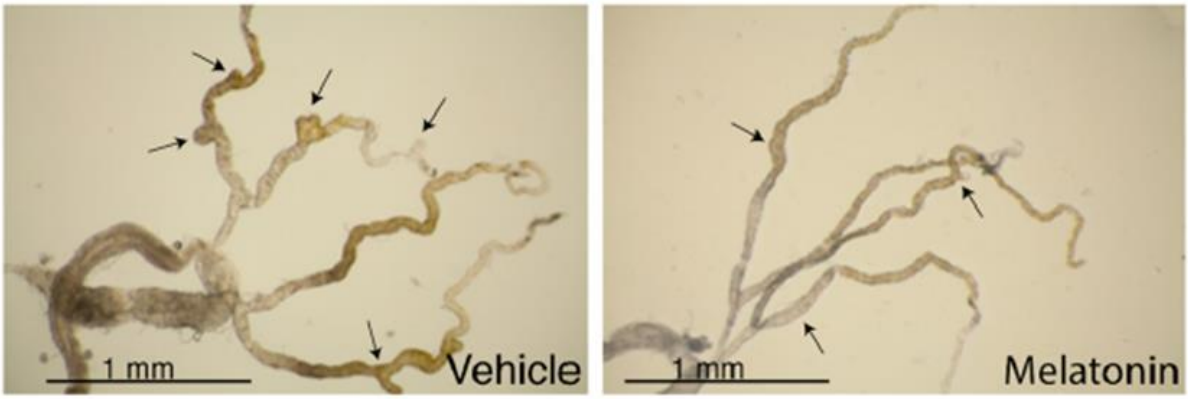


**Figure 4.** On the left hand side, the vehicle represents the MTs having cyst formation not treated with melatonin, whereas on the right hand side MTs treated with melatonin show reduction in cyst (5).

Scientific research has revealed that calcium-oxalate based calculi are present in the MTs of Drosophila melanogaster just as those found in human nephrolithiasis patients and has also identified the role of oxalate-co-transporter and role of excess zinc in mineralization of kidney stones (7). It was observed that contents of MTs also moved to hindgut via peristalsis where they get mixed with the fecal matter and it was discovered that stones formed in MTs will also be present in the fecal matter of flies. Functional high-throughput screening leads to testing and identification of many novel compounds with proven therapeutic effect.

One such compound is Arbutin or Hydroquinone β-D glucopyranoside which acts against calcium oxalate antagonists. Arbutin is isolated from the Bearberry dwarf shrub. Alendronate-fluorescein isothiocyanate (FITC) is a fluorescently labeled bisphosphonate that binds to oxalate calculi. Alendronate-FITC was used to stain calcium oxalate calculi and hydroxyapatite nanoparticles were used as positive control. Alendronate-FITC shows high binding affinity towards calcium oxalate crystals (Figure 5).

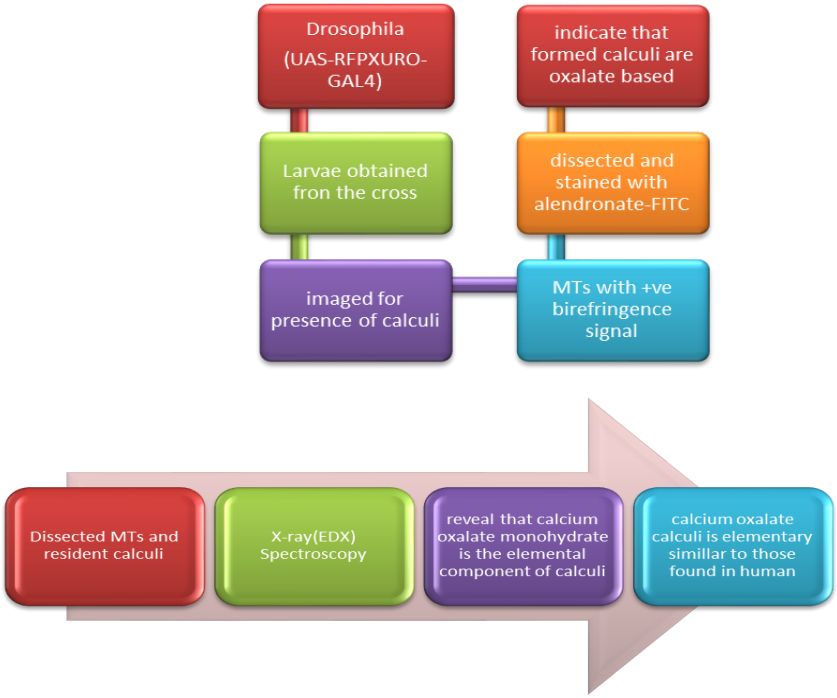


**Figure 5.** Examining oxalate-based stones in fecal matter of adult *Drosophila melanogaster*.

Drosophila was supplemented with sodium oxalate and ethylene glycol; sodium oxalate was more prominent in formation of calculi in MTs. GAL4/UAS was the tool used to develop transgenic flies. Larvae that express fluorescent RFP protein in the MTs were imaged. It revealed that oxalate-based calculi were found throughout the MTs and hindgut. Birefringence signals from crystals and alendronate-FITC staining of calcium oxalate led to quantification of crystal burden. In the similar way fecal excreta assay was developed to quantify changes in crystal burden. A coverslip was inserted in the vial, which once deposited with fecal excreta was subjected to polarized light microscopy wherein positive birefringence signals represent calculi (Figure 6).

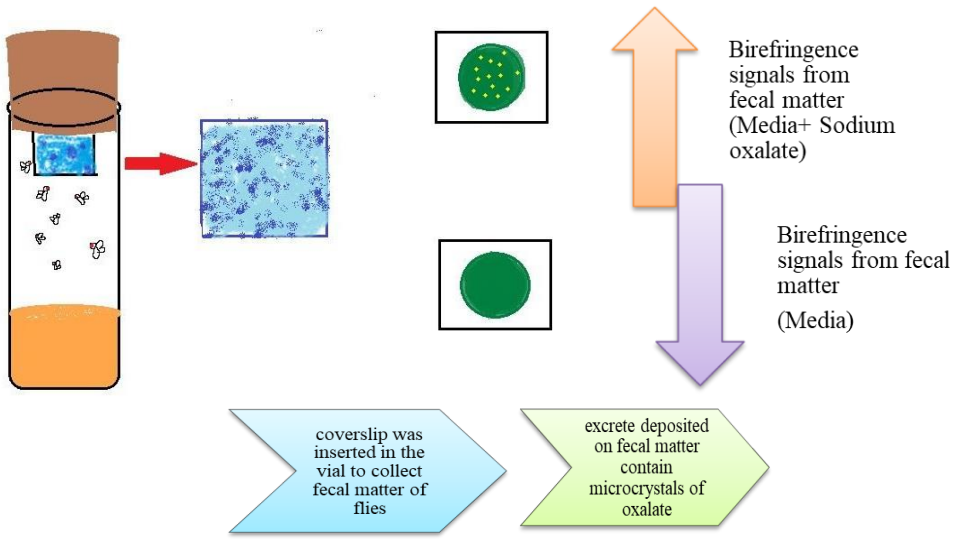


**Figure 6.** Birefringence signals from crystals and alendronate-FITC staining of calcium oxalate led to quantification of crystal burden.

Drug screening was performed on the basis of fly viability and anti-lithogenic effect of the drug, from which arbutin was chosen and it also validated Drosophila as a high-throughput model. Sodium oxalate and arbutin when supplemented together showed prohibition of calculi deposited in MTs.

**Conclusion**

HEK (Human Embryonic Kidney) cells incubated with sodium oxalate cells, but when arbutin was added in the medium it improves cell viability and cell survival. The pharmacokinetic effect of arbutin in the human body is still not established fully, it currently falls under the category of herbal supplement or plant-based extract. Still the question comes out whether it prevents stone formation or treats the pre-existing calculi.

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# 10. PUPILS CAN SPEAK, WHAT WE ARE UNAWARE OF

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## Pupil: A Window To Brain

Humans are fully capable of expressing themselves by various means as they are blessed with the ability to speak, to write and to enact. We have a range of actions to express who we are, what we think, what we want, what we are afraid of. Facial expressions are a way to communicate without words (1). Human face consists of viscerocranium (facial skeleton) having 14 bones, 43 mimetic muscles (facial muscles) and the most important are eyes which add a lot to facial expressions. In eyes, pupil is the dark center in the middle of iris. The special feature of pupil that enables it to express is that it can change in size which is controlled by the intraocular muscles including ciliary muscles, the sphincter pupillae, and the dilator pupillae (2). These changes in the pupil size are known as pupillary dilations and is an involuntary action mainly controlled by the Autonomic Nervous System. The pupil changes its size to control the amount of light entering into our eyes but they play a major role in expressing our emotions. Pupils reflect our perception of our surrounding activities, thoughts even before our brain perceives it. Eyes become a critical source of knowledge about oneself. Eyes superscribe dual roles. First, they can express a range of social information and direct the attention of a partner during a group activity. Second, they represent a window to our brain, where the incoming actions, words arouse our mental state and our emotions are reflected in the form of pupillary dilations. This provides us with quick feedback and expresses the understanding of another person's emotional state. For instance, during a penalty kick in a football match, the player who is supposed to make a shot never looks in the eyes of the goalkeeper. Because, by looking in the eyes, one can make out the direction in which he will shoot the ball. Sometimes false body actions are also made to confuse each other but it is never advised to make eye contact. To predict other's future actions, humans gather information from the body movements and the eye signals. A study shows that humans like to deal with another's eyes more than their arms or body. Even when decisions are not conscious, they are nonetheless revealed by pupil dilation, which shows a person's decisions even before they consciously carry them out. Understanding human joint action capacities require an understanding of pupil dilation (Figure 1) (3).

**Figure 1.** Pupils add a lot more to our facial expressions.

**Experimental Analysis**

An experiment was conducted, in which the participants were presented with a video depicting arm movement of actors reaching for an object and placing it at the center of a table. The stimulus material was 10 different video clips of a typical, uninformed individual, or "person A," moving their right arm. Person A was sitting while being filmed. Person A was seated across from Person B, and a board game was placed in between them. Person A reached for the wooden dowel in front of him in half of the videos and placed it in the middle of the table with the implied intention of using it again (personal intention) or, in the other half of the videos, with the intention to switch turns and give Person B the opportunity to reposition the dowel (social intention).

As a result, the video clips featured two motor parts acting sequentially throughout a reach-to-grasp phase and a transport phase. The following event was not depicted in the video. After the object was put in the middle of the table, the video clips were shut off exactly one frame later. Ten separate videos were used, five of which featured motor activities motivated by social goals and five of which were motivated by personal intentions. These were chosen because they presented the least amount of overlap between circumstances for the highest elevation of the hand, and they each displayed the most stereotypical kinematics of social and personal objectives for reach-to-grasp motions. The volunteers were placed at a table in a hushed, dark experiment room, facing a screen with several videos playing. Behind the display, a remote eye tracker was installed, allowing the individuals' pupil sizes to be recorded. Two response keys (e.g., "left ctrl" for "social intention" and "right ctrl" for "personal intention," counterbalanced for half of the keyboard) were placed on the center of the table. Participants were asked to watch the video clips and group them into categories based on what they thought the actor was trying to convey. The first analysis's goal was to examine the participants' pupil sizes during trials in which they had correctly identified the motions they had seen. Video Type was used to predict pupil size (personal or social). The second analysis's goal was to forecast the participant's choice, personal or social, based on the size of his or her pupil just before the choice. Decision was used as the dependent variable in a binary logistic multilevel linear model analysis (coded: personal=0, social=1) and pupil size is the predictor (Figure 2) (3).

**Figure 2. (A)** Constricted pupil **(B)** Dilated pupil
(Source:https://www.pexels.com/photo/person-s-eye-in-close-up-photography-3594720/)

**Results**

Three results are mainly concluded from the analysis of the categorization done by the participants. First, it was demonstrated that participants can infer other people's intentions from their arm movements, confirming prior

findings. Mean accuracy for the videos depicting social intention was 59.9% and for personal intention it was 59.0%. Second, right choices made by the participants during the trial were looked at. The findings demonstrated that participant's pupils were larger after watching the videos depicting personal intention as opposed to social intention. Third, it was examined whether participants' interpretation of the seen videos could be predicted from their pupil diameters using a logistic generalized linear model.

Here, it was confirmed that participants can distinguish between societal and personal motives. The right interpretation of the participants was reflected in their pupil diameters, but differently for video demonstrating social or personal aims. Last but not the least, even before participants expressly stated whether or not they believed the movements in a video constituted social clues for communication, their pupils had already revealed their choice by demonstrating how they saw the movement. Also, it has been demonstrated that a person's pupil size changes in response to their emotions. Due to the unconscious nature of pupil changes, they may provide partners with direct knowledge of the decisions made by others (3).

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## 11. GARLIC: A WONDER NUTRACEUTICAL

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Garlic (*Allium sativum*) has been used as a food for thousands of years and is known for its medicinal properties in civilizations around the world. Surviving ancient corpora can support their use in Chinese, Egyptian, French, and Ayurvedic medicine. Garlic is native to Central Asia, where people live the longest and have the lowest known cancer rates. This is not accidental (1). Garlic (pulp) has been found to contain more than 200 compounds, including volatile oils and sulfur compounds such as allicin, allin, and ajoene. It also contains enzymes such as alliinase, peroxidase and myrosinase (1).

**Garlic As Nutraceutical**

It is clear that garlic is used as a food all over the world. Today, it has become an integral part of our diet (Figure 1). Scientists around the world have proven that garlic has medicinal properties for the treatment and prevention of certain diseases. It has curative and preventive properties. New attention is being paid to the prevention of heart disease and cancer by using garlic as a nutraceutical (5,2).

**In Cardiovascular Diseases**

Today, studies around the globe have suggested that garlic consumption can reduce the risk of heart disease caused by the hardening of the arteries. Garlic is considered good for the health of the heart because it lowers the cholesterol and blood fats called triglycerides in the bloodstream. Sulfur compounds of garlic, including diallyl disulfide (DADS) seem to help smooth blood flow by preventing platelets from sticking together and clotting. Garlic also has been shown to protect blood vessels from the deleterious effects of free radicals. Its blood cholesterol-lowering effects and capacity to reduce cholesterol deposits on blood vessel walls have both been attributed to this antioxidative activity (4).

**Anticancer agent**

Recent studies confirm the fact that garlic has shown great potential for cancer prevention. Population-based observations suggest that people with a diet high in raw or cooked garlic have a lower risk of colon, stomach, breast, prostate, and throat cancers. A substance called DADS suffocates cancer cells until they shrink in number and begin to die. Another substance in garlic, diallyl trisulfide (DATS), was 10 times more effective at killing human lung cancer cells than DADS. Its effectiveness is comparable to 5-fluorouracil, a widely used chemotherapy agent. Garlic contains compounds that help protect against nitrites, substances commonly found in some foods and pollutants that turn into nitrosamines, nitrosamines which are harmful compounds that can cause cancer in the body (5,2).

**Figure 1.** Garlic as a nutraceutical
**(**Source: https://www.pxfuel.com/en/search?q=garlic+oil)

**Antibiotic property**

Louis Pasteur was the first to scientifically test the antimicrobial properties of garlic in 1858, showing how it could kill bacteria under laboratory conditions. Several modern comprehensive studies have confirmed that garlic has certain antibiotic properties that are effective against many bacteria, fungi and also garlic have antioxidants properties which neutralize harmful free radicals before they can damage healthy cells (2,1).

**Role as an Antidiabetic**

According to a few studies that have suggested it may have some minor blood sugar-lowering characteristics. Garlic is hypothesized to lower blood sugar levels by slowing the pace at which insulin is inactivated and degraded by the body, effectively increasing quantities of circulating insulin and decreasing blood glucose levels. In general, sulfur compounds in garlic are believed to exert hypoglycemic activity by competing with insulin (1,3).

**Conclusion**

Garlic has been used for thousands of years for its medicinal properties Many studies have shown its beneficial effects on cardiovascular diseases. Studies have also shown its positive effects as an anti-cancer, natural immune defense, antioxidant, antibiotic and anti-diabetic agent. On the other hand, studies have also reported some side effects of garlic when used with blood-thinning, HIV, or blood sugar medications. This observation suggests that more research is needed on the safe and positive use of garlic as a dietary supplement (5,1).

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## 12. NUTRITIONAL PSYCHIATRY: HOW CAN DIET LESSEN THE BURDEN OF DEPRESSION?

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**What Is Nutrition Psychiatry?**

The phrase "you are what you eat" is accurate (1). Science has demonstrated that a healthy diet has an effect on physical health. Science is now demonstrating that eating a balanced diet may have an effect on mental health. Research is being done on how diet affects mood and other characteristics of mental disease. The concept of employing food and dietary supplements as complementary therapies for mental health illnesses is known as nutritional psychiatry (2). For patients with depression and anxiety, nutritional psychiatry is becoming a viable option for treatment assistance. In terms of nutritional psychiatry, research shows that what we eat affects how we feel on a psychological level. According to accumulating evidence, diet and nutrition are important for

human biochemistry and body composition, but they also have a big impact on people's moods and mental health. Despite the complexity of the elements that influence mental health, research shows a substantial correlation between a poor diet and the escalation of mood disorders, such as anxiety and depression, as well as other neuropsychiatric problems (3). The availability of suitable nutrients, such as lipids, amino acids, vitamins, and minerals, is necessary for the composition, structure, and function of the brain. As food consumption and food quality inherently affect brain function, nutrition is a changeable factor that can be used to target mental health, mood, and cognitive performance (4). In addition, the composition of the diet has a direct impact on endogenous gut hormones, neuropeptides, neurotransmitters, and the gut flora (5).

**Make These Good Mood Foods Part of Your Diet (6)**

- Citrus fruits and Berries: If you have a sweet tooth, swap out sweets and pastries with blueberries, raspberries, or strawberries. Berries are a wonderful source of vitamin C and have little natural sugar. This vitamin helps the body control the release of the stress hormone cortisol.
- Green leafy vegetables: Broccoli, kale, spinach, and leaf lettuce are examples of probiotic foods. These are the meals that the good bacteria in your stomach eat. Dark, leafy greens are a good source of folate, magnesium, potassium, and vitamin B12. These nutrients are known to lessen anxiety and depression.
- Nuts: Almost all nuts contain tryptophan. This amino acid contributes to the synthesis of serotonin, a brain neurotransmitter that controls mood. The finest nuts for elevating mood are walnuts, cashews, and almonds.
- Fermented foods: Gastrointestinal health is essential for brain and mood wellness. Probiotics should be given to our GI system in the form of fermented foods like unsweetened yogurt, kombucha, kimchi, or sauerkraut to maintain its health.

**Connection between Gut Microbiome and Brain**

Anatomically speaking, the vagus nerve connects the gut and brain. Recent research has shown that the intestinal microbiome plays a crucial role in the relationship between the gut and the development and function of the brain. Additionally, an increasing number of studies has shown that the gut microbiota has a significant role in how the body reacts to stress and affective disorders like anxiety and depression (7). It has also been claimed that a balanced gut microbiome is essential for controlling serotonin metabolism and serotonin plays a significant role in mediating happiness. Stress can also damage and upset the gut flora, which has a detrimental effect on digestive health. Hence, a high-quality diet may aid in regulating the gut flora, lowering stress and inflammation in the brain, and maintaining healthy cognitive function over the course of a person's lifetime. Intriguingly, recent research has shown that prebiotics can reduce the activation of age-related microglia and has the potential to ameliorate age-related neuroinflammatory diseases and cognitive decline (8). Similarly, diets rich in omega-3 polyunsaturated fatty acids, eicosapentaenoic acid, docosahexaenoic acid, and docosapentaenoic acid and vitamin A normalized the negative behavioral, cognitive, and neurochemical effects of stressed adolescent rats and also caused changes in the microbiota's composition (9). While the host's genetics and environmental factors, such as lifestyle, influence the composition of the gut microbiota, diet and nutrition continue to be the primary drivers of gut microbiota composition and function. For instance, studies have already demonstrated that Mediterranean and high-fiber diets foster a diverse gut flora and are linked to a lower risk of depression (10). Moreover, fermented meals may have the ability to change gut physiology, the composition of the gut bacteria, and even one's mental state (Figure 1). So, it is evident that gut microbiota may have an impact on mental health, but the exact processes by which this occurs are yet unknown. There is an urgent need for mechanistic research to determine the molecular mechanisms underlying the influence of the

gut microbiota on centrally controlled activities. Future research should discover diets that can alter brain activity by causing particular bacterial strains to produce centrally active compounds.

**Impact Of Vitamin Deficiencies On Mental Health**

Vitamin B12 (whose deficiency results in fatigue, lethargy, depression, poor memory, and is linked to mania and psychosis), thiamine (vitamin B1; its deficiency results in beriberi with numbness as a CNS symptom and Wernicke's encephalopathy), folic acid (vitamin B9; deficits are linked to a higher risk of depression during adulthood), and niacin (vitamin B3; its deficiency causes Pellagra with dementia as a result) are some of the vitamins which are linked with depression (11). Randomized controlled trials (RCTs) conducted during infancy, adolescence, and adulthood have, though not always consistently, shown that vitamin D supplementation has a positive impact on depression and attention deficit/hyperactivity disorder. According to cutoffs determined from bone health evaluation, a significant number of the general population is vitamin D deficient, which emphasizes the need for clear proof of its effectiveness in treating neuropsychiatric illnesses particularly in conditions associated with high levels of inflammation, such as liver diseases, a healthy diet rich in polyphenols, polyunsaturated fatty acids (PUFAs), and nutritional supplements, including vitamins, has been reported to exert positive effects on mental health, including on cognitive performance, mood, stress reactivity, and neuroinflammation. Vitamin C and Vitamin E are also associated with lower risk of depression as shown in table 1.

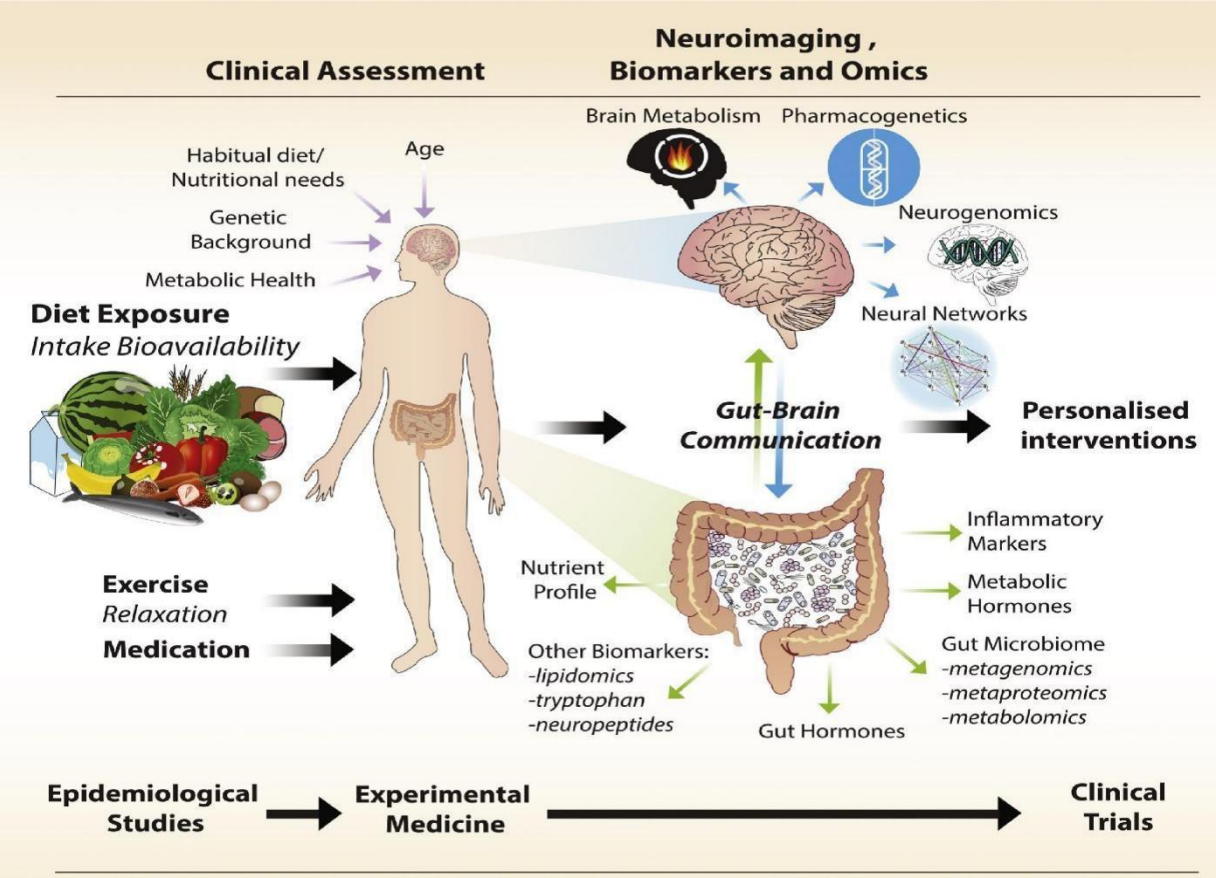


**Figure 1**. The Gut-Brain Connection

(Source-https://www.semanticscholar.org/paper/Nutritional-psychiatry%3A-Towards-improving-mental-by-Adan-Beek/b42e7949e40318c05f1d1a00f712409633d1ab74/figure/0)

**Role Of Flavonoids in Fighting Depression**

Fruits contain polyphenolic compounds called flavonoids that may act as a depressive disorder prophylactic. A rise in levels of brain-derived neurotrophic factor (One of the most common validated indicators of depressive disorder is decreased levels of BDNF) (12), a reduction in oxidative stress, and a reduction in neuroinflammation are proposed as possible reasons for this impact. Flavonoids have been shown to have antidepressant effects in a recent meta-analysis. Flavonoids are recognized as promising plant-based bioactive components that can affect several facets of synaptic plasticity. They can be found in a number of fruits and vegetables. Current research is focused on elucidating the processes through which flavonoids affect cognitive function. Long-term supplementation studies in animals reveal that flavonoids may influence synaptic plasticity via activating neuronal receptors, signaling proteins, and gene expression. Early research shows that stimulation paradigms that cause long-term potentiation (LTP) in the hippocampus proper region upregulate BDNF (brain-derived neurotrophic factor) mRNA. These results support the hypothesis that BDNF affects synaptic LTP, which depends on activation of extracellular signal-regulated protein kinase (ERK) and mitogen-activated protein kinase (MAPK).

**Antioxidant Effect of Antidepressant Flavonoids**

Metabolic abnormalities of monoamine neurotransmitters implicated in NE, 5-HT, and DA signaling are the primary biochemical causes of depression. The outer mitochondrial membrane proteins known as monoamine oxidases (MAO) catalyze the oxidation of primary, secondary, and tertiary amines, including a number of neurotransmitters, to the equivalent imines. Hesperidin, naringenin, quercetin, and astolibin are some flavonoids that have shown antidepressant-like activity and have been shown to reduce depressive symptoms in animal experiments or in vitro models, primarily by (i) inhibiting monoamine oxidases (MAOs) and (ii) changing oxidative/antioxidant defenses and/or (iii) inflammatory responses. The main ways that flavonoids work are by quenching free radicals and stimulating the body's own antioxidant enzymes. Hesperidin actually reduced MDA synthesis in cultured human cell lines such as HaCaT and ARPE-19 cells, led to increased levels of superoxide dismutase (SOD), glutathione (GSH), and reduced ROS generation. While amentoflavone exhibits inhibitory effects on the synthesis of superoxide anion and total reactive oxygen species (ROS), it also has neuroprotective properties by restoring reduced superoxide dismutase (SOD) activity, glutathione reductase (GR) activity, and glutathione content that is stimulated by glutamate. By pretreating cells with chrysin, naringenin, quercetin, astilbin, icariin, 7,8-dihydroxyflavone, hyperoside, baicalein, rutin, luteolin, and kaempferitrin, the oxidative damage caused by various oxidative agents was reduced (13). Chelation of transition metal elements was another way that flavonoids' antioxidative properties were manifested. These organic substances then allowed metals to chelate or bind to metal ions in both people and animals, preventing them from being susceptible to oxidation (Figure 2).

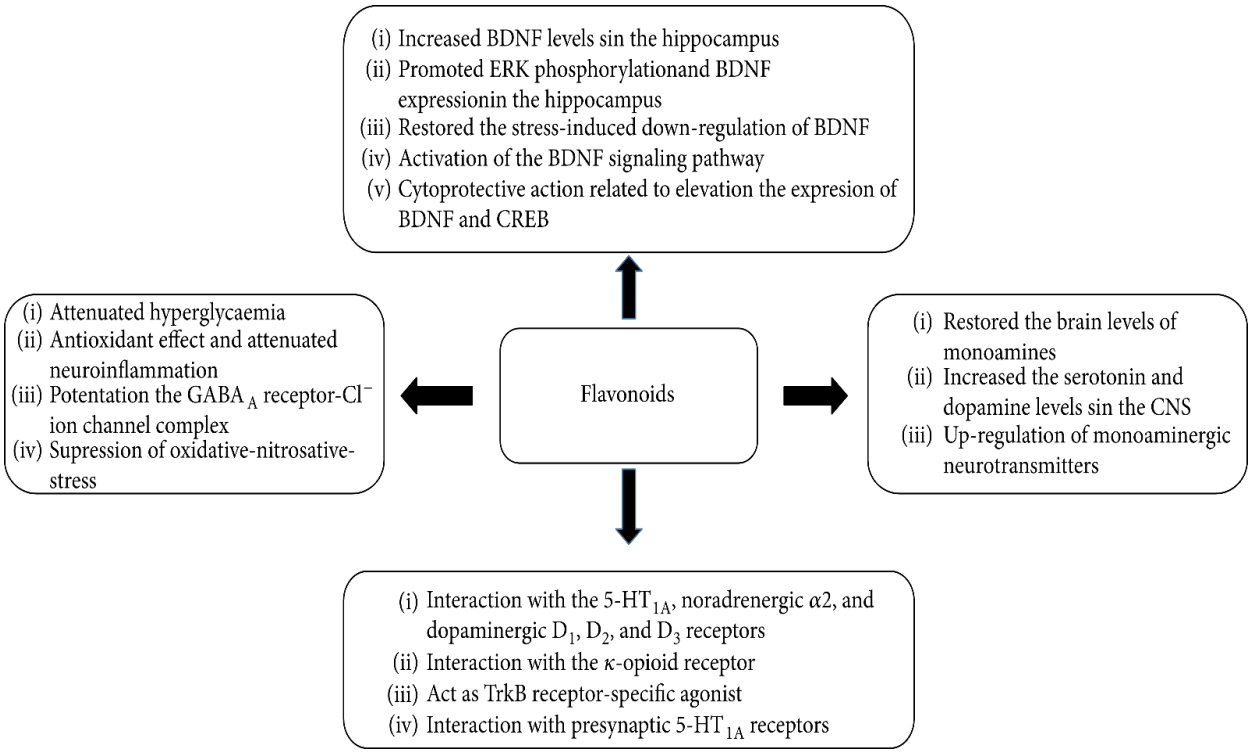


**Figure 2.** Possible mechanisms of action of flavonoids with antidepressant activity (Source- https://www.hindawi.com/journals/omcl/2017/5762172/fig1/)

**Experimental Evidences**

The ketogenic diet for kids with epilepsy is a well-known illustration of a dietary intervention that has an impact on brain health. The mechanism in this case is unknown, however the decreased frequency of epileptic seizures during fasting, when ketone bodies are the brain's primary energy source, points to a potential contributing factor. Another substance for which an exclusion diet can stop cognitive deterioration is phenylketonuria. In addition, research has demonstrated that shortages of several nutrients, especially vitamins, affect cognition. Apples, pears, and citrus fruits, which are high in flavonoids, were linked to a lower incidence of depression, according to food-based analysis. In the study conducted by Zui Narita et al., published in 2022 (14), the association between vitamin and fruit consumption – particularly flavonoid-rich fruits – in mid-life and major depressive disorder (MDD) in later life was evaluated and following observations found in the table below.

As predicted, it was discovered from the study that eating fruits high in flavonoids was inversely correlated with Major Depressive Disorder (MDD) diagnosis. These relationships persisted even after taking sociodemographic characteristics, such as physical activity, into account. In contrast, overall fruit consumption including juice produced non-significant outcomes. Fruit juice is said to have a lower antioxidant density than raw fruits and a higher glycemic index than raw fruits, both of which have been linked to depression risk. Moreover, fruit juices strip fruits of their fibers, suggesting that fibers may potentially help to lower stress levels.

| | Group 1 | Group 2 | Group 3 | Group 4 |
|---|---|---|---|---|
| **Vitamin C**<br>Median intakes, mg/d | 103.3 | 152.0 | 193.3 | 265.2 |
| No. of cases/controls | 24/276 | 25/276 | 23/278 | 21/281 |
| Fully adjusted model, OR (95% CI) | Ref. | **0.88** (0.49, 1.58) | **0.73** (0.38, 1.40) | **0.64** (0.33, 1.24) |
| **Vitamin E**<br>Median intake, mg/d | 6.2 | 8.1 | 9.7 | 11.8 |
| No. of cases/controls | 25/275 | 20/281 | 25/277 | 23/278 |
| Fully adjusted model, OR (95% CI) | Ref. | **0.60** (0.29, 1.25) | **0.69** (0.36, 1.32) | **0.55**(0.26, 1.18) |
| **Flavonoid- rich fruits**<br>Median intake, g/d | 55.2 | 105.1 | 156.8 | 335.1 |
| No. of cases/controls | 22/218 | 20/221 | 17/225 | 15/226 |
| Fully adjusted model, OR (95% CI) | Ref. | **0.67** (0.33, 1.35) | **0.49** (0.24, 0.99) | **0.44**(0.20, 0.97) |

**Table 1:** Observations proving that intake of vitamins and flavonoids is inversely proportional to major depressive disorder (MDD) (14)

OR – Odds ratio, CI- Confidence Interval

**Conclusion**

Growing research supports the idea that diet, stress sensitivity, mental health, and mental function across the lifetime are all directly correlated. To guide public health policy on diet, new groundbreaking research on the symbiotic links between nutrition and brain function is desperately needed. The development of innovative nutritional therapies and evidence-based recommendations that will enhance and sustain brain fitness throughout life will be guided by improved mechanistic understanding of how diet affects mental health and cognition (15).

**"The doctor of the future will no longer treat the human frame with drugs, but rather will cure and prevent disease with nutrition"- Thomas Edison**

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## 13. CAN HUMANS REGENERATE THEIR LIMBS?

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The planarian worms have the ability to regenerate their missing portions. It is because of the electrical gradient of the wound controlled by ion channels and signals that lead the way whether to create a head or a tail. It turns

out that with the change in electrical gradient of the wound it regenerates a head instead of a tail, thus creating a doubled headed worm! (Figure 1)

**Figure 1.** A two headed planarian worm
(Source: https://www.iflscience.com/scientists-grow-flatworm-with-two-heads-instead-of-tail-41823)

A number of questions arise like can this information be further used to create a worm with three limbs? How does that relate to the growth of a tadpole with eyes on their tails? Also lastly how are the planarian worms and frogs so similar that they were able to regrow their limb using principles learned from this without any genetic engineering! In future it may be possible to regenerate the limb of a mouse or even a human? Let's dwell deep into this... All animals from axolotls to humans have millions of cells with cell membranes. There are various types of ion channels and their main function is to move charged ions across the cell membranes. For the movement of ions there is constantly a voltage potential between the outside and inside of a cell. It is most commonly studied with action potentials at axons in the brain.

The bioelectricity with voltage potentials isn't just limited to the brain. It is happening in every cell of every animal due to the ion channels. Ions moving in and out of the ion channels end up polarising the entire cell and the polarised cells interacting together end up creating polarity on a larger scale like polarising the heads and tails of a planarian worm. This polarisation signals to grow either a head or a tail after it is cut in half.
For a better visualisation, if a magnet is cut in half, it divides into north and south pole and it regrows the missing pole. This can be seen in planaria because when it is cut, certain enzymes appear that belong to the head or the tail. It is not restricted to cutting it in half but if a chunk is taken out of the middle of the worm it can be seen that each side of the chunk has different voltage potentials. These different voltage potentials signal to turn on different processes to grow either a head or a tail (Figure 2).

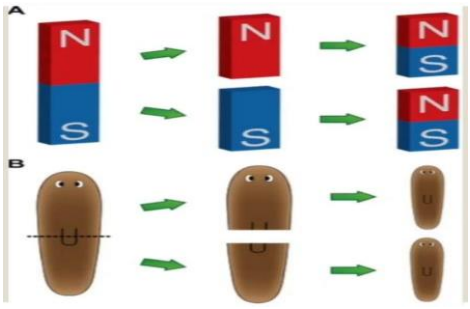


**Figure 2**. Planarian worms restore their polarity like bar magnets
(Source: researchgate.net)

If the same chunk is taken and added an antibiotic named ‘nigericin’, voltage on the right side becomes same as that of the left side (Figure 3). It means that the process to stimulate growth of a head occur on both sides of the wound of the worm. So, “a two-headed worm has been made”.

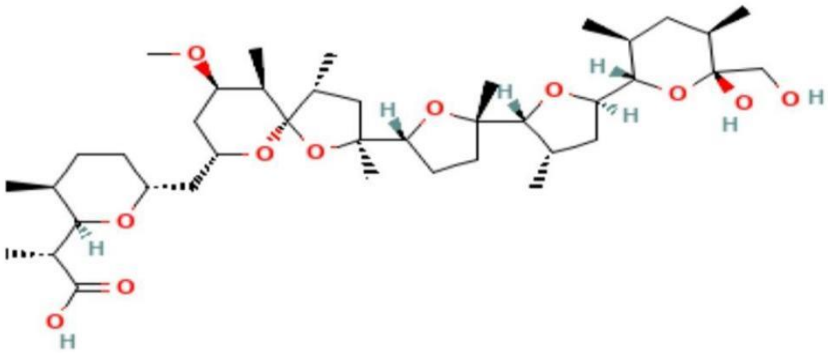

**Figure 3**. Structure of Nigericin
(Source: pubchem.ncbi.nlm.nih.gov)

If required, slight changes can alter the process so that each time the worm is cut it regrows with two heads over and over. It is not limited to creating just two headed worms, the voltage potential can be changed at any point of the worm and create triple headed or quadruple headed worms. That is how researchers have ended up with “two headed one tailed worm” (Figure 4). It is not limited to flatworms, even spiky worms or cup shaped worms can be created just by altering the electric circuits.

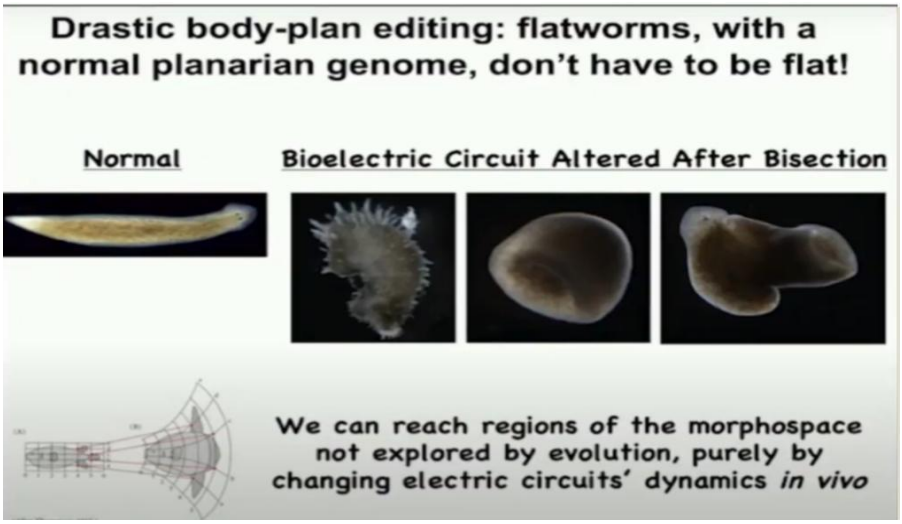


**Figure 4.** Different worms with different sizes can be made by altering their electric potentials.
(Source: https://as.tufts.edu/biology/levin-lab)

Before moving towards frogs there are two more things about worms. Firstly, if the tail is cut in half and regenerate a new head, it will still have memories from the original head. Secondly, if the electrical potential is changed at wound so that when it regrows, it grows back the heads of different species of these worms. The head eventually goes back into the shape of the original species after around thirty days. Thus, it means a

different species of worm could be grown without using the genetic engineering and only bioelectricity (Figure 5).

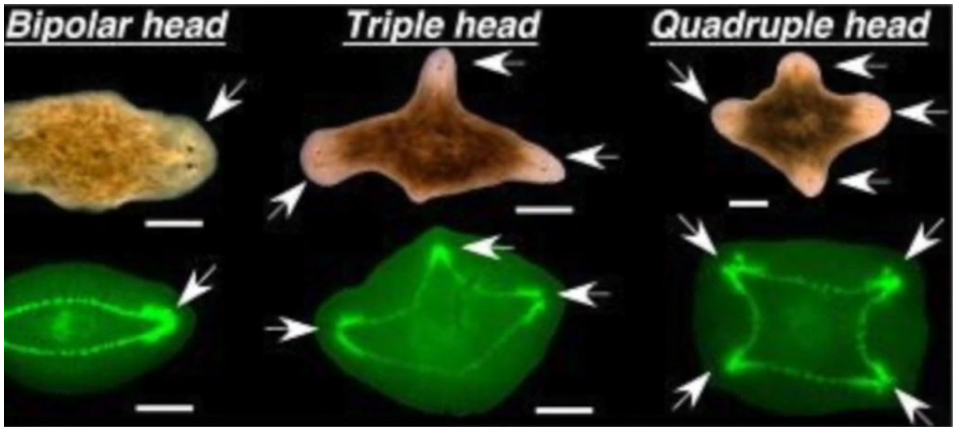


**Figure 5.** Worms with more than one head can be created by applying appropriate bioelectric charges. (Source: https://as.tufts.edu/biology/levin-lab)

Let's talk about frogs now. Frogs cannot regenerate limbs unlike their amphibian counterparts- the 'axolotls'. They lose this ability when they undergo metamorphosis from a tadpole into a frog. This is what some of their attempts at regeneration look like after amputation. It can be seen this one grows a little but it is mostly a scar tissue and not a usable limb (Figure 6).

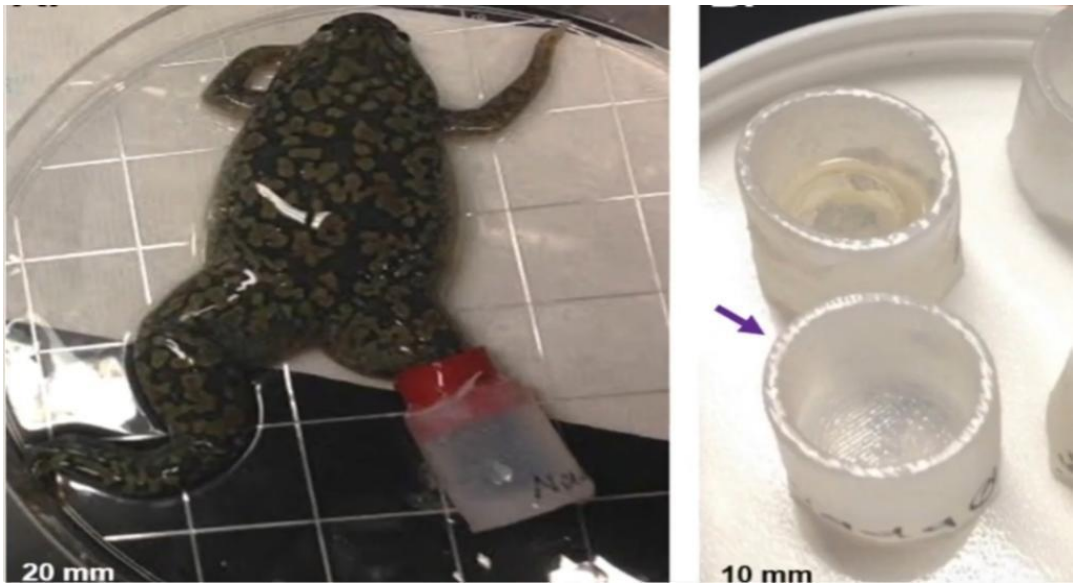


**Figure 6**. Frog applied with bioreactor containing progesterone. (Source: https://as.tufts.edu/biology/levin-lab)

If this limb is amputated and a bioreactor is attached containing progesterone which is a potent neuro-steroid it promotes nerve repair then the limb starts regeneration. This is what it looks like after regeneration of the frog's limb over nine and a half months. In this case the frog regenerated everything up to the webbing on its limb and gained full mobility of the limb.
The most astonishing aspect is that the bioreactor was only applied for 24 hours and it stimulated the entire nine and half months of growth. It is because progesterone causes an up-regulation and down regulation of certain cell processes.

The important thing is related to the resting potential of the cell membrane and this change in resting potential stimulates a pro-regenerative bioelectric profile. These processes essentially tell the frog to go through the same process as it did while growing from a tadpole into a frog. So now regenerates the limb instead of scarring over and we can easily observe these changes in the cartilage core compared to the control limb by seeing increased vascularisation and energy supply. It has been previously shown to induce nerve growth by modulating the host resting potential or altering the bioelectricity and this pathway has been activated in the grafted eye of the tadpole, nerve growth could be seen. Over time this growth could be observed, attached to the rest of the nervous system and now a blind tadpole can see out of it's grafted eyes (Figure 7).

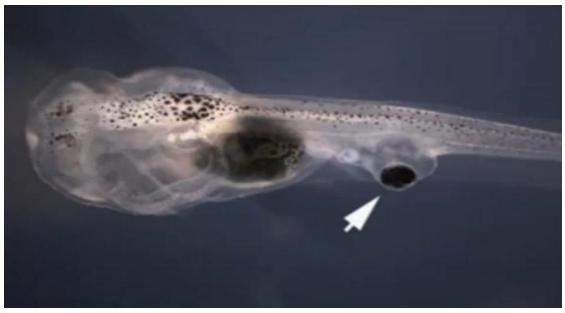

**Figure 7**. An eye grafted to the tail of a tadpole
(Source: https://as.tufts.edu/biology/levin-lab)

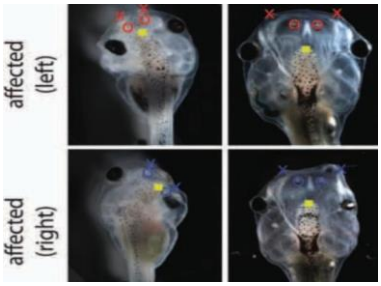


**Figure 8**: An eye grafted to a tadpole at an incorrect place slide back to the correct place.
**(**Source: https://journals.plos.org/ploscompbiol/article?id=10.1371%2Fjournal.pcbi.1002481)

One more thing before getting to the future of bioelectricity, if the salamander is cut and it's tail is grafted to where a limb used to be and then over a time it will form into a limb. This is because at this location the salamander's body knows that the lowest resting potential is in the shape of a limb and not a tail, so it reshaped itself over time. Talking about it's mammalian applications and medicines for humans. It is known since 70's

that if a child's finger is amputated it can regrow in around 24 hours, without any treatment other than wrapping it. Also, it is applied only to fingers of young children, not toes or full limb amputation. Adults do not have the ability to regenerate without any intervention but it can regenerate with an intervention. So, the question is how can this information be used?

Let this frog be taken and turned back to a tadpole. When the eyes are adjusted up and down or right and left, they will eventually slide back in to the correct place. It corrects it's position when it detects altered bioelectricity and the best way to describe it is like it is looking for the lowest point on this gradient. The lowest point would be considered the resting potential. If it detects that eye is at the top of the gradient with altered bioelectricity, it moves it to the bottom to find the resting potential.
Next is mammalian applications and also the work for human medicine at some point could be done. Since the frog diome was used to stimulate the regulatory pathways simultaneously to develop processes. It makes sense if it could be done for mice and eventually humans, because just like the frog humans already have the growth pathways in their genetics, it is just a matter of stimulating them after amputation (Figure 8).

**No scarring process rather a growing process!**
All that needs to be done is apply a biodome reactor immediately after amputation at least initially. Since human bodies know how to grow limbs, they have done it before so it would not overgrow.

Here lies the future of limb regeneration in humans!

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## 14. OBSESSIVE-COMPULSIVE DISORDER: JUVENILE CRIME AND TEENAGE SUICIDES ON RISE DUE TO "ADOLESCENTS BEING MADE VULNERABLE BY OCD SCRUPULOSITY"

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"You don't have to learn how to control your thoughts; you just have to stop letting them control you"

### OCD: When Unwanted Thoughts Take Over

Obsessive Compulsive Disorder or OCD is not an adjective, or a choice, or a cute personality quirk, or a flaw in one's character, moreover, its not at all just about cleaning and organising, but it is a torturous disorder that involves living with intrusive thoughts and images about the last thing you would ever want to think. OCD is a prevalent, long-term disorder marked by uncontrollable, recurring thoughts (obsessions) that can lead to repetitive behaviours (compulsions). Although everyone worries or feels the need to double-check items from time to time, the symptoms of OCD are severe and persistent. These symptoms can be distressing and result in behaviours that impede daily activities. People with OCD may feel compelled to check items repeatedly or perform routines for more than an hour each day in order to temporarily relieve anxiety. If OCD symptoms are not treated, they can disrupt job, school, and personal relationships, as well as cause distress.

OCD symptoms usually develop in childhood, around the age of 10, or in early adulthood, between the ages of 20 and 21, and they appear sooner in males than in females. By the time they reach early adulthood, the majority of individuals have been diagnosed with OCD (1). Although most people experience obsessive ideas and/or compulsive actions at some time in their lives, this does not imply that we all have "some OCD." To be diagnosed with OCD, the cycle of obsessions and compulsions must be so severe that it takes a lot of time, causes significant distress, or interferes with essential activities that the person values.

### Symptoms

**Obsessions and compulsions.** Obsessions are repetitive ideas, images, or instincts that feel out of the person's control. People suffering with OCD do not wish to experience these distressing thoughts. Obsessions are accompanied with intense and unpleasant sentiments such as dread, disgust, anxiety, and doubt, or a sense that everything must be done "exactly perfectly." Obsessions consume time and interfere with vital tasks that the individual values in the setting of OCD. This final point is critical to remember because it helps to establish whether someone has OCD – a psychiatric condition — rather than an obsessive personality feature (Figure 1).

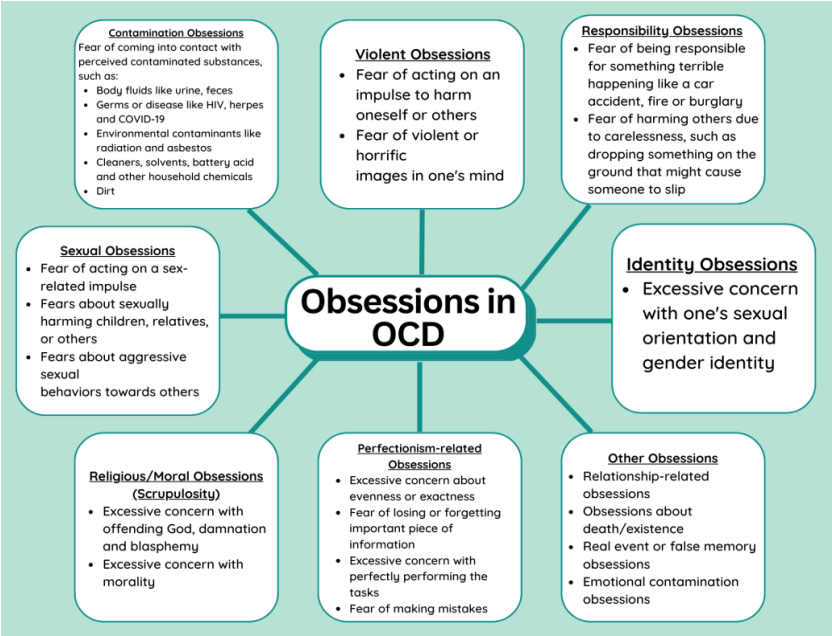


**Figure 1.** Obsessions in OCD (2)

Compulsions are recurrent acts or ideas that a person employs to eliminate their obsessions. Individuals with OCD are aware that this is only a temporary solution, but in the absence of a better method to deal, they rely on compulsions. Avoiding circumstances that provoke obsessions is another form of compulsion. Not all recurrent activities or "rituals," like obsessions, are compulsions. This is determined by the function and context of the activity. Bedtime rituals, religious practices, and acquiring a new skill, for example, all entail some amount of repetition of an activity, but are typically a functional aspect of everyday life (Figure 2) (2).

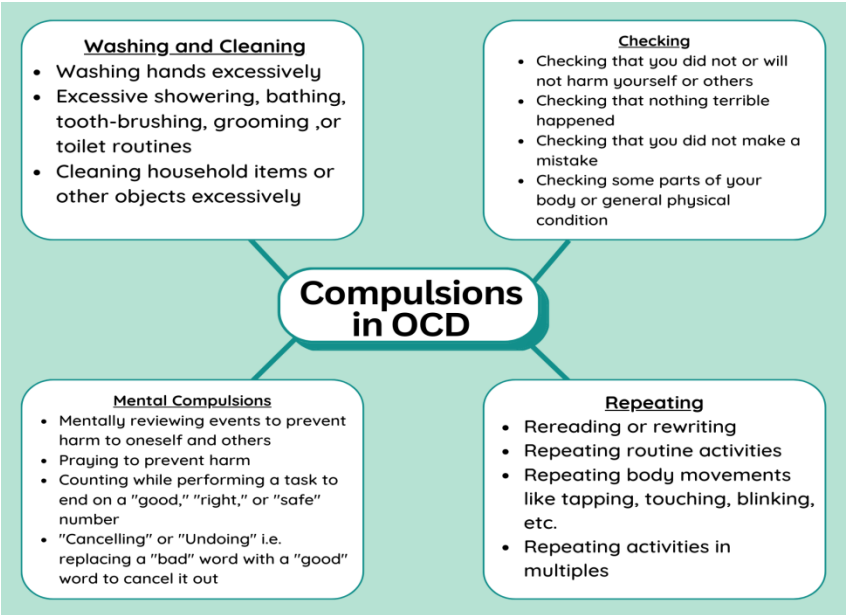


**Figure 2.** Compulsions in OCD (2)

**What causes OCD?**

Scientists are uncertain of OCD's precise cause. The environment, genetics, and anomalies of the brain are regarded to be contributing factors. It frequently begins in adolescence or early adulthood. Yet, it can also begin in infancy. Both men and women are impacted by OCD. According to one of these studies, non-shared environments accounted for 51% of the variance in obsessive-compulsive symptoms while additive genetic influences accounted for 40% of the variance (3).

**Genetics factors leading to OCD**

Twin studies have shown that obsessive-compulsive disorder has a hereditary component. Twins that have the same DNA, or who are identical, are more likely to have OCD than non-identical twins, who only share about 50% of their DNA. The risk of developing OCD is further enhanced if a person has an OCD parent, child, or sibling. The serotonin neurotransmitter is connected to one potential genetic variation. In a small number of families with a history of OCD, mutations in the hSERT (human serotonin transporter) gene have been discovered. Less serotonin is accessible because the transporters are working too efficiently. Several OCD medications work to change this by raising serotonin levels. Finding disorder-specific elements is crucial to comprehend the pathophysiology of OCD. According to previous studies, serotonin-related polymorphisms (5-HTTLPR coded as triallelic and HTR2A rs6311/rs6313) and, in men, a polymorphism implicated in catecholamine regulation; COMT, are linked to OCD (rs4680). To determine whether these polymorphisms are unique to OCD, a study was conducted and the findings showed that 5-HTTLPR, HTR2A, and COMT polymorphisms, but only in males, are linked to OCD. Nearly all other types of psychopathologies, such as bipolar disorder, schizophrenia,etc. were not linked to these polymorphisms. The findings imply that the SNPs examined in this study are largely unique to OCD (4).

**Brain Structure and Functioning in OCD patients**

Changes in particular brain circuits may act as a mediating factor for the cognitive and affective processing deficiencies in OCD patients. Early research proved that people with particular brain lesions could develop OCD. By speculating the participation of parallel, partially segregated cortico-striato-thalamo-cortical (CSTC) circuits that are implicated in sensorimotor, cognitive, affective, and motivational processes in OCD, models have combined data from neuroimaging and cognitive-affective research (Figure. 3). Alterations in frontolimbic, frontoparietal, and cerebellar networks have also been suggested by other models (5). As shown in figure 2, parieto-cerebellar regions and the superior temporal gyrus may be associated with the dorsal circuit and during executive function processing, responsiveness in prefrontal-striatal loop decreases while responsiveness in orbitofrontal-striatal loop increases during emotional data processing (Figure 3) (6).

**Environmental factors that trigger OCD**

Several environmental factors have been identified as potential risk factors for OCD. A person who has experienced trauma frequently exhibits increased physiological arousal as well as emotional and mental reminders of the incident. Furthermore, physical, emotional, and cognitive distress worsen as one approaches the peritraumatic period. Maladaptive thoughts centred on guilt or self-blame may surface during post-trauma healing. These unwanted ideas, pictures, or memories could be misinterpreted as important and relevant by the person, leading to increased time and effort spent avoiding them and the development of an obsession. By engaging in compulsive behaviours like hoarding possessions, counting, or repetitive cleaning, an individual may make an effort to escape the unfavourable thoughts, physiological sensations, and feelings that go along with the obsessions (7).

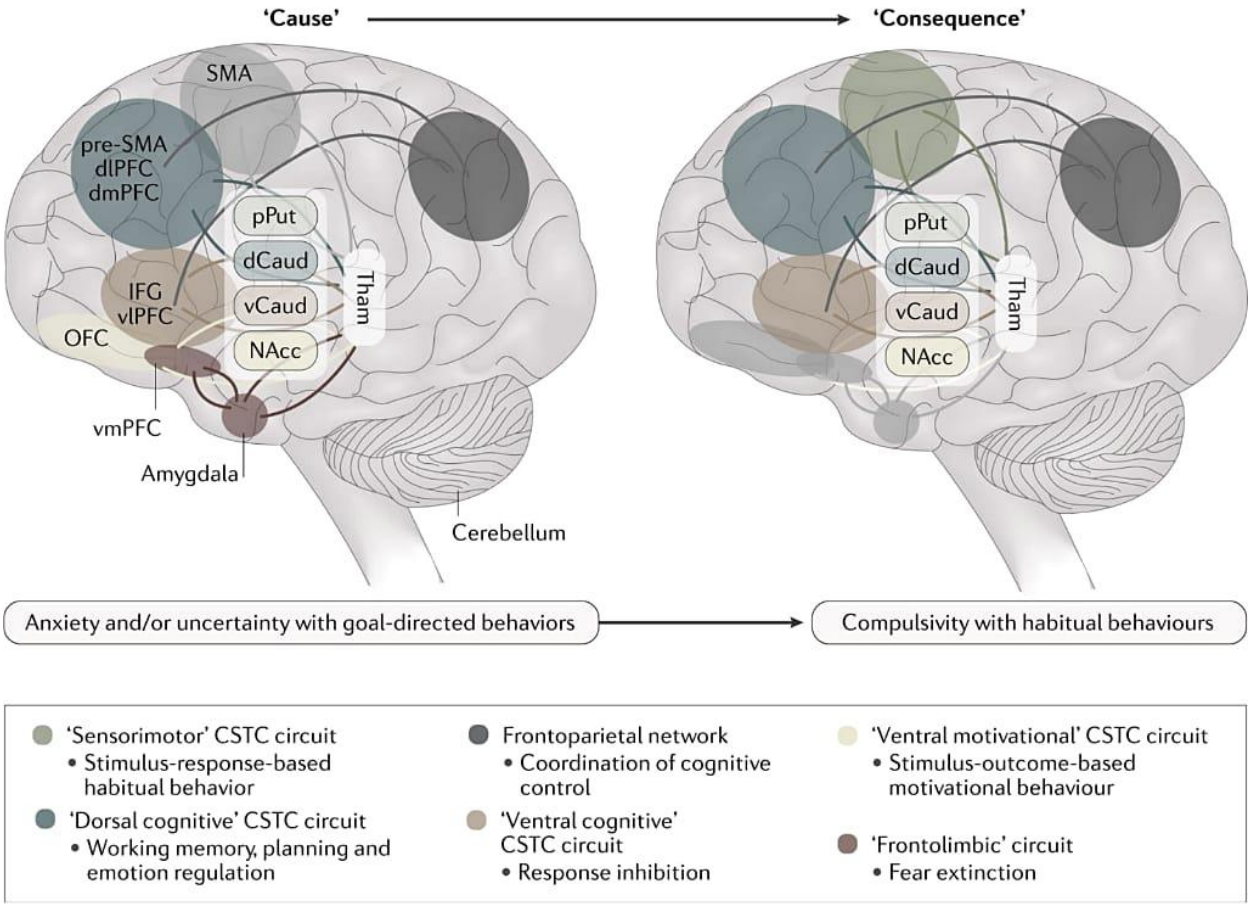


**Figure 3.** Neural circuits involved in OCD

dCaud: dorsal part of caudate nucleus; dlPFC: dorsolateral prefrontal cortex; dmPFC: dorsomedial prefrontal cortex; IFG: inferior frontal gyrus; NAcc: nucleus accumbens; OFC: orbitofrontal cortex; pPut: posterior part of putamen; pre-SMA: pre-supplementary motor area; SMA: supplementary motor area; Tham: Thalamus; vCaud: ventral part of caudate nucleus; vlPFC: ventrolateral prefrontal cortex; vmPFC: ventromedial prefrontal cortex (Figure 4).

(Source- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7370844/figure/F5/)

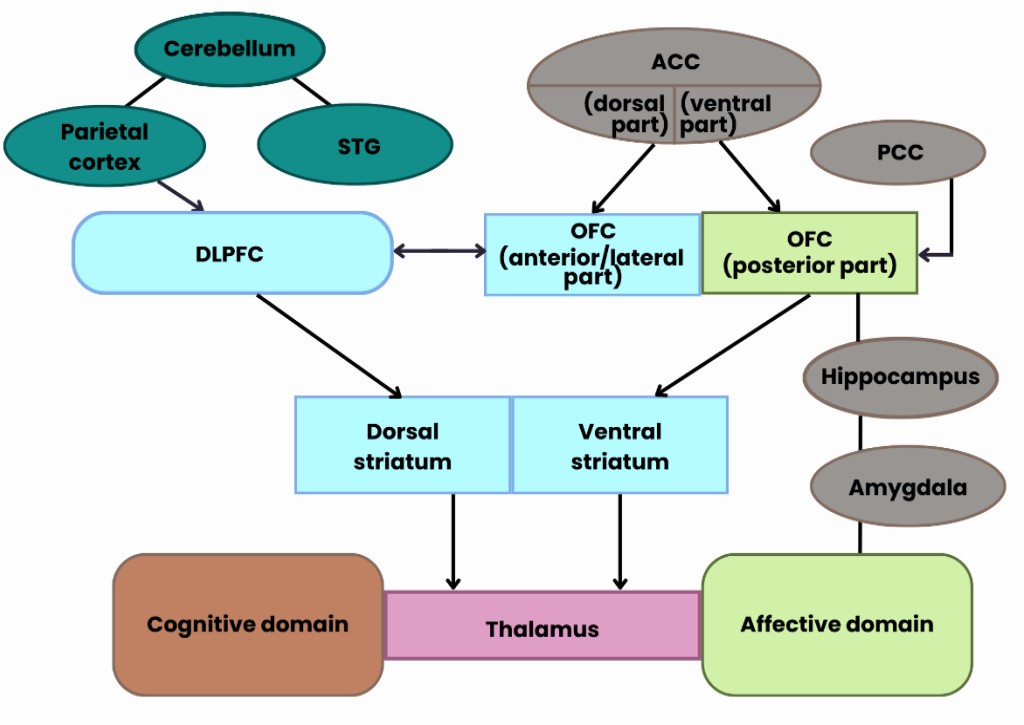


**FIGURE 4.** Model of pathophysiology in obsessive compulsive disorder (OCD)- ACC: Anterior cingulate cortex; DLPFC: Dorsolateral prefrontal cortex; OFC: Orbitofrontal cortex; PCC: Posterior cingulate cortex; STG: Superior temporal gyrus (5)

(Source- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7370844/figure/F5/)

**Juvenile Crime on the Rise**

Intense worries about physically harming children, putting people into vulnerable situations, or engaging in inappropriate sexual behaviour are symptoms of some types of OCD. OCD sufferers occasionally exhibit aggressive criminal behaviour (8). There may be several causes. One is due to the distress experienced when someone unintentionally or purposefully interrupts or tries to interrupt an obsession. The secondary concern is that people could become aggressive or threatening towards family members or medical personnel. Because there is frequently a very high level of family involvement in rituals, which can produce a great deal of irritation and anger in the home, this is more likely to happen in children or teens. A person with OCD may also become upset and worried when they believe someone has been harmed, behave inappropriately physically to protect them, and end up being accused of violent crimes as a result.

Chronic internalization of unpleasant feelings is a result of OCD patients' highly developed demand for control, particularly with regard to regulation of emotional expression. Also, there is a direct correlation between their mental health issues and bad judgment, inadequate coping mechanisms, and intolerance for circumstances beyond their control. Several crimes that seem to have a sexual component often have obsessive-compulsive roots. Several studies have discovered that sex offenders have a significant frequency of OCD. In fact, if such offenses are thought to be motivated by obsessions that haven't been sufficiently addressed by therapy, this can pose a risk to the community's continued safety — it poses a recidivism risk. There is a chance that pedophilia-

related intrusive thoughts or obsessive ideation in respect to a variety of possible victims could be significant risk factors for recidivism. It should come as no surprise that some OCD sufferers engage in harassment and/or stalking. In stalking, five psychological variables come together: violence, pathological narcissism, obsessional thinking, social ineptitude, and loneliness (8).

According to the 2018 'Crime in India' report, the number of offenses allegedly perpetrated by juveniles was over 31000, a decrease of about 6% from 2017. Boys make up more than 99% of the adolescents detained for these offenses. With the participation of a juvenile in the Nirbhaya gang rape case, which shocked the nation in December 2012, juvenile delinquency or criminal conduct by juveniles under the age of 18 years has been a matter of controversy. According to the NCRB's most recent 'Crime in India' report for 2018, a total of 31,591 offenses perpetrated by adolescents were registered in 2018. Maharashtra was responsible for 19% of these incidents. According to the NCRB, the number of 'Juveniles in dispute with the law' shows the recorded number of offenses committed by juveniles under the age of 18 (Figure 5) (9).

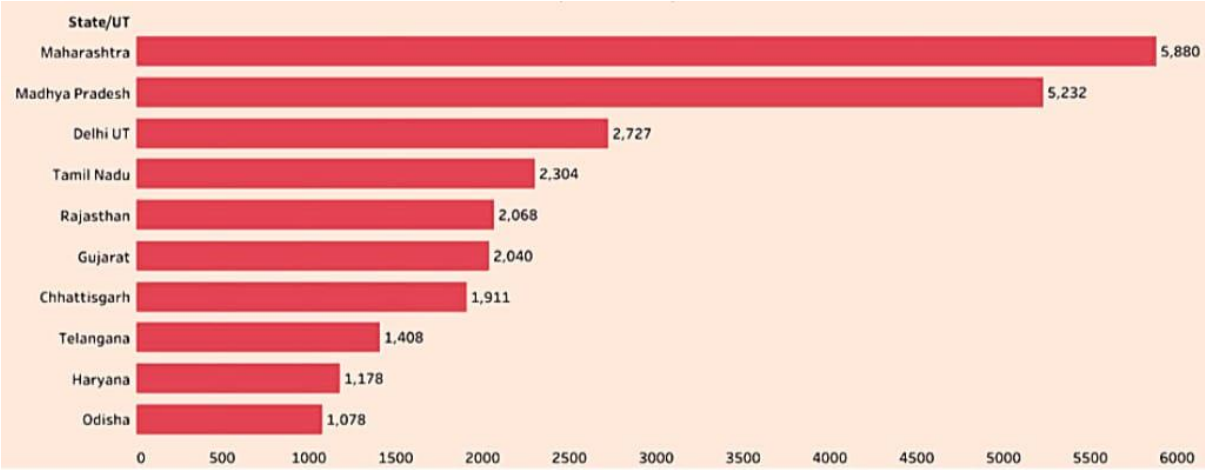


**Figure 5.** State wise number of cases involving juveniles (NCRB, 2018) (9)

The vast majority of adolescent offenses were against the human body and property. 92% of the instances involving juveniles included IPC violations. Offenses affecting the human body accounted for the greatest number of instances (37.7%), including both IPC and SLL. Hurt and grave injury (47%), rape (13%), and attack on women to offend her modesty (12%) were among the many examples. Property-related offenses accounted for 37.6% of all juvenile crimes. Steal accounted for 70% of these offenses, with burglary accounting for 16.8% and robbery accounting for 10%. Cases under the POCSO Act of 2012 accounted for 45.4 % of all SLL cases.The symptomatology of OCD may call into question an accused person’s criminal responsibility at times. Moreover, OCD may be relevant to a criminal's culpability at the time of providing context, explanation and potentially some mitigating factors for their culpability. This can only be established by expert evidence provided by psychiatrists who are not only aware of the relevant diagnostic criteria but also of the nature of the person’s symptomatology, its severity and how it influenced the offender’s behavior.

This data shows the type of offenses committed by juveniles and more in-depth study is required to be conducted to segregate this data based on the mental and physical condition of the juvenile involved in each case. This type of survey will give a clear picture of the total number of juveniles (involved in crimes) suffering from OCD (Figure 6).

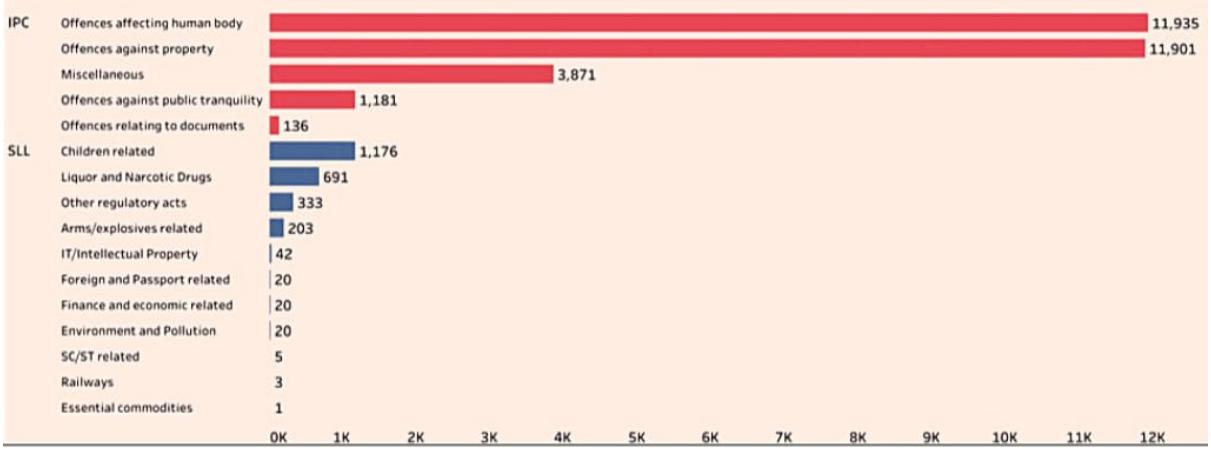


**Figure 6.** Types of offenses committed by juveniles (NCRB, 2018) (9)

**How is OCD turning juveniles into criminals?**

OCD symptoms are challenging enough for adults who have reached their full potential, but what about teenagers who start displaying OCD symptoms as they develop their sense of individuality and self? For younger children, they may speak up about any unusual feelings or urges they may have. Teenagers who are beginning to feel independent, though, might choose to handle things on their own. As a result, many teenagers are suffering from morbid obsessions. Even though all types of OCD can be unpleasant, crippling, revolting, and debilitating, morbid obsessions are among the nastiest and most shocking. This is especially true for obsessions that are violent in character and involve fantasies about killing or hurting oneself or others, or acting sexually inappropriately. Both violent pictures in the mind and acting impulses are common in violent thoughts. Examples of these include instances in which individuals witness themselves striking, stabbing, strangling, mutilating, or otherwise harming their children, family members, strangers' pets, or even just themselves. They may feel the need to shove or hurl someone into the path of moving vehicles, out of windows, or off of balconies, buildings, or other high locations. (10).

**OCD being a major reason for increased teenage suicides**

Suicidal ideas or fantasies are frequently the result of extreme distress when they occur in adults, and even in teenagers. They see suicide as a method to put an end to their pain. Yet, some young individuals experience intrusive suicidal thoughts, which are a totally different variety from the usual suicidal thoughts. These kids are afraid of suicide rather than being drawn to it. They also experience disturbing suicidal thoughts, such as: What if I jumped out of this window? What would happen if I ran in front of that truck? — are a type of obsessive-compulsive disorder. What if I take too many pills? (11)

This study's objective was to assess the relationships between childhood trauma (CT) and obsessive-compulsive (OC) symptom dimensions and suicidal ideation in individuals with OCD. 60 controls and 70 OCD outpatients who had attempted suicide in the past were included (9). The results revealed higher scores of OCD patients on CT, suicide ideation, depression and anxiety than controls. Patients and controls had no significant differences in gender and age as shown in table 1. According to socio-scientific issues (SSI) Scores, 97.1% of OCD patients reported having recent thoughts of suicide. Compared to controls, OCD patients scored higher on the Childhood Trauma (CT), suicidal ideation, sadness, and anxiety scales. Suicidal ideation was explained by the CT history of sexual abuse (SA) and the OCD symptom feature of undesirable thoughts. Compared to earlier research, the

current study's rate of suicidal ideation (97.1%) was higher. According to the earlier study by Gupta et al. (2014) (12), 46.1% of OCD patients reported having suicidal thoughts. Long illness duration, a family history of suicide behaviour, single marital status, and hopelessness were found to be associated with increased rates of suicide ideation and lifetime suicide attempt, according to studies. A high severity of OCD symptoms has also been linked to an increased risk of suicide in OCD patients. Compared to compulsions, obsessions have been found to have a stronger association with suicidality. This implies that serious obsessions may function as an OCD-specific mechanism that triggers suicidality. (Table 1)

| CHARACTERISTICS | OCD PATIENTS (n=70) Mean values of all the subjects | NORMAL CONTROLS (n=60) Mean values of all the subjects |
|---|---|---|
| Gender, male/female | 35/35 | 30/30 |
| Current age (years) | 35 | 34 |
| Suicide ideation (%) calculated on the basis of psychological examination. | 26 | 7 |
| Depression (%) | 17 | 4 |
| Anxiety (%) | 16 | 5 |
| Childhood trauma (%) | 78 | 43 |
| Age at OCD Onset (years) | 19 | - |

**Table 1.** Results of the study showing increased suicidal risk in OCD patients (12)

**Treatment and Therapies**

OCD treatment often consists of specialized forms of psychotherapy (such as cognitive behavioral therapy), medication, or a mix of the two. A mental health expert may discuss the advantages and dangers of various treatment choices with you and assist you in determining the best therapy for you. People who have OCD may also experience anxiety, sadness, or body dysmorphic disorder, a disorder in which someone incorrectly feels that a part of their body is wrong. It is critical to consider these additional illnesses while making treatment options.

It is critical to stick to your treatment plan since both psychotherapy and medicine need time to work. Although there is no cure for OCD, contemporary therapies help many individuals manage their symptoms, engage in daily activities, and live full, active lives (Figure 7).

- **Psychotherapy**

  Psychotherapy can be a useful treatment option for both adults and children suffering with OCD. Some forms of psychotherapy, such as cognitive behavioral therapy (CBT) and other related therapies (such

as habit reversal training), have been shown in studies to be as helpful as medicine for many patients. Others may find that counseling works best when combined with medication.

Exposure and Response Prevention (ERP) CBT, according to research, is beneficial for decreasing obsessive behaviours, even in those who did not react well to medication. Those who use ERP spend time in situations that trigger their compulsion (for example, handling unclean things) and are prohibited from indulging in their regular urges (such as handwashing). Although this strategy may create anxiety initially, most people's compulsions diminish as they continue treatment.

- **Medication**

  Medication may be prescribed by your doctor to assist treat OCD. Serotonin reuptake inhibitors (SRIs) are the most often used kind of medicine for the treatment of OCD. SRIs, especially selective serotonin reuptake inhibitors (SSRIs), are commonly used to treat depression, but they can also aid with OCD symptoms. It may take up to 8 to 12 weeks for symptoms to improve with SRI medication, and treatment for OCD may necessitate greater SRI dosages than are generally used to treat depression. Some people may experience adverse effects such as headaches, nausea, or problems sleeping as a result of taking these drugs (13).

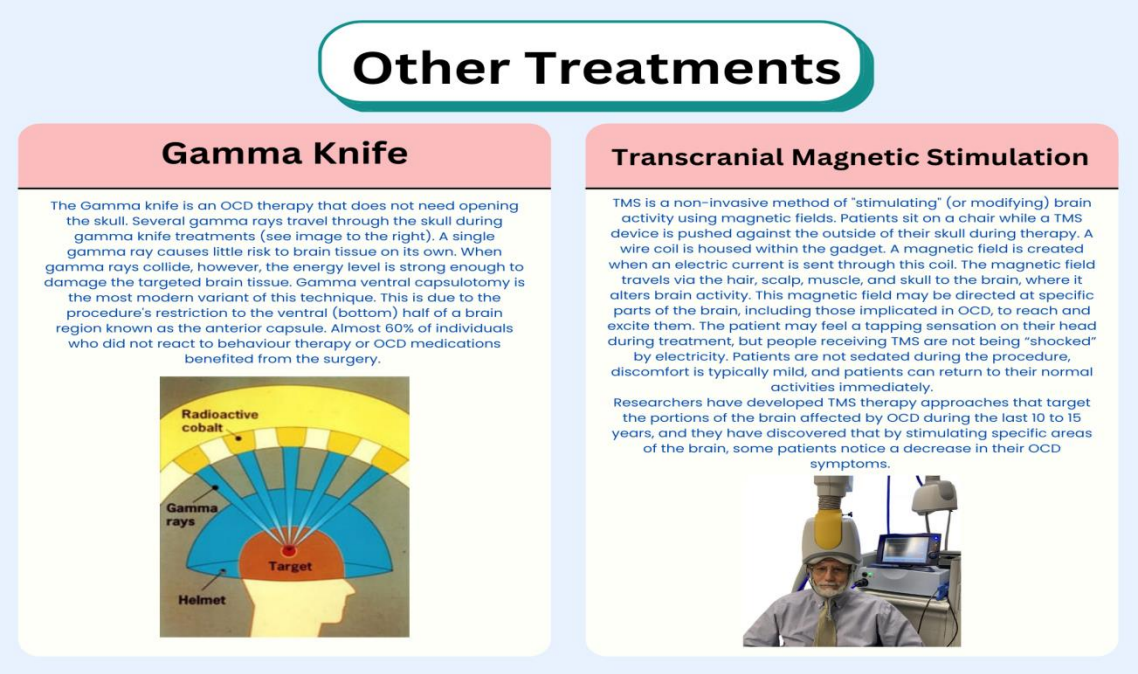


**Figure 7.** Treatment and therapies to cure OCD (13)

**What about PANDAS?**

PANDAS (Paediatric Autoimmune Neuropsychiatric Disorders Associated with Streptococcal Infections) is an uncommon variety of OCD that develops in children as a result of an overreaction of the immune system to an illness, such as strep throat. PANDAS should be treated for strep infections as soon as possible. Standard OCD therapies, such as exposure and response prevention (ERP) therapy and/or SRI medication, can be used to address persistent symptoms. (5)

**Conclusion**

The idea that violent obsessions are more difficult to treat than other types of symptoms is a popular one but this is wholly untrue. Regardless of your symptoms, you can get better if the right tactics are applied, you recognise that things can't continue the way they are, and you're willing to put in the effort necessary to become well and take back control of your life. The findings suggested that suicidal ideation may be related to early trauma and inappropriate beliefs. Hence , it is important to closely monitor OCD patients who are experiencing unacceptably disruptive thoughts to look for red flags of suicide. A thorough understanding of the cellular and molecular mechanisms by which genetic and environmental risk factors affect endophenotypes and, ultimately, OCD is also needed.

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# 15. CHILDHOOD OBESITY LEADING TO A CANCEROUS ADULTHOOD WITH INCREASED RISK OF CARDIOMETABOLIC DISEASES

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Childhood obesity is now more prevalent than ever, it has become a significant public health concern that increases the risk of developing cardiometabolic diseases and cancer in adulthood (1). It depends on a complex interplay of genetic, environmental, and behavioral factors. Prevention and early intervention are crucial in addressing this issue. Numerous longitudinal studies confirm the strong association of pediatric obesity with the persistence of adult obesity, and the future development of cardiovascular disease, diabetes, and increased risk of death. Excess adiposity in youth is a marker of increased cardiometabolic risk (CMR) in adolescents and adults (2). The risk of long-term obesity, cardiovascular and metabolic problems increase with the emergence of severe obesity at a young age. Being overweight and obese from childhood to adulthood have been related to an increased risk of T2DM, AH and dyslipidemia (2).

Childhood obesity is a major risk factor for developing cardiovascular disease. Studies have shown that obese children are more likely to have high blood pressure, high cholesterol levels, and other cardiovascular risk factors than their non-obese peers. This can lead to the development of atherosclerosis, a condition where the arteries become narrow and clogged, increasing the risk of heart attacks and strokes. It is also a significant risk factor for developing metabolic syndrome, and the risk increases with the duration of obesity. Metabolic syndrome is a group of medical conditions that include high blood pressure, high blood sugar and high cholesterol levels. Metabolic syndrome increases the risk of cardiovascular disease, type 2 diabetes, and other health problems (Figure 1).

**Figure 1.** Obese Child
(Source: https://www.thehansindia.com/featured/womenia/understanding-the-factors-leading-to-childhood-obesity-744038 (2022))

Childhood obesity has been related to an increased risk of developing various cancers as an adult. While the specific processes behind the association between juvenile obesity and cancer are unknown, a number of variables may contribute to this elevated risk (3). Chronic inflammation, which is a characteristic of obesity, is one likely reason. Obesity raises the production of inflammatory cytokines, which can cause cell and tissue damage and increase the risk of cancer over time. Persistent inflammation interferes with normal cellular

functions and contribute to cancer growth and progression (4, 5). Another potential cause is insulin resistance, which is common among obese persons. Elevated insulin levels can encourage cancer cell proliferation and raise the risk of various forms of cancer, including breast, colon, and pancreatic cancer (6).

In addition to these factors, childhood obesity may also increase the risk of cancer through its effects on hormone levels. Obese individuals often have higher levels of estrogen and testosterone, which can promote the growth of some types of cancer, such as breast and prostate cancer. Numerous studies have demonstrated a link between childhood obesity and an increased risk of cancer in adulthood. For example, a study published in The Lancet in 2015 found that overweight and obese children had a higher risk of developing cancer in adulthood, with each additional unit of BMI increasing the risk by 9% for women and 11% for men (7). Childhood obesity must be prevented and treated in order to lower the risk of cancer in adulthood. Parents, carers, and healthcare professionals may all play an important role in encouraging healthy lifestyle choices including regular physical activity, a nutritious diet, and screen time limits. Preventing childhood obesity is crucial for reducing the risk of cardiometabolic diseases in later life. Early intervention is critical since preventing childhood obesity is more easier than treating it later in life. We can help minimize the risk of cancer and achieve better long-term health outcomes for children by reducing childhood obesity (8).

In conclusion, childhood obesity is a significant risk factor for developing cardiometabolic diseases, including cardiovascular disease, type 2 diabetes, and metabolic syndrome. The risk of developing these diseases increases with the duration of obesity, highlighting the importance of preventing childhood obesity. By promoting healthy lifestyle habits, we can reduce the risk of these diseases later in life and ensure a healthier future for children.

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## 16. ANTIMICROBIAL RESISTANCE (AMR)

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Antimicrobial resistance (AMR) is a growing problem that threatens the effectiveness of modern medicine. It occurs when microorganisms such as bacteria, viruses, fungi, and parasites evolve to resist the drugs that are used to treat infections caused by these organisms (Figure 1). This makes it difficult, and in some cases impossible, to control infections, leading to increased morbidity and mortality rates.

AMR has become a global public health issue and is estimated to cause 700,000 deaths each year worldwide. If left unchecked, this number could rise to 10 million by 2050, surpassing the number of deaths caused by cancer. The problem is compounded by the lack of new antimicrobial drugs in the pipeline, which means that we are rapidly running out of options for treating infections. Antibiotic-resistant infections are already prevalent in the United States and around the world (1). Many public health organizations have called the rapid outbreak of resistant bacteria a "crisis" or "nightmare scenario". The Center for Disease Control and Prevention (CDC) declared in 2013 that the human race has entered the "post-antibiotic era," and the World Health Organization (WHO) warned in 2014 that the antibiotic resistance crisis is becoming dire. MDR has been declared a significant threat to public health in the United States. Antimicrobial-resistant pathogens include Methicillin-Resistant *Staphylococcus aureus* (MRSA), Vancomycin-Resistant Enterococci, Drug-Resistant *Streptococcus pneumoniae*, Drug-Resistant *Mycobacterium tuberculosis*, Carbapenem-Resistant Enterobacteriaceae, MDR *Pseudomonas aeruginosa* etc. (1).

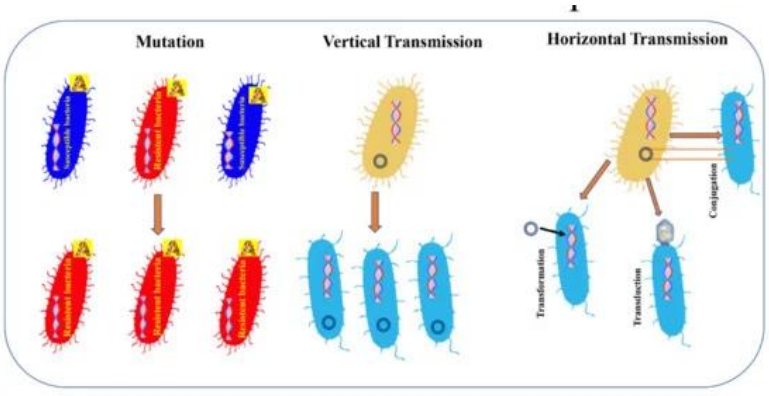


**Figure 1.** How Antibiotic Resistance spread
(Source: https://doi.org/10.3390/pathogens10101310 (2021))

The activation of genes brought on by exposure to clinical doses of antibiotics can also result in the development of natural resistance in bacteria. Bacteria can acquire resistance through a mutation that occurs in

the DNA of the cell during the replication or DNA transfer. The natural resistance follows through the vertical pathway and the acquired resistance follows the horizontal pathway (Figure 2).

One study found that bacterial antimicrobial resistance played a role in an estimated 4.95 million deaths globally, including the 1.27 million directly caused by resistant infections. The estimates are based on an analysis of hospitals, surveillance and other sources of data covering 204 countries and territories by an international group of researchers called the Antimicrobial Resistance Collaborators (2,3). Antimicrobial Resistance may be caused by a variety of biochemical and physiological mechanisms, including the multidrug efflux system, enzyme production, quorum sensing, the presence of antibiotic resistance genes in bacteria, and chromosomal DNA changes, including the overuse and misuse of antimicrobial drugs.

Antibiotics, for example, are often prescribed when they are not needed or are prescribed for conditions that are caused by viruses, which are not affected by antibiotics. This overuse and misuse of antibiotics is a major driver of AMR because it creates an environment in which bacteria can evolve and develop resistance to these drugs (Figure 2).

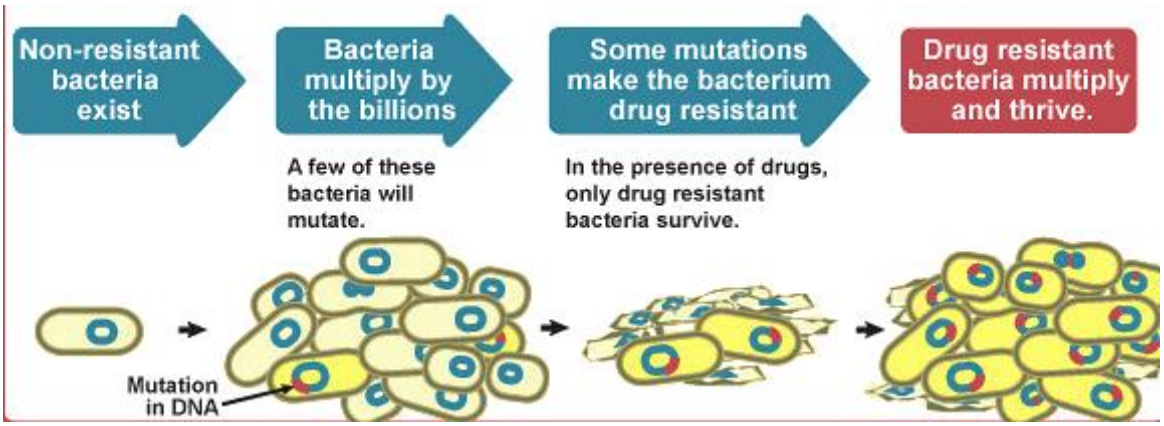


**Figure 2.** Genetic mutation in bacteria causes drug resistance
(Source: https://www.flickr.com/photos/niaid/5081362184 (2010))

Another factor contributing to the development of AMR is the use of antimicrobial drugs in agriculture. These drugs are often used to promote growth in livestock and prevent infections, which can lead to the development of resistance in bacteria that can be transmitted to humans through food. AMR is not just a problem for human health; it also has economic and social implications. The cost of treating infections caused by resistant organisms is often much higher than treating infections caused by susceptible organisms. This is because it requires more expensive and less effective drugs, longer hospital stays, and more intensive care.

There is no simple solution to this problem and solution to AMR requires a multifaceted approach that includes reducing the unnecessary use of antimicrobial drugs in human and animal health, improving infection, prevention and control measures, and investing in the development of new antimicrobial drugs. It is important to remember that everyone has a role to play in reducing AMR, from healthcare professionals to the general public..

In conclusion, AMR is a growing problem that threatens the effectiveness of modern medicine. It requires a concerted effort from all stakeholders to reduce the unnecessary use of antimicrobial drugs, improve infection

prevention and control measures, and invest in the development of new drugs. Failure to address AMR could have devastating consequences for public health, the economy, and society as a whole.

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## 17. HALLUCINATIONS AS A TRAUMATIC MEMORY

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**Relationship between Traumatic Events and Hallucinatory Experiences**

It is pivotal from a clinical perspective to understand how hallucinations relate to real-life occurrences. This article examines the extent to which the content of auditory and visual hallucinations may be related to traumatic events that had occurred in the past and discusses implications for current clinical practice and future research.

**Introduction**

According to popular belief, the phenomenon of hallucinations occasionally stems from suppressed or forgotten traumatic events resurfacing in consciousness (1). The understanding of traumatic events in schizophrenia and other psychotic diseases has significantly improved during the past few years. This is a complicated area of research that looks at a variety of factors that might be connected to the causes of these ailments. Among these factors, attention must necessarily be paid to people's social development and genetic, biochemical, autoimmune, viral, or neurophysiological nature (2). According to estimates, 15% of the population with schizophrenia also have post-traumatic stress disorder (PTSD) (3). The question of whether the same phenomena could meet the diagnostic requirements for schizophrenia and PTSD is up for dispute. For example, if someone has schizophrenia, hearing voices or seeing images would be classed as hallucinations, and if they have PTSD, they are classified as reliving a traumatic incident. The defining symptom of PTSD is believed to be an intrusive recall of a traumatic incident, typically in the form of a visual image, and when it comes to schizophrenia, hearing voices and other auditory intrusive sensory disturbances have drawn the most significant attention. Most of the study done to comprehend psychotic symptoms concerning traumatic events has been on auditory verbal hallucinations (AVHs) or voices. However, theoretical advancements based on psychological PTSD models have mostly concentrated on intrusive pictures.

**Linking Hallucinations with Trauma Memories**

- The earlier findings of a high incidence of auditory hallucinations, notably command hallucinations to harm themselves, and delusional cognition among inpatients with a history of abuse was verified by an

examination of case files of 100 patients who had been hospitalized in a psychiatric unit. The claim that hallucinations of abuse survivors are "pseudohallucinations" was disproven (4).

- Recent cognitive analyses of psychotic signs have postulated that mechanisms responsible for maintaining psychiatric disorders may also be responsible for maintaining delusions and hallucinations. One of the major symptoms is the occurrence of images. Images seem to be linked to beliefs and memories. The 35 patients who were interviewed provided evaluations that supported the existence of the imaginal occurrence. They saw reoccurring visuals, were able to link them to their experiences with specific emotions and beliefs and were able to connect them to memories of specific past events. They were also able to relate these images to their psychotic symptoms (5).

- There have been numerous phenomenological studies conducted, one of which is McCarthy-Jones' study of auditory hallucinations, which is thought to be the largest auditory study to date. In this study, 199 voice hearers reported experiencing identical replays of memories of prior conversations as well as similar but different conversations. This survey found evidence for the existence of AH (Auditory hallucination) subtypes. In practice, there are several therapies that are specifically tailored to AH subtypes (6).

- After evaluating 41 individuals who had gone through a first episode of psychosis, it was determined that there was a connection between the paranoid delusions sounds and intrusive traumatic events. This has consequences for both theoretical conceptions of psychosis and early psychological treatments (7).

- Invasive hallucinations were discovered not to be connected to traumas in general. Bullying and sexual abuse were the traumas that were most likely linked to hallucinations. Around 75 people with nonaffective psychosis were evaluated to demonstrate this. In a subgroup of people (N = 40) who had experienced trauma, 12.5% reported hallucinations with themes and content similar to their traumas, 45% reported hallucinations with themes but with no similarity between content and traumas, and 42.5% reported no discernible correlations between their hallucinations and previous trauma (8).

**Theories of Trauma-Related Memories and Hallucinations**

Trauma-related memories and hallucinations have been the subject of much research and debate in psychology and psychiatry. There are several theories that attempt to explain the nature and origins of these phenomena.

- **The Encoding Specificity Theory**: This theory suggests that traumatic memories are encoded in a highly specific way, linked to the sensory and emotional context in which the trauma occurred. As a result, stimuli that are similar to the original traumatic event can trigger memories and flashbacks. This theory explains why trauma survivors have vivid and highly detailed memories of the traumatic event but have difficulty recalling other details of their lives (9).

- **The Reconsolidation Theory**: According to this theory, traumatic memories are not fixed and unchanging, but are subject to modification and updating every time they are retrieved. When a person recalls a traumatic memory, it becomes temporarily unstable and can be modified or weakened by new

information or experiences. This theory suggests that it is possible to intervene in the reconsolidation process to help trauma survivors overcome the negative effects of their traumatic experiences (10).

- **The Cognitive Theory**: This theory suggests that trauma-related memories and hallucinations are the results of cognitive processes, such as attention and interpretation. Trauma survivors focus more on negative stimuli and interpret ambiguous or neutral stimuli as threatening, which can lead to the creation of false memories and hallucinations. This theory also suggests that cognitive therapies, such as cognitive-behavioral therapy, are effective in helping trauma survivors overcome the negative effects of their traumatic experiences (Figure 1) (11).

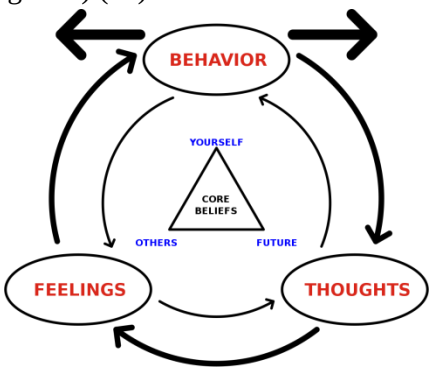


**Figure 1**. Cognitive behavioral therapy
(Source: https://en.wikipedia.org/wiki/Cognitive_behavioral_therapy (2021))

**The Dissociation Theory**: According to this theory, trauma-related memories and hallucinations are the results of dissociative processes, in which the individual separates themselves from the traumatic experience as a way of coping with the overwhelming emotions and sensations associated with the trauma. Dissociation can lead to fragmentation of memory, with some aspects of the traumatic experience being forgotten or repressed, while others are remembered in a fragmented and disorganized way. This theory also suggests that dissociative therapies, such as eye movement desensitization and reprocessing (EMDR), are effective in helping trauma survivors overcome the negative effects of their traumatic experiences (12).

**Clinical Implications**

It is important to note that the relationship between Schizophrenia and PTSD is complex, and there is still much to be understood about the co-occurrence of these conditions. The limited research on the use of interventions such as EMDR and exposure therapy in treating PTSD symptoms in individuals with schizophrenia suggests that these approaches may be effective in reducing symptoms of trauma, but may not have a direct impact on hallucinations. The study on picture rescripting in individuals with schizophrenia who hear voices suggests that this approach may be effective in addressing intrusive memories and reducing distress associated with these experiences. However, this was a small case series and further research is needed to determine the effectiveness of this intervention in a larger sample. Given that trauma is a common experience in individuals with schizophrenia, further research on effective interventions for trauma-related symptoms, including distressing voices and images, would be valuable in improving the quality of life for individuals with this co-morbidity.

**Conclusion**

In conclusion, the relationship between hearing voices, seeing visions, and traumatic occurrences is a complex

and still largely unresolved issue in clinical psychology. While there is evidence to suggest that trauma can be a contributing factor to these experiences, a complete theoretical understanding of this connection is still elusive. Interventions based on a well-developed theoretical understanding of reactions to trauma are effective in treating the subgroup of voices and visions that are directly related to stressful situations. Clinical experts should continue to explore this area and develop new interventions that address the unique needs and experiences of this co-morbid population.

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## 18. OPTICAL ILLUSION: HOW IT TRIGGERS THE BRAIN?

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Optical illusions have captured individuals' attention throughout the globe for generations. It never fails to

make you think that human eyes may observe something that isn't present. Individuals think about why the vision has become so powerful that users may discover more visual tricks and cognitive teasers. When the human brain gets some break, it develops several shifts along the path, that is something how the optical illusions work. Someone's brain begins to build an assumption based upon those signs since elements like color schemes, dark spots, and various perspectives aid the mind's ability to comprehend the content of viewing.

**What is an optical illusion?**

How do the sensory neurons in the nervous system process knowledge, and unrealizable messages that can happen? The impression of some hallucinations is less related to the mechanics of the sight but more to the method by which the mind organizes the data. The human brain takes time to understand everything that comes into it via the sensations, and frequently these conclusions are incorrect. Though all this brain puzzling is commonly referred to as "optical illusions," medical researchers distinguish these visual teasers and psychologists refer to them as visual processing, thus possibly not being accurate every time.

**Coordination Process**

Users can't blame their eyes for moving quickly; it's an unconscious reflex. According to research, as people travel, it's recorded in the photoreceptors and appears as a fresh picture. Imagine it as being a ghost representation covering a fresh picture. Human perception of a single thing is altered when related characteristics are reinforced and combined. The person perceives the visual as fluctuating because of this process. The eyes process a huge amount of information very quickly. In actuality, the processing of a picture by the visual system usually requires minimal 13 milliseconds. Following "viewing" the picture, the mind starts processing in the background (Figure 1).

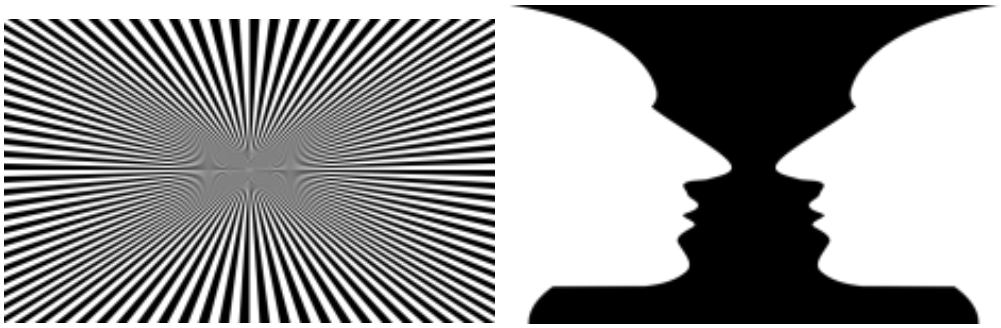

**Figure 1.** Examples of Optical illusion
(Source: https://pixabay.com/vectors/optical-illusion-black-pattern-153444/
https://pixabay.com/vectors/cranium-head-optical-illusion-human-2858764/)

This implies that the human brain continuously directs the vision to determine what to look next while the eyes have always been attempting to understand what they're currently experiencing. That sounds tiring. Even the master of the nerve center finds it tiresome! Since scientists see visualizations as just another fun mental task, they are closely related to neurobiology today. They investigate this same biological brain's interpretation of the data the eyesight provides through illustrations.

**Reality**

For us, the study of sensation raises a slight problem. Shouldn't people be interested in finding out how actuality

can be false because science informs us whether the mind is fabricating a "narrative" about existence? It's not necessary to cast doubt on what those sensations tell us. To improve as thinkers, we need to be aware of any blind zones. False memories have constantly been utilized by both artists and scientists to gather knowledge about the internal dynamics of such sensory information. Several paintings that people see have the potential to trick the real vision into believing that it can appear to be something that isn't really there. The sight illusion may cause individuals to either perceive the absence of something as well as missing an element that is present.

**Conflict**

Consider what it requires to recognize anything moving, such as the animated elements mostly in the examples above. The illustration is changed into complex electric transmission when it strikes the optic nerves inside the base of the eyes, which must then proceed toward the sensory monitoring system inside the middle of the head. Every signal then continues on its journey throughout the brain, building the information we perceive and storing it in the form of memory. Hence, the brain anticipates this motion's course before something occurs. It gives us such a narrative about the entity's direction, and then this narrative constitutes the experience.

**The reason behind the optical illusion**

When the human central nervous system and retina try to communicate with each other by employing basic signals, but somehow it can’t happen, optical illusions occur. For instance, it is believed that an object appears as it does because the eyes instructed everything, even the eyeballs' messaged the nervous system. Since it is proven quite helpful to be able to identify mobility immediately and frequently, the thoughts and eyeballs that have developed toward the object are highly susceptible to that modification.

**Brain language**

The brain functions like a powerhouse that is blind, but it is incredibly intelligent. The brain occasionally becomes perplexed with the information the eyeballs are attempting to communicate. This might imply that although something is motionless, the person perceives it as moving. Alternatively, someone could "see" colors, tints, or forms that aren't present. Both neurological systems communicate with one another in an extremely basic transmission, analogous to a little toddler who is unfamiliar with numerous words. For the majority of the moment, though, this doesn't pose an issue since the intellect can interpret whatever the retina is telling it.

**Harmful effects**

The majority of optical illusions remain harmless. They have been shown not to impair eyesight. On the other hand, prolonged staring at one object might result in discomfort, vision problems, eye irritation, damp eyes, and much more. There must be individuals who can respond negatively to these visual challenges as well. Certain distortions might be harmful to those who are hypersensitive. Be mindful of the conditions before gazing at visualizations, as they can, in a small number of unusual situations result in epileptic fits.

**Conclusion**

In principle, investigators generally understand fewer facts about the precise mechanisms underlying these "misapprehensions" afterward when they take place. Several academicians have devoted a great deal of energy and time over many centuries to attempting to comprehend exactly how optical illusions function. Yet the fact is that we just don't fully understand how the nervous system and vision interact to produce these appearances.

We are aware that such knowledge that eyeballs detect takes a far-reaching, convoluted path before the brain receives it. Slightly earlier in the voyage, there is some perplexity. Some optical illusions are now

comprehensively described by extremely complex mechanisms that come far beyond the initial illusion.

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## 19. HOW GUT MICROBIOME AFFECTS MENTAL HEALTH


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**Introduction**

The global population has seen an alarming increase in mental health diseases over the last decade. Recent reports estimate that over 300 million people worldwide suffer from depression, while over 260 million are affected by anxiety disorders (1). “Gut microbiome” refers to microorganisms and their genetic material that reside in the gastrointestinal tract. According to preliminary evidence, circadian genes interact with the gut microbiome and regulate mental state. A healthy state of an individual signifies equilibrium in the composition of gut microbiome and any disruption in this balance, i.e., dysbacteriosis increases the susceptibility of hosts to diseases (2). The gut microbiota may influence brain function via neural, endocrine and immune pathways (3). The composition of the gut microbiome consists mainly of microbes of phyla Firmicutes and Bacteroidetes. Other abundant species are Proteobacteria, Actinobacteria, Cyanobacteria, Verrucomicrobia, and Fusobacteria. Recent studies suggest that differences in the biological clock, gender of the host, and dietary food intake change the abundance of these microbes (2).

**Microbiome-gut-brain axis**

A large number of previous studies have suggested the presence of a microbiome-gut-brain (MGB) axis. The microbiota within this axis affects the brain through three different pathways, and the flow of information is bidirectional (4). The CNS also regulates the gut microbiome composition through these 3 pathways (2).

**Relationship between nutritional uptake and mental health**

Polyunsaturated fatty acids (PUFA) affect brain cells. Protein and amino acids from food influence the circadian cycle by modulating neurotransmitters. Like tryptophan, which acts as a precursor to melotonin and serotonin, and glycine, which reduces the core body temperature, thus improving sleep quality (1).

Increased intake of complex carbohydrates positively affects the brain, as when broken down by the gut microbiome, they release short-chain fatty acids (SCFAs) that show an anti-inflammatory response and regulate

immune homeostasis (4). The vitamin B group improves cognitive function; vitamin D may prevent neurodegenerative disorders; and the vitamin E group protects nervous membranes from oxidative damage (Figure 1) (1).

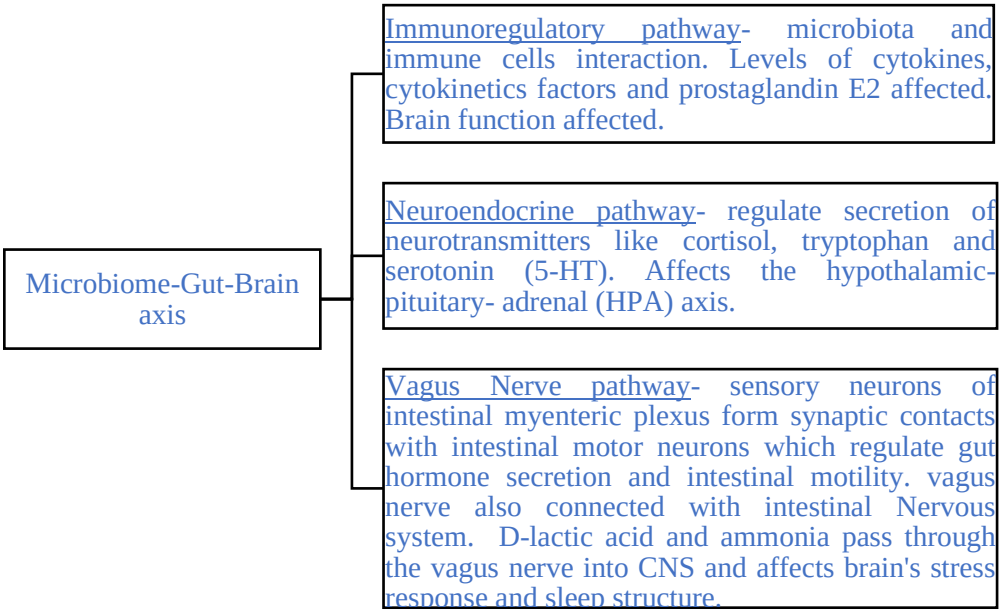


**Figure 1.** The three different pathways of the Microbiome-Gut-Brain axis (2)

**Gut microbiota and mental health**

The dysbacteriosis of the gastro-intestinal microbiome is due to disruption of the circadian clock of the host and has been shown to cause sleep disorders, stress, anxiety, depression, and insomnia in the host. Mutations in the expression of the core clock genes of the host (*Bmall, Per1*, and *Per2*) cause sleep dysfunction, which can further result in depression. Disruption in sleep patterns also causes stress and anxiety. Disturbed circadian rhythm causes physiological stress, altering the gut microbiome. This alteration affects the functioning of both the immune as well as nervous systems, reducing the ability of an individual to cope with stressful life events. In animal studies, neonatal rats were isolated from their mothers and they were shown to have an increased permeability of the gut mucosa in case of stress, and these mice showed anxiety-like symptoms (Figure 2) (2).

Corticosterone and melatonin are also involved in the development of stress and anxiety conditions. Studies suggest that glucose imbalance in shift workers (as opposed to normal workers) results in the loss of cortical rhythm, leading to metabolic imbalance. Probiotics like *Lactobacillus, Bifidobacterium,* and *Enterococcus* have an antidepressant-like effect as they reduce the stress induced secretion of corticosterone. Depression and insomnia go hand in hand, and insomnia increases depression. Recent studies suggest that the MGB axis plays a role in the comorbidity of depression and insomnia. Neurotransmitters like cytokines, 5-HT, GABA, short chain fatty acids (SCFAs), and other compounds affect the activity of the CNS, ENS, and vagus nerve.

Spore-forming gut bacteria can regulate the synthesis and secretion of 5-HT by acting on chromaffin cells of the gastrointestinal tract. It is observed that patients with depression and insomnia show abnormal GABA expression (2). *Lactobacillus* and *Bifidobacterium* can secrete GABA, and mice fed with *Lactobacillus rhamnosus* showed reduced depressive symptoms. However, vagotomized animals do not show such behavior (5). Emotional stress changes the composition of the gut microbiome (2).

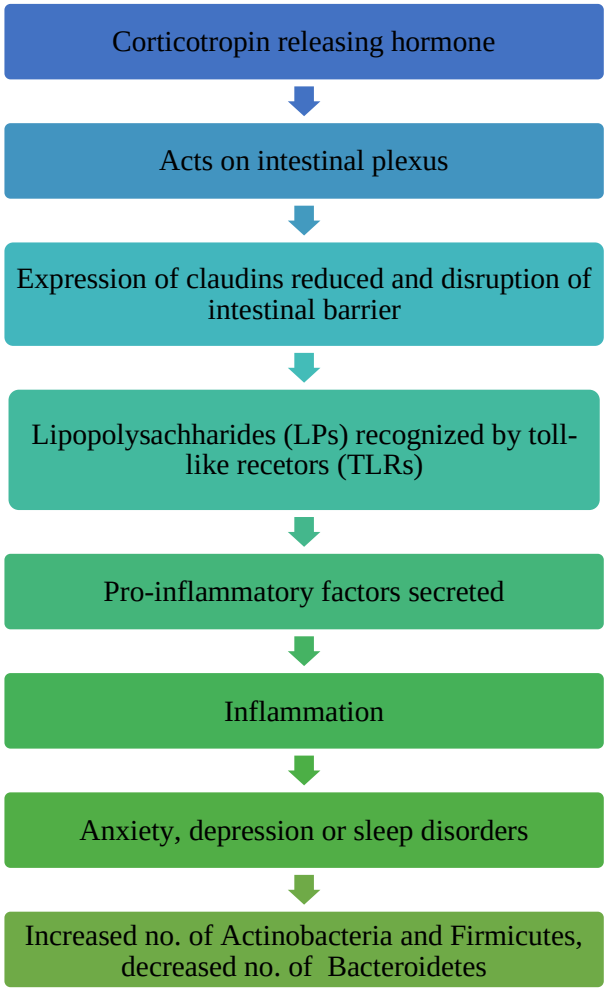


**Figure 2.** Flowchart depicting the effect of emotional stress on the gut microbiome composition (2)

**Inflammation: a link between sleep disorders and health problems**

Many studies suggest that the pro-inflammatory gut bacteria increase the gut permeability, which causes low-level chronic inflammation and disturbances in metabolic signaling (like insulin-mediated glucose uptake). Depression can also increase the risk of metabolic disorders. As mentioned above, depression changes the gut microbiome composition. The gut microbes' interaction with nutrients activates the parasympathetic nervous system and increases the acetate product, which results in obesity. (2) Stress can induce 'leaky gut' formation by increasing the permeability of the intestinal barrier. This leads to bacterial translocation and autointoxication, followed by chronic inflammation, as found in mental conditions like schizophrenia (5).

**Conclusion**

The gut-microbiota equilibrium is necessary for maintaining a healthy mental state, getting good and adequate sleep, and preventing other health problems. Probiotics play an important role in maintaining this equilibrium. It is imperative to do further research to understand the mechanism behind the bidirectional relationship between gut microbiome and health problems, and also understand the different effects of probiotics.

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## 20. GUT FEELINGS: HOW GUT MICROBIOTA INFLUENCE MOOD AND EMOTIONAL HEALTH

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On Earth, we find an amazing number of creatures living together. Each creature is unique. All of these bacteria are microscopic organisms that are said to be cosmopolitan i.e they are found nearly everywhere even inside our bodies. Many of them live in mutual relationships with us and are important for our nutrition while many of them are pathogenic too. The complete population present inside and on the body of a human is called the human microbiota. Among the complete body most of the bacteria are present inside the gastrointestinal tract and that is nearly 100 trillion bacteria. Gut bacteria have a strong coordination with our central nervous system. A good connection is essential for normal mental health and good mood.

**The Microbiota-Gut-Brain Axis**

The bacteria present in the gut link with the brain by means of various metabolic and signaling pathways, and have the potential to influence our mental and cognitive health. There are a number of associated studies that claim that the microbe present in our gut plays some sort of role in learning, memory, anxiety, stress, neurodevelopmental and various neurodegenerative disorders. The microbiota-gut-brain axis is a complex bidirectional communication network that links the gut microbiota, the gut, and the brain. This network involves a variety of signaling mechanisms, including neural, hormonal, and immunological pathways, which together regulate several aspects of host physiology and behavior (2,3).

**The Gut-Brain Axis: How Your Gut and Brain Communicate**

The gut and the brain are two of the most complex and important organs in the body, and they are intimately connected through the gut-brain axis. This communication network is responsible for regulating many aspects of host physiology and behavior, including digestion, nutrient absorption, mood, and cognition (3). Through the

gut-brain axis, the gut can influence brain function and behavior, and vice versa. For example, the gut microbiota can produce various metabolites and signaling molecules that can affect brain function and behavior, such as neurotransmitters and short-chain fatty acids. Conversely, the brain can also affect gut function through the gut-brain axis, regulating gut motility and secretion, and influencing gut immune function through the release of stress hormones and other signaling molecules (Figure 1).

The gut-brain axis is critical for maintaining homeostasis in the body, and alterations in this axis have been linked to the development of various disorders, including gastrointestinal disorders, metabolic disorders, and psychiatric disorders. Dysbiosis, an imbalance in the gut microbiota composition, has been linked to the development of conditions such as inflammatory bowel disease, irritable bowel syndrome, and obesity. Alterations in the gut microbiota have also been associated with mood disorders such as depression and anxiety (2). Research has shown that a healthy diet, rich in fiber and diverse in plant-based foods, can promote a healthy gut microbiota composition and support gut-brain axis function. Additionally, certain probiotics and prebiotics have been shown to improve gut microbiota composition and support gut-brain axis function, potentially reducing the risk of various disorders.

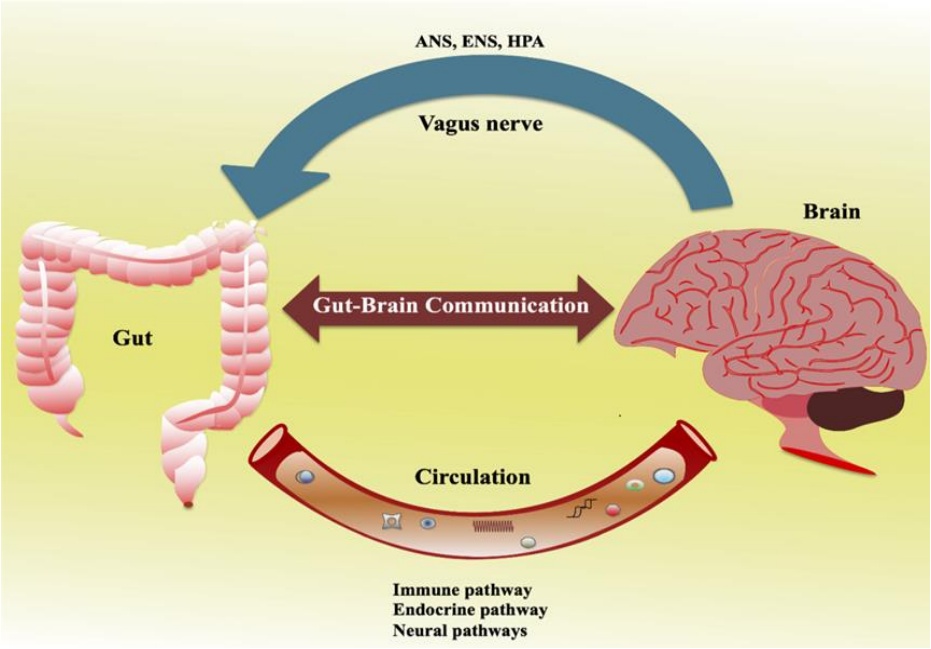


**Figure 1**. Pathway of communication between Gut Microbiota and Brain**.**
*(*Source:https://upload.wikimedia.org/wikipedia/commons/6/63/Gut-Brain_Axis.png?20211116023821)

In conclusion, the gut-brain axis represents a critical communication network that links the gut and the brain, regulating many aspects of host physiology and behavior. Alterations in this axis can contribute to the development of various disorders, highlighting the importance of maintaining a healthy gut microbiota composition and supporting gut-brain axis function (2,3).

**Important Roles of Gut Microbiota**

The gut microbiota, which refers to the collection of microorganisms that reside in the gut, plays a crucial role in maintaining gut homeostasis and promoting host health. The microbiota can influence the host's metabolism, immune system, and even mood and behavior. In turn, the host's behavior and emotions can also affect the microbiota composition and function. The gut-brain axis refers to the bidirectional communication between the gut and the brain, which involves both neural and hormonal signaling pathways. This axis plays a crucial role in regulating various physiological and behavioral processes, including appetite regulation, stress response, and mood regulation.

The microbiota-gut-brain axis represents the interconnection between the microbiota, the gut, and the brain. This axis involves a variety of mechanisms, including the production of microbial metabolites, the activation of immune cells, and the modulation of the gut-brain signaling pathways. Through these mechanisms, the microbiota can influence various aspects of brain function, including behavior, mood, and cognitive function. The microbiota-gut-brain axis has been implicated in a wide range of disorders, including gastrointestinal disorders, metabolic disorders, and psychiatric disorders. Research in this area is ongoing, and scientists are working to better understand the complex interactions that occur within this network and to develop new therapies that target this axis for the treatment of various disorders (Figure 2) (1).

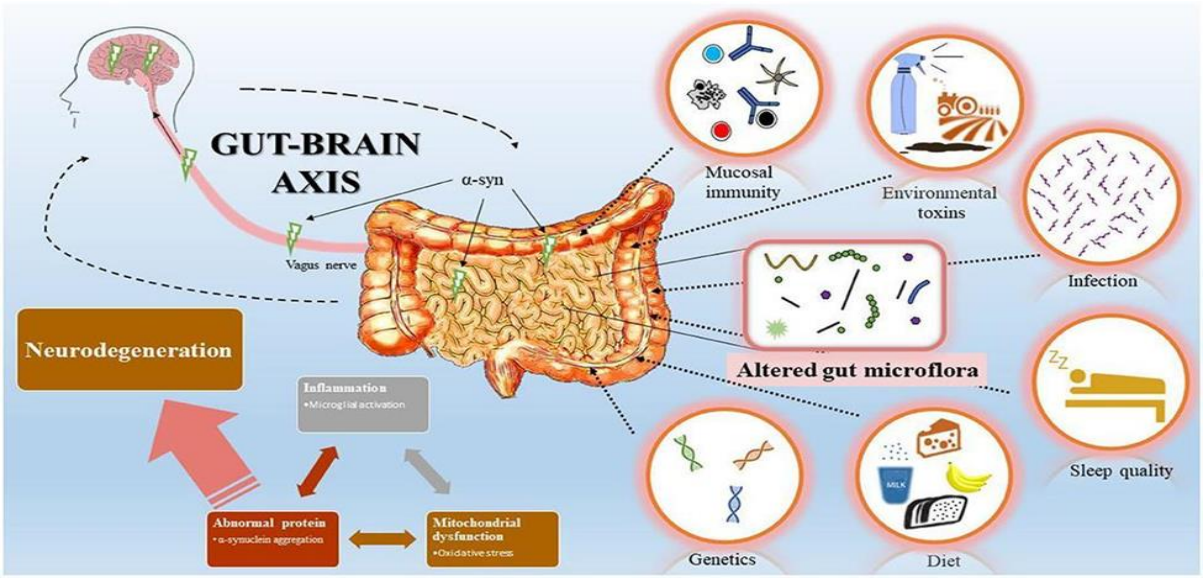


**Figure 2.** The microbiota-gut-brain (MGB) axis: it is a link between the bacteria present in our gut and the brain. It is a bidirectional axis that uses the vagus nerve as the main connection. This figure includes the hypothalamic-pituitary-adrenal (HPA) axis and its link with the MGB axis.
(Source: https://commons.m.wikimedia.org/wiki/File:Gut-brain_axis_overview.jpg)

**How Gut Microbiota Affect Mood Regulation**

The gut microbiota, which is the collection of microorganisms that live in our intestines, plays a significant role in our overall health and well-being. Recent research has highlighted the connection between gut microbiota and human feelings, including mood, behavior, and emotional responses. Here are some of the different ways gut microbiota can affect human feelings:

- **Production of neurotransmitters:** The gut microbiota can produce neurotransmitters such as serotonin, dopamine, and GABA, which are involved in regulating mood, behavior, and emotions. Serotonin, in particular, is often referred to as the "feel-good" chemical because it is associated with positive emotions and feelings of well-being.
- **Regulation of the immune system:** The gut microbiota helps regulate the immune system, which can impact feelings of fatigue, malaise, and mood. Research has shown that an imbalance in the gut microbiota can lead to chronic inflammation, which is associated with a higher risk of depression and other mood disorders.
- **Influence on hormone production:** The gut microbiota can influence the production of hormones such as cortisol, which is involved in the stress response system, and oxytocin, which is associated with social bonding and feelings of happiness.
- **Regulation of inflammation:** The gut microbiota can influence the levels of inflammation in the body, which have been linked to depression and other mood disorders.
- **Modulation of brain activity:** The gut microbiota can influence brain activity and neural circuits involved in mood and behavior. Studies have found that changes in the gut microbiota can affect brain function and cognitive processes, which can impact mood and behavior.
- **Production of short-chain fatty acids (SCFAs):** The gut microbiota can produce SCFAs, which play a role in regulating gut motility, glucose metabolism, and inflammation. SCFAs have also been linked to improved mood and reduced symptoms of depression and anxiety (2,3).

**Conclusion**

In conclusion, the gut microbiota plays a critical role in regulating human feelings, including mood, behavior, and emotional responses. It accomplishes this through a complex network of pathways and mechanisms, including the production of neurotransmitters, regulation of the immune system, influence on hormone production, modulation of brain activity, and the production of short-chain fatty acids. Disruptions in the gut microbiota can lead to symptoms of anxiety, depression, and other mood disorders.

Maintaining a healthy gut microbiota is essential for optimal mental health and well-being. This can be achieved through a healthy diet, regular exercise, and the use of probiotics and prebiotics. By taking care of the gut microbiota, we can enhance our emotional and mental health, leading to a more fulfilling and satisfying life. Further research is necessary to fully understand the relationship between gut microbiota and human feelings, but current evidence suggests that the gut-brain axis is a promising avenue for the development of new therapies for mental health disorders.

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Lyte J.M., Martin J.A., Molinero-Perez A., Moloney G., Morelli E., O'Connor, R., … Dinan T.G. The Microbiota-Gut-Brain Axis (2019). *Physiological reviews*, 99(4), 1877–2013. doi: https://doi.org/10.1152/physrev.00018.2018

3. Clapp M., Aurora N., Herrera L., Bhatia M., Wilen E., & Wakefield S. Gut microbiota's effect on mental health: The gut-brain axis (2017). *Clinics and practice*, 7(4), 987. doi: https://doi.org/10.4081/cp.2017.987

## 21. *DROSOPHILA* ACCESSORY GLAND: A MODEL FOR PROSTATE CANCER

*Pooja Gupta (Batch of 2020-23)*
*pj65701@gmail.com*
*Department of Biochemistry, Shivaji College, University of Delhi*

The prostate gland is an exocrine gland which is a part of male reproductive system of humans (1). The secretions of the prostate gland play a necessary role in sperm capacitation (2). This gland is responsible for maturation and production of seminal fluid. The activities of the prostate gland depend on the androgen hormone, which is mostly produced by testis of the male (1). The epithelium layer of the human prostate is pseudostratified. The prostate epithelium is arranged in branch tubules which are connected by ducts (2). The abundance of exosomes is the characteristic feature of prostate epithelium. Exosomes are microvesicles which are secreted from the endosomal multivesicular body (MVB) that on fusion with sperm modifies its activity and helps in protecting its homeostasis (1).

Prostate cancer is the most widespread cancer worldwide which mostly affects older men (3). The prostate gland becomes excessively enlarged that leads to lower urinary tract symptoms which includes disturbance in urinary retention and frequency. There is uncontrolled and virulent growth of cells in the prostate gland causing symptoms like pain or difficulty with urination and ejaculation. Prostate cancer is a heterogeneous cancer which needs distinct and various modified treatments depending on the aggressiveness of the tumor. They show heterogeneous behaviour that makes it difficult to determine which genetic deformity is the cause of initiation, further development, and ultimately treatment resistance in the prostate gland (3). Prostate cancer is of various types in which Adenocarcinoma (i.e epithelial region) is an aggressive tumor that rapidly advanced to a metastatic stage and can be partially stopped by androgen deprivation therapy because cells of prostate cancer depend on the androgen hormone for their growth and proliferation (1, 3).However, subsequent treatment demonstrates resistance after an early response. Because of this, patients develop castration-resistant prostate cancer (CRPC) which cannot be cured. Aggressive treatments can only slow down this disease which ultimately leads to death (Figure 1) (3).

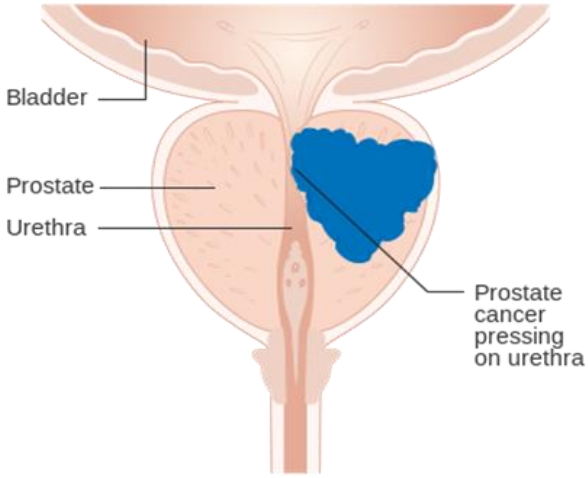


**Figure 1.** Malignant growth of cells in prostate gland
(Source: Science Rach)

Research and various studies on male accessory gland of *drosophila* revealed that it shows similar physiology to human prostate epithelium. The male accessory gland of *drosophila* is used by a genetic screening method which identifies genes that promote growth or development and migration of the secondary cells, that is homologous to the genes which are expressed in human prostate cancer (1). The male accessory glands are present in pairs and secrete most of the protein [such as glycoprotein, cysteine rich proteins, and lectins] which contain seminal fluid (2). The accessory gland of *drosophila* present in the secondary layer of epithelial cells continues to proliferate like that happened in the human prostate. Due to this growth, replicas of endocrine tumors, such as human prostate adenomas, have been created (Figure 2) (1).

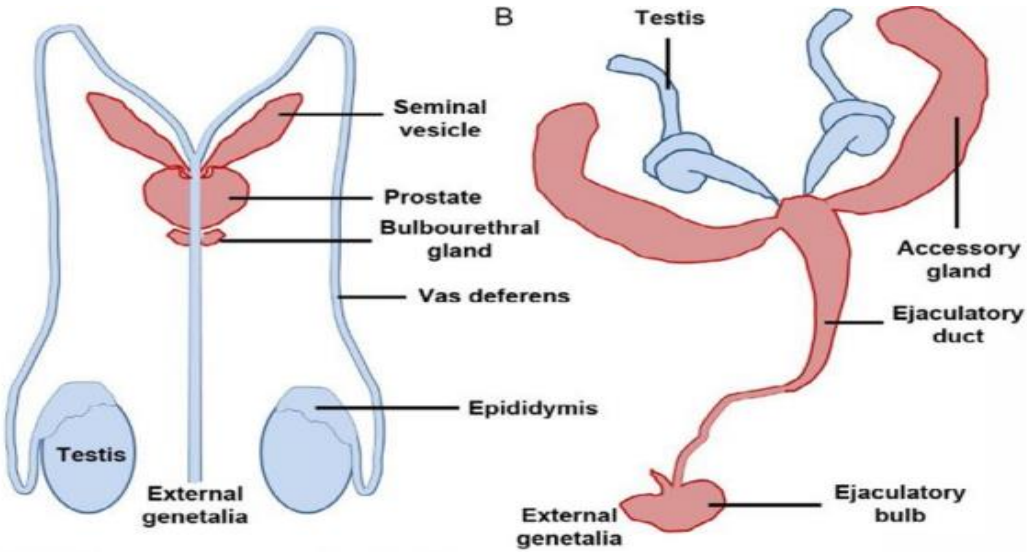


**Figure 2.** Male reproductive system of (A) Humans and (B) Flies
(Source: C. Wilson et.al (2))

In *Drosophila*, the secretion of epithelium of accessory glands depends on ecdysone. Whereas in humans, the secretion of epithelium depends on testosterone. Ecdysone and testosterone, both are steroid hormones. PTOV1

is an adaptor protein that modifies cell proliferation and the cell cycle. Throughout the development of prostate tumors, they overexpressed. The relationship between PTOV1 and the Notch signaling system is studied using *Drosophila* as a model organism. As a negative regulator in the notch pathway, PTOV1 induces the growth of notched wings and the correction of developmental defects brought on by a Notch gain-of-function mutation. Based on the studies on *Drosophila*, there is also another known pathway i.e., hippo signaling pathway and major gene of this pathway is MYC, which overexpressed itself during prostate cancer tumorigenesis. lgl (lethal giant larvae) which first expressed itself in *drosophila*, as the tumour suppressor gene. This gene is involved in epithelial cell polarity. The abnormal growth of the larval brain and imaginal disc is because of the loss of expression in epithelial cell polarity (3).

The three genetic tools that make *Drosophila* a powerful model to analyze the role of signalling pathways very precisely with extreme spatial and temporal precision are:

- The combination of the UAS/Gal4/Gal80 binary expression system,
- The FLP-FRT recombinase system, and
- The availability of RNAi transgenic animals

The native gene promoters of *drosophila* are used so that Gal4 can be expressed in time and tissue. The secondary cells of male accessory gland of *drosophila* can move by detaching from their epithelial layer. For discovering new regulators of human cancer progression that promote growth and migration of secondary cells, tissue specific genetic screening is done directly in male accessory gland in which this ability of migration has been used. By using *drosophila* as a disease model, it brings different approaches and different perspectives for understanding various mechanisms and techniques involved in prostate cancer (Figure 3) (3).

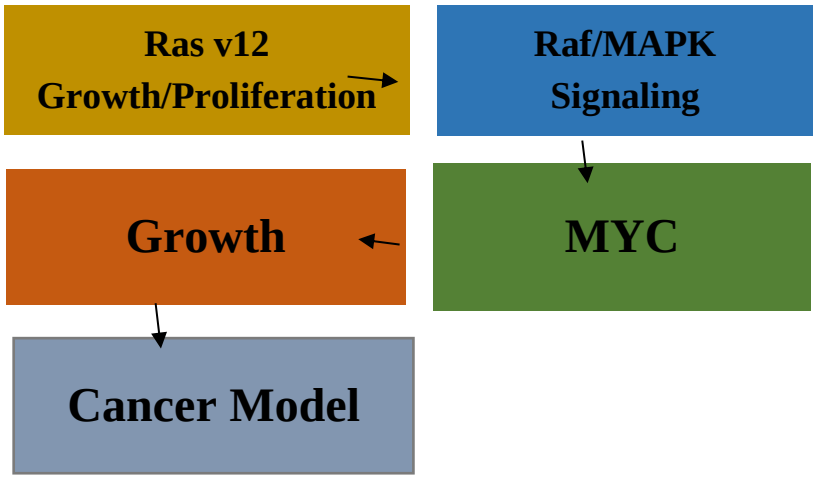


**Figure 3.** Prostate Cancer signaling Pathway

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5. Chapter Eleven - The *Drosophila* Accessory Gland as a Model for Prostate Cancer and Other Pathologies published in book: *Current Topics in Developmental biology*, vol. 121, pages-339-375. doi: 10.1016/bs.ctdb.2016.06.001

# B. SCIENTIFIC GALLERY

## 1. BACTERIAL ENDOSPORE

*Sudhanshu Shukla (Batch of 2020-23)*
*Department of Biochemistry, Shivaji College, University of Delhi*

Some bacteria like Bacillus, Clostridium etc. produce endospore to survive unfavorable environmental conditions. Endospores are dormant and highly resistant structures that germinate and return to their vegetative state when condition is favorable. The strain of *Bacillus subtilis* was stained by Schaeffer-Fulton's method. Malachite green is the primary stain used here which stains bacterial endospore and Safranin is used as a counterstain which stains vegetative cells only. Before they are released from the vegetative cell, spores may be central, polar, or subpolar in location.

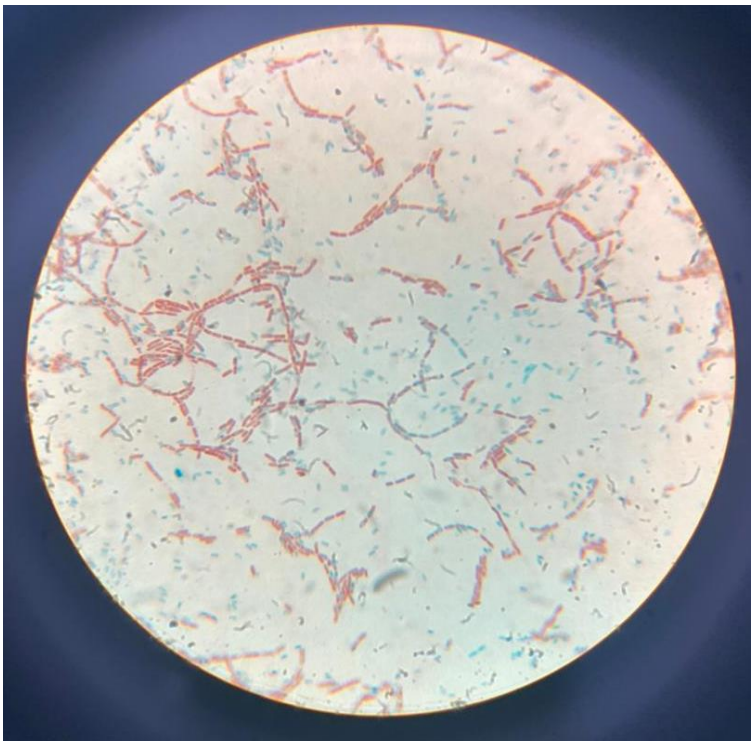


**Figure. Microscopic image of bacillus showing Endospore (Green) and Vegetative cell (Pink).**

The shape of the endospore was nearly an oval & the position was observed to be polar or terminal when seen at 100X magnification from compound microscope

- **Scientific Name:** *Bacillus subtilis*
- **Camera:** Realme 3 Pro
- **Microscope:** Compound Microscope
- **Location**: RLA College, University of Delhi, South campus
- **Date:** 28th December, 2022
- **Captured By:** Sudhanshu Shukla

**Reference:** https://asm.org/ASM/media/Protocol-Images/Endospore-Stain-Protocol.pdf?ext=.pdf

## 2. PLAQUE ASSAY: MEASURING INFECTIOUS VIRAL PARTICLES

*Mehfooz Helal (Batch of 2020-23)*
*Department of Biochemistry, Shivaji College, University of Delhi*

A plague can be defined as a clear zone formed on a bacterial monolayer due to their susceptibility to bacteriophages (viruses that kill bacteria). Plaque assay is an assay performed to measure infectious viral particles. It is a common way to determine phage titre. It requires bacterial cells that are susceptible to infection by a virus of interest to grow on a suitable growth medium forming a monolayer. The virus is serially diluted to a concentration that leads to formation of a number of plagues that can be counted. The aliquots of diluted virus samples are added to the bacterial growth plate and incubated for a few hours, ensuring the virus to attach the target cells (infection). A semi-solid media (usually agar of 0.4 to 0.5 %) is layered onto this and the plate is incubated for about 16 hours (incubation period depends on the type of bacterial cells chosen). The infectious virus present within the bacteria replicate to form their progeny. The semi solid media restricts particle movement and ensures only newly produced viruses infect the neighbouring bacterial cell. A lytic phage causes death of the host leading to formation of circular clear zones.

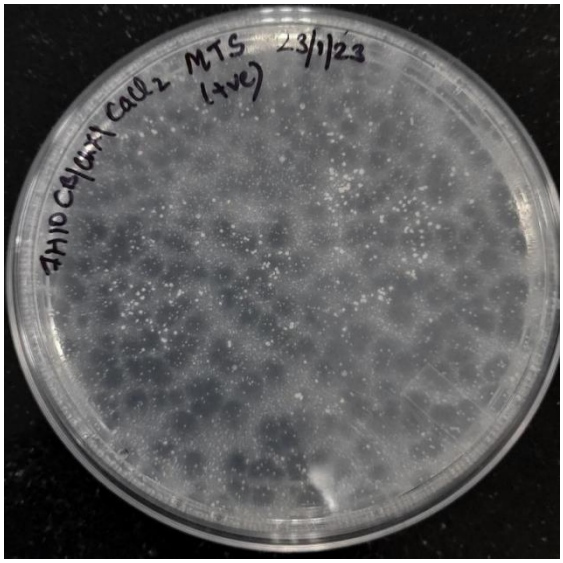



**Figure. Plaque formation on the monolayer of *Mycobacterium smegmatismc*² 155** (Carbenicillin resistant) grown on Middlebrook 7H10 Agar base, semi-solid media (soft agar 0.35 % of Middlebrook 7H10 Agar). Carbenicillin and Cycloheximide antibiotic solution were added to the growth medium to prevent growth of non-specific bacterial and fungal contamination, respectively.

- **Scientific name:** *Mycobacterium smegmatis*
- **Camera:** Samsung Galaxy M12
- **Location:** Acharya Narendra Dev College, Govindpuri
- **Date:** 25th January 2023
- **Captured by:** Mehfooz Helal

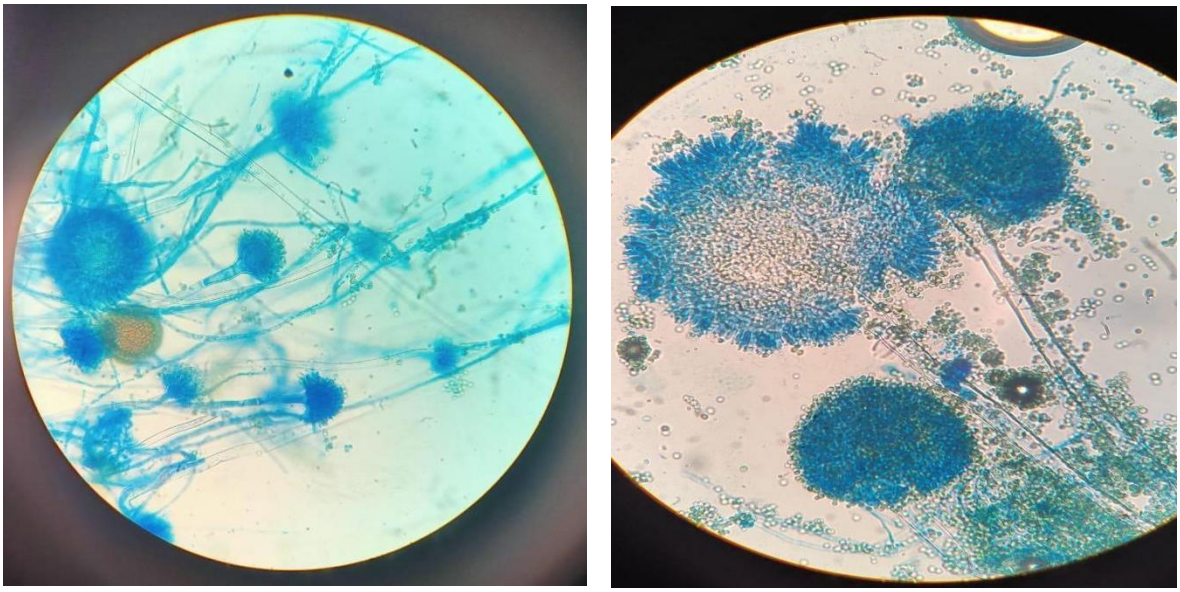
**Reference:** https://virologyresearchservices.com/2022/08/10/the-plaque-assay/

## 3. UNVEILING THE UNSEEN: A CLOSER LOOK AT THE MICROSCOPIC WORLD OF FUNGI

*Sudhanshu Shukla* **(***Batch of 2020-23)*
*Department of Biochemistry, Shivaji College, University of Delhi*

There are over 300 known species of Aspergillus, many of which have important roles in Agriculture, Industry, and Medicine. The Flavi, Fumigati, Nidulantes, Terrei, and Circumdati sections are among the several groups or sections into which Aspergillus species are divided. Each section includes multiple species with similar morphological, genetic, and ecological characteristics.

LPCB which stands for lactic acid phenol cotton blue is used to visualize the cell walls of fungal organisms, this staining solution works by penetrating the fungal cell wall and binding to the chitin, which is a structural polysaccharide that makes up a significant portion of the fungal cell wall. The stain also binds to the fungal cytoplasm and helps to differentiate the fungal structures under a microscope.



**A** **B**

**Figure. Microscopic image of fungi Aspergillus stained by Lactophenol Cotton Blue (A) 40X magnification (B) 100X magnification**

- **Scientific Name:** ***Aspergillus***
- **Camera:** Realme 3 Pro
- **Microscope:** Compound Microscope
- **Location:** RLA College, South Campus, University of Delhi.
- **Date:** 28th December, 2022
- **Captured By:** Sudhanshu Shukla

**Reference:** https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/aspergillus

## 4. A BEAUTIFUL BIO WEAPON

*Mitali Singh (Batch of 2020-23)*
*Department of Biochemistry, Shivaji College, University of Delhi*

Because of the shape of these flowers, which resemble dolphins, the genus name Delphinium was derived from the ancient Greek word delphinion, which means "dolphin." Over 300 species of annual and perennial blooming plants belong to the genus *Delphinium*, which is native to the whole Northern Hemisphere as well as the highlands of tropical Africa. Broad-spectrum bioactivities of the *delphinium* plant include anti-inflammatory, immunosuppressive, analgesic, anti-tumor, cardiotonic, anti-hypertensive, and vasodilatory effects. Since *Delphinium* plants have a wide range of bioactivities, it can be stated as A beautiful bio weapon, God blessed us with.

**Figure. Flowers of *Delphinium Elatum***

- **Scientific Name:** *Delphinium Elatum*
- **Camera:** Samsung Galaxy F41
- **Date:** 2nd March, 2023
- **Captured by:** Mitali Singh
- **Location:** Gautam Buddha Centenary, (North Campus) University of Delhi

**Reference:**


- https://www.wikidoc.org/index.php/Delphinium
- https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/delphinium#:~:text=The%20plant%20of%20Delphinium%20has,et%20al.%2C%202014)

## 5. AERIAL ELECTRORECEPTION IN BEES

*Bhavya (Batch of 2021-24)*
*Department of Biochemistry, Shivaji College, University of Delhi*

Electroreception is the ability of organisms to detect external electric fields. This is common in aquatic animals like fishes, amphibians, etc. But studies showed that bees can also perform electroreception. Aquatic creatures and bees have different mechanisms of action. In aquatic animals stimulus is transferred directly from water (the conducting medium) to the nervous system of aquatic animals. However, since air is resistive to electricity, how do bees perform electroreception?

Although honey bees and bumblebees achieve aerial electroreception using different physiological strategies, both strategies rely on an electromechanical mechanism. Bumble bees have mechanosensory hairs that are deflected when they come in contact with the negative electric field of a flower, whereas there is a positive electric field surrounding the bees. Similarly, honey bee antennae oscillate when near a flower's small electric field. The minimum electric field required to produce deflection in hair ranges between 0.77 and 61 V/m. Antennae requires a larger electric field between 15.3 and 306 V/m. By this electromechanical information, bees can distinguish between rewarding and unrewarding flowers.

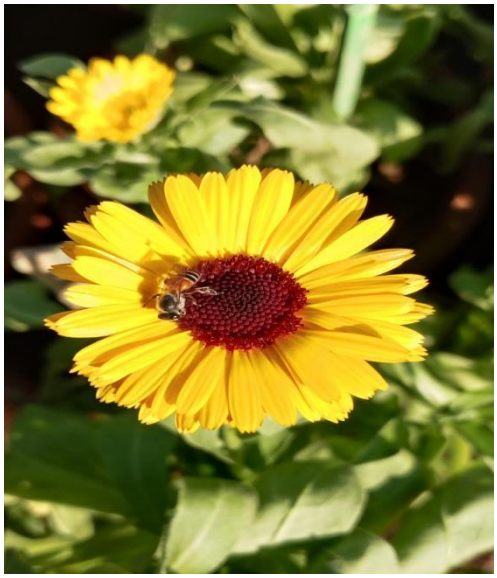


**Figure. Bees perform electroreception and differentiates between rewarding and unrewarding flowers**

- **Scientific name:** *Apis florae*
- **Camera:** Samsung Galaxy M12
- **Location:** Mahatma Gandhi Rd., Shivaji Enclave, Raja Garden, New Delhi, Delhi 110027
- **Date:** 7th February 2023
- **Captured by:** Bhavya

**Reference:** Clarke, D., Morley, E., & Robert, D. (2017). The bee, the flower, and the electric field: electric ecology and aerial electroreception. Journal of comparative physiology. A, Neuroethology, sensory, neural, and behavioural physiology, 203(9), 737–748. https://doi.org/10.1007/s00359-017-1176-6

## 6. NO GARDEN TRULY BLOOMS UNTIL BUTTERFLIES HAVE DANCED UPON IT

*Simran Kumari (Batch of 2021-24)*
*Department of Biochemistry, Shivaji College, University of Delhi*

One of the most prevalent Indian butterflies is the *Danaus genutia*, often known as the Common Tiger, which belongs to the Brush-footed Butterfly families' Danainae group. Based on regional variations, the common tiger butterfly (*Danaus genutia*) species is classified into 16 subspecies. *D. genutia* is present in Southeast East Asia, Australia, Sri Lanka, Myanmar, and all of India. The insect resembles the monarch butterfly of the Americans very well. Wingspans range from 75 to 95 mm. The butterfly's tawny wings have large black stripes identifying the veins, and both sexes have them. The Female's hindwing has a pouch on it. The wings have two rows of white dots along their black borders. On the underside of the hindwing of the male common tiger, a large black-and-white patch may be seen. The common tiger butterfly's larvae acquire a source of poison by consuming poisonous plants, making the caterpillar and butterfly an unappealing feast for predators.

**Figure. *Danaus genutia,* the common tiger**

- **Scientific name:** *Danus genutia*
- **Camera:** MI 11lite NE 5g
- **Location:** Subroto Park, Palam
- **Date:** 30th November, 2022
- **Captured by:** Simran Kumari

**Reference:** https://www.inaturalist.org/taxa/146923-Danaus-genutia

## 7. THE BUDGERIGAR

*Mitali Singh (Batch of 2020-23)*
*Department of Biochemistry, Shivaji College, University of Delhi*

The **budgerigar** is also known as the common parakeet, or budgies most commonly found in drier parts of Australia. The name 'budgerigar', means good food. They are among the third most popular pets across the world (small in size, low maintenance cost, mimic ability). Their heart beats up to 300 beats per minute, which is around four times faster than a human's heart rate. Budgies have monocular vision and are able to move one eyeball independently to the other eyeball. A budgie has more vertebrae in the neck region as compared to that of a human, this enables them to turn their heads up to 180° and thus they can look backward. Budgies do not have a bladder for the retention of urine or faeces, they directly excrete through a common orifice. These tiny birds have a big enough brain to learn simple sums and can count up to three.

**Figure. Budgerigar, the most popular pet birds**

- **Scientific name:** *Melopsittacus undulatus*
- **Camera:** Samsung Galaxy F41
- **Date:** 2nd November, 2021
- **Captured by:** Mitali Singh
- **Location:** Delhi (East Delhi, Yamuna Vihar)

**Reference:** https://www.littlepeckers.co.uk/s/amazing-facts-about-budgerigars

## 8. WHY DO CAT EYES GLOW IN THE DARK?

*Simran Kumari (Batch of 2021-24)*
*Department of Biochemistry, Shivaji College, University of Delhi*

There are 38 species of cats on the planet earth and because of a unique reflective structure called the tapetum lucidum, cat eyes appear to shine in the dark. The tapetum lucidum, which means "shining layer" in Latin, is effectively a tiny mirror in the back of the eyes of many different nocturnal animals. It simply makes it such that these animals can see quite well at night.

**Figure. Eyes that glow**

- **Scientific name:** *Felis catus*
- **Camera:** MI 11lite NE 5G
- **Location:** Base Hospital, Delhi Cantt
- **Date:** 14th March 2023
- **Captured by:** Simran Kumari

**Reference:** https://carnegiemnh.org/meowfest

## 9. BUCCAL EPITHELIAL CELLS

Vanshika Bansal *(Batch of 2020-23)*
*Department of Biochemistry, Shivaji College, University of Delhi*

The basal mucosa, the tissue that borders the interior of the mouth, is primarily made up of **squamous epithelial cells.** Often known as cheek cells, such cells multiply roughly every 24 hours and are regularly shed by the human body. Such a substance that may be collected using noninvasive techniques is buccal cells. With the use of oral exfoliative cytology, buccal cells have been employed to find modifications connected to cancer inside the oral cavity. In order to amplify high molecular mass fragments for use in large-scale population sampling, buccal epithelial cells provide a trustworthy source of DNA.

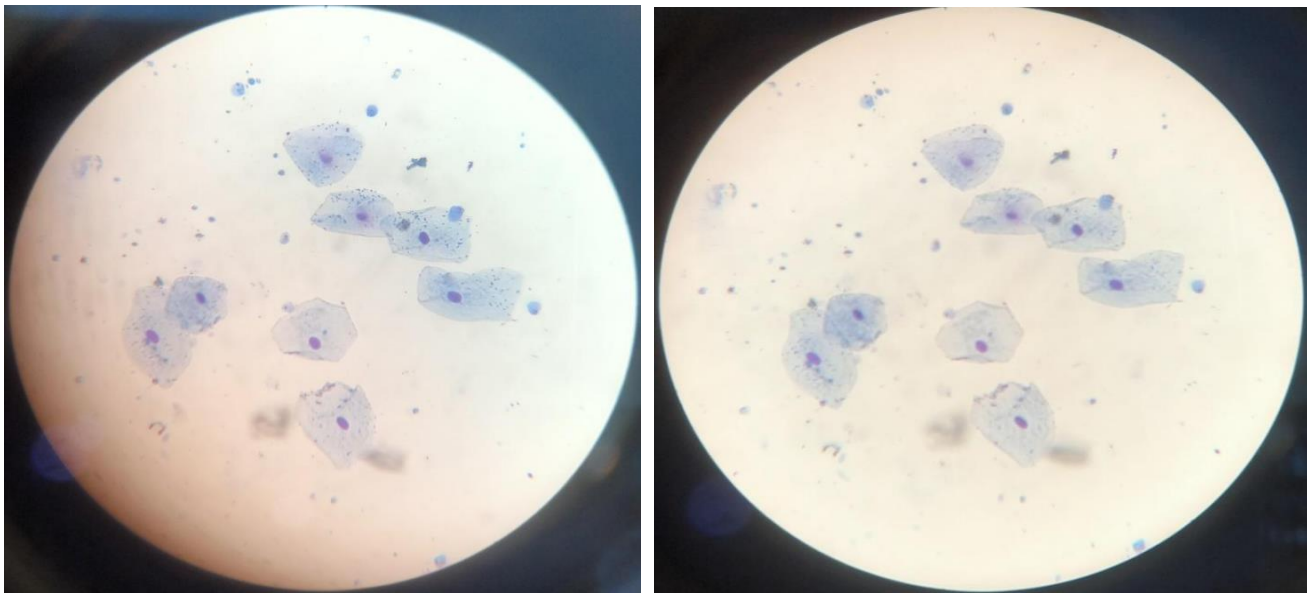


**Figure. Stained cheek cells under the microscope**

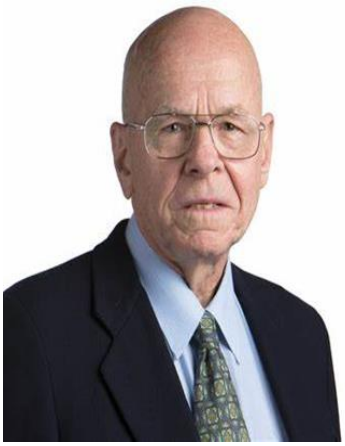
- **Camera:** Samsung M21 edition
- **Location:** Biochemistry Lab, Shivaji College
- **Date:** 15th September 2022
- **Captured by:** Vanshika Bansal
- **Equipment:** Compound Microscope Nikon E200
- **Magnification:** 40X

**Reference:**

https://www.olympus-lifescience.com/en/microscope-reesource/primer/techniques/dic/dicgallery/cheekcellslarge/

# C. NOBEL HALL OF FAME
# 2022-2023





**Carolyn R. Bertozzi (1)** **Morten Meldal (2)** **K. Barry Sharples (3)**

**The Nobel Prize in Chemistry (2022)** has been awarded to three scientists Carolyn R. Bertozzi, Morten Meldal and K. Barry Sharpless for the development of “click chemistry and bioorthogonal chemistry"

**Svante Pääbo (1)**

**The Nobel Prize in Physiology or Medicine (2022)** has been awarded to Svante Pääbo "for his discoveries concerning the genomes of extinct hominins and human evolution.”.


1. https://cdn.britannica.com/01/236201-050-8DE760B2/Carolyn-R-Bertozzi-2022-Nobel-Prize-Winner-Chemistry.jpg?w=400&h=300&c=crop
2. https://opoyi.com/wp-content/uploads/2023/01/Morten_Meldal_0IHQuaMeg-scaled.jpg
3. https://www.scripps.edu/_faculty/headshots/300x300_karl_sharpless.jpg
4. https://erc.europa.eu/sites/default/files/2022-12/P%C3%A4%C3%A4bo.png

# D. STUDENTS PROGRESSION

| Name of the student | Name of programme | Name of the Department<br>Name of Institute/ University |
|---|---|---|
| **B.Sc. (H) Biochemistry 2019-22** | | |
| Merlin Mathew | M.Sc. Biochemistry | Department of Biochemistry<br>University of Delhi, South Campus (UDSC) |
| Lishika | M.Sc. Biotechnology | Department of Biotechnology<br>AIIMS, Delhi |
| Sunidhi Bisht | PG Diploma in Molecular Diagnostics | Multidisciplinary Centre for Advance Research and Studies<br>Jamia Millia Islamia, Delhi |
| Afreen Shamsi | Project Assistant | Policy Research<br>CSIR-NIScPR |
| Riya Thomas | M.Sc. Biotechnology | Postgraduate department of Biotechnology<br>St. Xavier's College (Autonomous), Mumbai University |
| Sonali Singh | M.Sc. Biochemistry | Department of Biochemistry<br>University of Delhi, South Campus (UDSC) |
| Jaya Kumari | M.Sc. Biochemistry | Department of Life Sciences<br>Central University of Rajasthan |
| Parvana P | M.Sc. Forensic Science | Department of Life Sciences<br>Christ University, Bangalore |
| Maurya Sharma | M.Sc. Biochemistry | Department of Biochemistry<br>University of Tuebingen, Germany |
| Varsha | M.Sc. Biotechnology | Department of Biotechnology<br>DCRUST |
| Takhellambm Malemnganba | M.Sc. Biochemistry | Department of Biochemistry<br>University of Delhi, South Campus (UDSC) |

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|---|---|---|
| Rajat Maurya | M.Sc. Forensic Science | Department of Anthropology<br>Lucknow University |
| Vaibhav Sharma | M.Sc. Bioinformatics | Department of Computer Science<br>Jamia Millia Islamia, Delhi |
| Aditi Rattan | M.Sc. Biochemistry | Department of Biochemistry<br>University of Delhi, South Campus (UDSC) |
| Sagar | M.Sc. Biochemistry | Department of Biochemistry<br>University of Delhi, South Campus (UDSC) |
| Kaushal Grover | M.Sc. Computational and Integrative Sciences | School of Computational and Integrative Sciences<br>Jawaharlal Nehru University |
| **B.Sc. (H) Biochemistry 2018-21** | | |
| Vinayak Joshi | MSc Biochemistry | Department of Biochemistry, University of Delhi, South Campus |
| Pallavi Dutta | MSc Biotechnology | Jawaharlal Nehru University |
| Ronit Khandelwal | MBA | LBSIM Dwarka |
| Palak Joshi | MSc | Deenbandhu Chhotu Ram University of Science and Technology, Sonipat |
| Deepika Gola | MS Biochemistry | Technical University of Dresden, Germany |
| Utsav Kapoor | Social Media Manager at Q-one | |
| Kratika Rastogi | MSc Biochemistry | Central University of Punjab, Bathinda |
| Deepika Bhola | Diploma from Imarticus | |
| Shashank Gupta | Freelance Copywriter | |
| Anshika Rohilla | MSc Biotechnology | Maharaja Sayajirao University of Baroda |

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|---|---|---|
| Devendra | MSc Biotechnology | Guru Jambeshwar University of Science and Technology, Hisar |
| Aditya | MSc Plant Biochemistry and Biotechnology | Department of Plant Molecular Biology, University of Delhi, South Campus |
| Nikita | MSc Chemistry | Amity University, Gurugram |
| Ritika Kukreja | MSc Biochemistry | Jamia Hamdard University |

# E. CAREER NOTIFICATIONS

## I. Competitive Examinations

**Tentative dates** of some important competitive examinations for students pursuing biological sciences

| S. No. | EXAMINATION NAME | REGISTRATION STARTS FROM (Tentative) | MONTH OF EXAMINATION (Tentative) |
|---|---|---|---|
| 1. | TIFR (Tata Institute of Fundamental Research Graduate School Admissions) | October 2023 | December 2023 |
| 2. | IIT JAM (Indian Institute of Technology Joint Admissions Test for M.Sc.) | September 2023 | February 2024 |
| 3. | GAT-B (Graduate Aptitude Test Biotechnology) | March 2024 | April 2024 |
| 4. | AIIMS MSc Biotechnology, Biochemistry, Entrance Exam | February 2024 | June 2024 |
| 5. | GATE(Graduate Aptitude Test Examination) | August 2023 | February 2024 |
| 6. | IBAB (Institute of Bioinformatics and Applied Biotechnology Entrance Exam) | January 2024 | May 2024 |
| 7. | CUCET (Central Universities Common Entrance Test) | March 2024 | June 2024 |
| 8. | KIITEE (Kalinga Institute of Industrial technology Entrance Exam), M.Sc. Biotechnology | December 2023 | February 2024 |
| 9. | University of Madras M.Sc. Entrance Exam | April 2024 | June 2024 |
| 10. | ICAR (Indian Institute of Agricultural Research All India Entrance Examination) | March 2024 | June 2024 |
| 11. | Punjab University CET-PG | April 2024 | July 2024 |

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|---|---|---|---|
| 12 | JNTU M.Sc. Biotech Entrance Exam | June 2023 | July 2023 |
| 13. | Jamia Millia Islamia MSc Biotechnology Entrance Exam | March 2024 | June 2024 |
| 14.. | Hyderabad University, M.Sc. Biochemistry | April 2024 | June 2024 |
| 15. | HPU Shimla, M.Sc. Biotechnology | June 2023 | July 2023 |
| 16. | Osmania University, Hyderabad, M.Sc. Entrance | April 2024 | July 2024 |

## II. Internships

Tentative Dates of some important internships/training programs for students pursuing Biological sciences:

| S. No | Internship/ training program title | Organizing institution | Duration | Eligibility (BSc bio-science courses) |
|---|---|---|---|---|
| 1. | Visiting Students Research Program (VSRP) | Tata Institute of Fundamental Research | 8 weeks | BSc (2nd year completed) |
| 2. | Summer Undergraduate Research Program (SURP) | Dr. B.R Ambedkar Center for Biomedical Research | 6-8 Weeks | BSc. in Biomedical Science, Life Science or related subjects |
| 3. | Science Academies' Summer Research Fellowship Programme for Students and Teachers | ●Indian Academy of Sciences, Bengaluru<br>●Indian National Science Academy, New Delhi<br>●The National Academy of Sciences, India, Prayagraj | 8 Weeks | BSc (2nd year only) |
| 4. | Project Oriented Biology | Jawaharlal Nehru | 6 to 8 weeks | BSc (1st year of 3 year B. Sc |

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|---|---|---|---|---|
| | Education (POBE) | Centre for Advanced Scientific Research (JNCASR) | over 3 consecutive summers | programme only) |
| 5. | Summer Research Fellowship Programme (SRFP) | Indian Academy of Science | 8 weeks (renewable for a second year for selected students) | BSc (1st and 2nd year) |
| 6. | Summer Student Programme (SSP) | IISER Pune | 4 to 8 weeks | BSc (2nd year onwards) |
| 7. | Summer Research Program | IISER Mohali | 4 to 8 weeks | BSc( 2nd year onwards) |
| 8. | Summer Student Research Programme | IISER Kolkata | 4 to 8 weeks | BSc |
| 9. | Summer Visiting Programme | IISER Thiruvananthapuram | 8 weeks | Bsc (preferably 2nd year) |
| 10. | IARI internship training | Indian Agricultural Research Institute (IARI) | 1 to 6 months | BSc (any year) |
| 11. | Summer Internship Programme | NIT, Durgapur | 4 weeks or more | BSc (any year) |
| 12. | Bose Institute Summer Training | Bose Institute | 8 weeks | BSc (Only if recipient of KVPY, INSPIRE, JBNSTS, NTSE or other similar awards) |
| 13. | Annual Summer school program | School of Life Sciences, Jawaharlal Nehru University | 8 weeks | BSc (any year) |
| 14. | Summer Research Internship | Regional Centre for Biotechnology, RCB | 7 weeks | BSc (3rd year) |

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| 15. | Summer Research Internship Program (SRIP) | IIT Gandhinagar | 8 weeks | BSc (any year) |
| 16. | CRG Summer Internship Program | The Centre for Genomic Regulation, Barcelona, Spain | 8 weeks | BSc (2 full years i.e 4 semesters completed)<br>MSc students not eligible |
| 17. | Max Planck Summer Internship | International Max Planck Research Schools (IMPRS), Germany | 10 weeks | BSc (or MSc)<br>IELTS or TOEFL required |

## III. Scholarships

Tentative dates of some important scholarships for students pursuing biological sciences:

| S. No. | NAME | BENEFITS | ELIGIBILITY CRITERIA |
|---|---|---|---|
| 1. | **Kishore Vaigyanik Protsahan Yojana (KVPY)** | INR 5000 monthly fellowship and 20000 annual contingency grant during B.Sc. and 7000 monthly fellowship and 28000 annual contingency grant during M.Sc. | Students enrolled in XI Standard (Science Subjects) during the academic year 2021-22 and having secured a minimum of 75% (65% for SC/ST/PWD) marks in aggregate in MATHEMATICS and SCIENCE subjects in the X Standard Board examination immediately in the preceding academic year, Students enrolled in XII Standard/ (+2) (Science subjects) during the academic year 2020–21 and aspiring to join undergraduate program in Basic Sciences namely Physics/Chemistry/Mathematic s and Students enrolled in the 1st year of undergraduate program in Basic Sciences |

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| 2. | **Dr. B.R. Ambedkar State Award to SC/ST/OBC/Mino ritie s Students, Delhi 2021** | INR 25,000 to students who top among the SC/ST/OBC/Minorities in each discipline of the professional/technical degree course | Must be pursuing graduation in recognized college/institutions and Belonging to SC/ST/OBC/Minority community |
| 3. | **Sardar Patel Scholarship for Students Pursuing Graduation** | INR 15,000 | Must be studying in the 1st/2nd year of a 3-year graduation programme in regular full-time mode and the annual family income should be less than INR 6,00,000 (6 lakhs) per annum. |
| 4. | **INSPIRE Programme** | INR 5000 to one million young learners of the age group 10-15 years, ranging from Class VI to Class X standards, INR 80,000 per year is offered to talented youths in the age group 17-22 years, for undertaking Bachelor and Masters level education in natural sciences. | Candidates are eligible to apply for INSPIRE programme if they are a part of the top 1% students in their Class 12 board exams and are studying Natural and Basic Sciences at BSc level or Integrated MSc level or are among top 10,000 rank holders in JEE or NEET and have also opted to study Natural and Basic sciences in any institute or university leading to BSc and MSc degrees or have studied at any of the below-mentioned colleges and have opted to study Natural and Basic sciences at the BSc or MSc level are eligible for SHE Scholarship: IISERs, NISER, Department of Atomic Centres for Basic Sciences, KVPY, NTSE, JBNSTS scholars and International Olympiad Medalists. |
| 5. | **Narotam Sekhsaria Scholarship Programme** | Maximum INR 20 lakhs | Final year graduate student or have completed graduation from a recognised university, below 30 years of age who want to pursue PG courses in fields like Applied Sciences, Pure Sciences, Social Sciences and Humanities, Architecture Law, and Management at good Indian as well as international universities. |
| 6. | **HDFC Educational Crisis** | INR 10,000 to INR 25,000 per annum | Aspirants who are pursuing a Diploma, Graduation Degree or |

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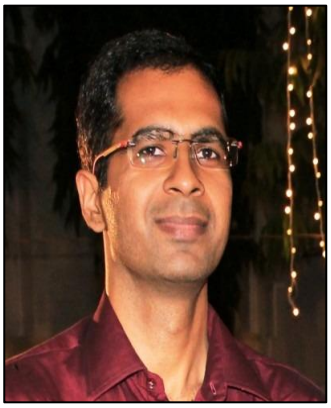
|---|---|---|---|
| | **Scholarship Support (ECSS)** | | Postgraduate degree and whose annual family income is equal to or less than INR 3,00,000 are eligible to apply for this scholarship. |
| 7. | **Post-Graduate Merit Scholarship for University Rank Holders** | INR 3,100 per month for the duration of two years. | Rank holders of each university at UG level are eligible to apply for this scholarship. |
| 8. | **Indira Gandhi Scholarship for Single Girl Child** | INR 36,200 per month for maximum two years | Any girl below 30 years of age who is the only girl/twin daughter/fraternal daughter of a family and has secured admission in full-time (regular) Master's degree programme from a recognised university/college. |

# F. MEMORY LANE

**Dr Anuj Kumar, (Batch 2001-2003), Scientist C & Nodal Officer NTTL at ICMR-National Institute of Cancer Prevention and Research, Ministry of Health and Family Welfare**



I got admission to the Biochemistry department of Shivaji college in 2001. We were a small batch of just eleven students, still it was a great learning experience with all of them. The faculty was highly dedicated and role models for all of us. I made a few very good friends at the time, who are still in touch with me after such a long time. I still remember that we used to play cricket on the college ground and listen to guitar (played by a buddy) during our free time at the college. Overall, my college days were very productive years of my life.

**Subhasis Sahoo (2014-17) Pursuing PhD from National Center for Cell Science, Pune**

My 3 years of life at Department of Biochemistry, Shivaji College was one of the best part of my life so far. Under the guidance of a great faculty and helpful lab assistants, my knowledge increased day by day. I was the President of the biochemical society in final year and Secretary in my second year. The best part about these posts was Interaction with my juniors and seniors which was always an enlightening for me. I really feel very proud to say that I was, I am and I will be a part of Biochemistry Department, Shivaji College. Thanks to all…

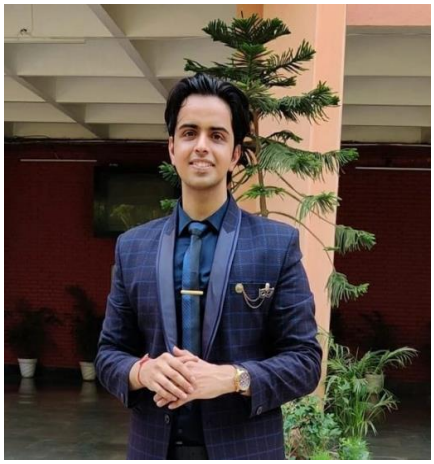
**Ritika Kukreja (Batch 2018-2021), Intern at Epigenetic Lab, AIIMS**

The Department of Biochemistry is not just a place where I did my graduation. It is more of an emotion to me! My second family. The warmth I have received is beyond one can ask for. The knowledge and exposure I got have made me a much more confident person. The teachers and all the lab members are the true gem, for they have molded us in the best way possible.

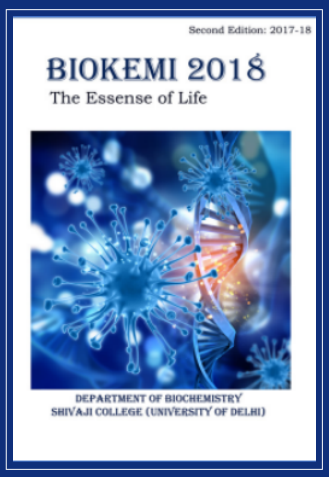
**Aditi Rattan (Batch 2019-2022), MSc Biochemistry, Department of Biochemistry, University of Dehli**

My 3 years' experience (2019-2022) at the Biochemistry department, Shivaji college is the timeline I would want to go back to any day! The faculty and my friend circle are majorly responsible for my personal growth. I will always be thankful to the teachers for giving me exposure. The way they trusted me with all the responsibilities made me believe in myself more. I feel lucky to have been a part of such an academically extraordinary yet fun department.

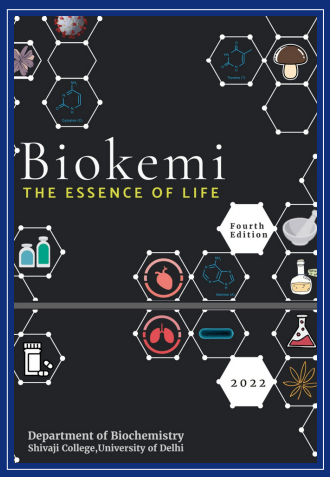
**Vaibhav Sharma (Batch 2019-22), M.Sc. Bioinformatics, Jamia Millia Islamia**



My undergraduate journey at the Biochemistry Department, Shivaji College was absolutely wonderful. I will forever be grateful to the professors for not only what I learnt academically, but also for what I was taught on how to navigate life. Even amongst the times of COVID we never felt disconnected due to the constant support from the teachers. The Peers I had were equally amazing, from lighthearted quips to serious important conversations, we had it all here. There was so much warmth and support, that this department felt like a family and I think it is the magic of this place and its people that always makes you feel at ease. I would like to thank all the professors, friends, and also the staff for making this journey a memorable one and giving me the memories to cherish for life. As I move forward with my academic journey, this department will always be a part of me. To my Juniors, I'd just like to say that work hard, be kind to people, and good things will happen and yes, don't forget to have fun, these are some of the best years of your life.



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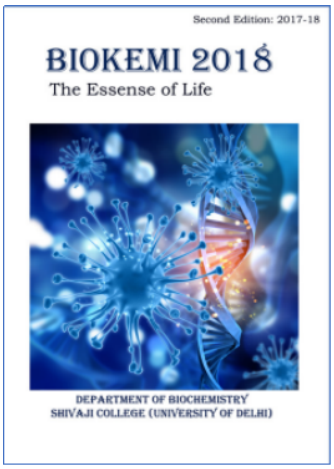



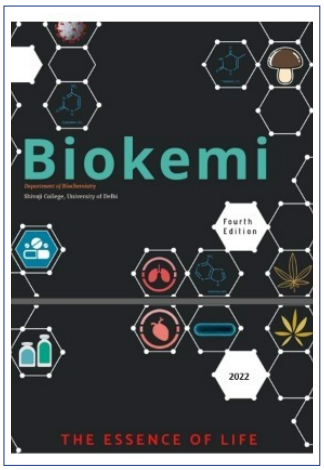


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