B.J.B AUTONOMOUS COLLEGE
BHUBANESWAR

2020
2021
2022
2023

THREADS OF EXISTENCE

SEMINAR BULLETIN

DEPARTMENT OF ZOOLOGY

Words from Principal’s Desk

Prof. (Dr.) Gulam Moinuddin Khan

It is a pleasure to have so many bright and dedicated minds gathered here for this enriching experience. This seminar represents an important opportunity to expand our knowledge, foster meaningful discussions and collaborate with like-minded individuals. A special thanks to everyone who has contributed to organize this event. I hope this seminar has sparked everyone's curiosity and motivates everyone to further study the complexities of life.

Words from HOD’S Desk

Mrs. Jayanti Behera

As the Head of Department, I am honored for being able to host seminar events in our department. This event represents a unique opportunity to engage in insightful discussions, share knowledge, and explore new ideas within our field. Our department is committed to fostering an environment of academic excellence and continuous learning. These seminars are platforms for collaboration and innovation, helping us all to grow and push the boundaries of knowledge.

Priyanka Kar

Dr. Priyanka kar

Seminar in charge

I am pleased to carry out the seminar event every year. This event is a platform for learning, sharing ideas, and engaging in meaningful discussions on important topics. We have gathered experts, practitioners, and students to explore new perspectives and deepen our knowledge. Everyone’s involvement is key to making this seminar a success. I sincerely hope that the sessions will inspire, spark new insights, and contribute to both personal and professional growth. Thank you for being part of this enriching experience.

Message from faculties

I would like to express my sincere appreciation for the seminar. The presentations were insightful, well-researched, and engaging. The biological principles behind the topics were beautifully conveyed in an accessible way. The seminar topics provided a rich overview of how biological processes shape life at every level from the molecular to the ecological. I am proud of the hard work and the collaborative spirit demonstrated throughout the seminar. Keep up the excellent work, and I look forward to more such enriching events in the future.

Soumya Nayak.

Dr.Soumya Nayak

Tripathy

Mrs. Barsha Tripathy

The seminar on biological topics provided a deep dive into the intricate systems that govern the life on Earth. We explored topics such as cellular biology, neurobiology, and ecological interactions, emphasizing the complexity and inter connection of living organisms. I hope this seminar has inspired everyone to think critically about the natural world and the innovative ways we can biology to improve our future. Keep up the excellent work and I look forward to all of your future contributions.

The seminar on biological topics was an enlightening discussion that spanned a wide range of subjects, from the cellular mechanisms that underpin life to the complex interactions within ecosystems. We explored recent advances in bio-technology, genetics and environmental science, emphasizing the role of biology in shaping solutions to pressing global challenges like health crises and climate change. I hope this seminar has encouraged you to further explore these dynamic fields and consider how biological research can drive positive change in the world. Keep up the excellent work!

Sabindra Kumar Samal

Dr. Sabindra Kumar Samal

CONTENTS (2022-23)

TRANSCRIPTION IN PROKARYOTES

NAME – MURALI MANOHAR
ROLL NO – BS(B)20-315

Introduction

The prokaryotes are mostly single-celled organisms that lack membrane-bound nuclei and other organisms; the central region of this DNA is the nucleoid region. Both prokaryotes and eukaryotes are known to perform the same fundamental processes. Transcription in prokaryotes takes place with the DNA double helix, which in turn unwinds in the region of RNA synthesis, and this phenomenon can be termed as transcription bubble. Transcription in Prokaryotes is always from one main DNA strand to every single gene, and this single main strand can be termed as a template strand.

These cells are unique because they lack membrane-bound structures. The DNA bundles in the nuclei of the cell, and the transcription and translation process occur simultaneously in which synthesis occurs.

RNA Polymerase

RNA polymerase is a enzyme that helps in synthesis of ribonucleotides, just like DNA polymerase produces deoxyribonucleotides during DNA replication. The prokaryotes use this RNA polymerase in transcription, prokaryotic RNA polymerase is composed of five subunits.

These subunits assemble to perform the process of transcription, and the five subunits combinedly a called as holoenzymes.

The mechanism of transcription in prokaryotes typically occurs in three stages: initiation, elongation and termination.

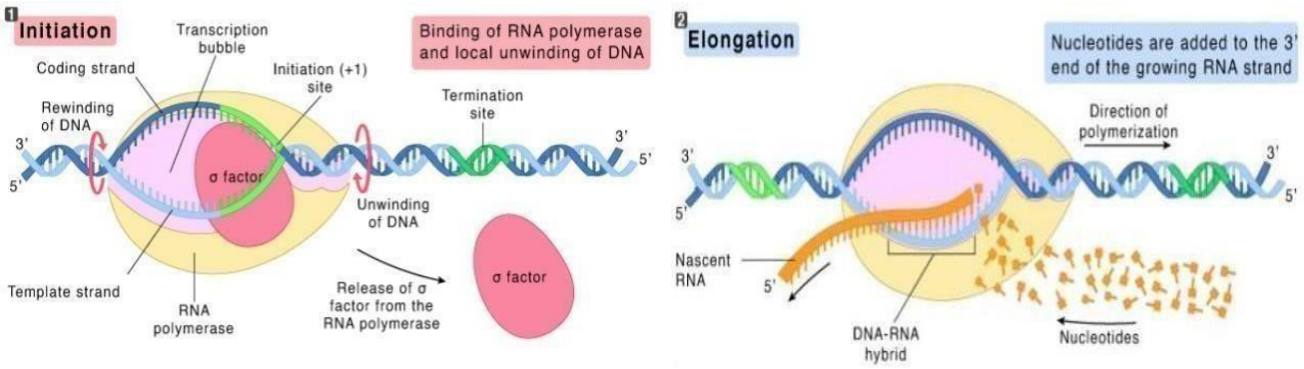
Through the help of both DNA and mRNA, a pre-mRNA molecule, which is then transformed into a mature mRNA molecule, is formed. During the process, the DNA acts as a base component, while RNA polymerase II, an enzyme, acts as a catalyst for mRNA formation.

Initiation

This is the beginning step in the processing and formation of mRNA. This process occurs when the enzyme RNA polymerase, which acts as a catalyst, binds to the region of a gene called a promoter. This action or procedure signals the DNA to unwind so the enzymes can ‘read’ the bases of the strands of the DNA. The enzyme, after this process, is ready to make mRNA with bases that are complementary.

Elongation

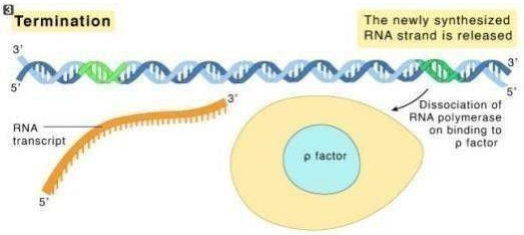
During this step of mRNA formation, the nucleotides are added to the mRNA strand, which is one of the most important steps in the formation because of the nucleotides. The enzyme that is RNA polymers acts like a signal taker, and thus this enzyme reads the DNA molecule, which is unwinding and thus starts building mRNA molecules with the help of complete base pairs.



It is during this stage that a very important step takes form. The newly formed RNA unwinds the DNA; thus, the adenine (A) of DNA pairs with the uracil (U) in the RNA, acts as a very prominent point.

Termination

In prokaryotes, transcription termination occurs when the RNA polymerase enzyme reaches a specific DNA sequence called a terminator. There are two types of terminators in prokaryotes: rho-independent and rho-dependent.



Rho-Independent Termination:
Rho-independent termination occurs when the RNA polymerase encounters a specific DNA sequence that forms a hairpin loop in the RNA transcript. This hairpin loop causes the RNA polymerase to pause and eventually release the transcript. The terminator sequence is typically a GC-rich region followed by a U-rich region.
Rho-Dependent Termination:
Rho-dependent termination occurs when the RNA polymerase encounters a specific DNA sequence that is recognized by the rho protein. The rho protein binds to the RNA transcript and helps to release the RNA polymerase from the DNA template.

Transcription Factors in Prokaryotes

Transcription factor proteins like the Oct4, Sox2, Klf4 and Nanog are used to bind specific DNA and control the transcription of mRNA and RNA; this controlling of mRNA and RNA is aided with blocking or promoting the RNA polymerase, which is the catalyst enzyme. Also, these transcription factors that are Oct4, Sox2, Klf4 and Nanog, are used in the formation of stem cells and other biological processes as well. These factors are thus considered important proteins in the formation of mRNA and DNA; though they aren't highlighted in the initial stages, they are binding components.

Conclusion

Transcription in prokaryotes is one important step related to both DNA, RNA, and mRNA formation. This transcription is aided with the help of various enzymes like the RNA polymerase II enzyme and, along with it, various transcription factors like the Oct4, Sox2, Klf4 and Nanog. The transcription process consists of three main steps: initiation, elongation, and termination. If some unwanted proteins are left off at the end of the transcription, then this might have some adverse effects.

MHC CLASSES

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Introduction :-

The major histocompatibility complex (MHC) is a substantial region on the DNA of vertebrates that encompasses a group of closely associated polymorphic genes. These genes encode proteins that are displayed on cell surfaces and play a crucial role in the adaptive immune system. The immune system's essential component, the Major Histocompatibility Complex (MHC), is fundamental in detecting and combating foreign invaders. These MHC molecules are tasked with displaying antigens, which are protein fragments from pathogens or abnormal cells, to T cells. This process is critical for the adaptive immune response, where T cells serve as key participants.

Classification :-

The organization of MHC (Major Histocompatibility Complex) molecules is determined by their structural features, functional roles, and interactions with specific T cell types. These molecules are divided into two primary categories: MHC Class I and MHC Class II. Both categories are crucial for antigen presentation, a fundamental process that triggers adaptive immune responses. There is also a third class present in MHC, called as MHC Class III. MHC Class III refers to a group of genes situated within the Major Histocompatibility Complex (MHC) region of the genome that are involved in immune system regulation but are not directly implicated in antigen presentation like MHC Class I and Class II molecules.

MHC Class I: -

Major Histocompatibility Complex (MHC) Class I molecules are key components of the immune system, responsible for presenting endogenous antigens to the immune system, especially CD8+ cytotoxic T cells discharged specifically, MHC class I molecules act as the body's internal surveillance system, constant inspection of cells for signs of pathology or mutation. MHC Class I molecules are complex cell surface glycoproteins composed of two main structural components are:

- Alpha (α) Chain
- Beta-2 microglobulin

Function -

- MHC Class I molecules are involved in presenting peptides derived from proteins that originate inside the cell.
- MHC Class I molecules bind these short peptides (8-10 amino acids in length) within a groove formed between the α1 and α2 domains of the MHC Class I molecule.
- The MHC Class I-peptide complex is recognized by CD8+ cytotoxic T cells.

- In addition to responding to viral infections, MHC Class I molecules are also essential in recognizing and presenting tumor-associated antigens.
- Polymorphism in MHC Class I genes ensures broad recognition of diverse pathogens.

MHC Class II: -

MHC Class II molecules primarily involved in antigen presentation to CD4+ helper T cells. While MHC Class I molecules are responsible for presenting endogenous antigens (from within the cell) to CD8+ cytotoxic T cells, MHC Class II molecules specialize in presenting exogenous antigens (from outside the cell) to CD4+ T helper cells. This distinction is crucial for coordinating the adaptive immune response, activating a range of immune effector cells, and enabling the body to fight infections more effectively. MHC Class II molecules are composed of two polypeptide chains as,

- Alpha (α) Chain
- Beta (β) Chain

Function -

- MHC Class II molecules present peptides derived from external sources, such as pathogens or foreign particles, that are ingested by antigen-presenting cells (APCs) (like dendritic cells, macrophages, and B cells).
- MHC Class II molecules play a critical role in the activation of B cells, which are responsible for humoral immunity (antibody production).
- MHC Class II molecules also participate in the development of self-tolerance.
- MHC Class II molecules also play a role in macrophage activation.

MHC Class III: -

MHC Class III molecules are a diverse group of proteins that play key roles in the immune response, but unlike MHC Class I and II, they do not directly participate in antigen presentation to T cells. Instead, MHC Class III is involved in various immune functions, primarily as part of the complement system and in the production of inflammatory cytokines.

Function -

- MHC Class III molecules are involved in the regulation of immune responses, primarily by encoding proteins that are part of the innate immune system.
- Encode inflammatory mediators, such as Tumor Necrosis Factor-alpha (TNF-α), Lymphotoxin-alpha (LTA), and Heat Shock Proteins (HSPs).
- MHC Class III molecules influence the activation of T cells indirectly by interacting with cytokines and complement pathways, which can promote antigen presentation.
- Some of the complement proteins encoded by the MHC Class III region are involved in the classical complement pathway.

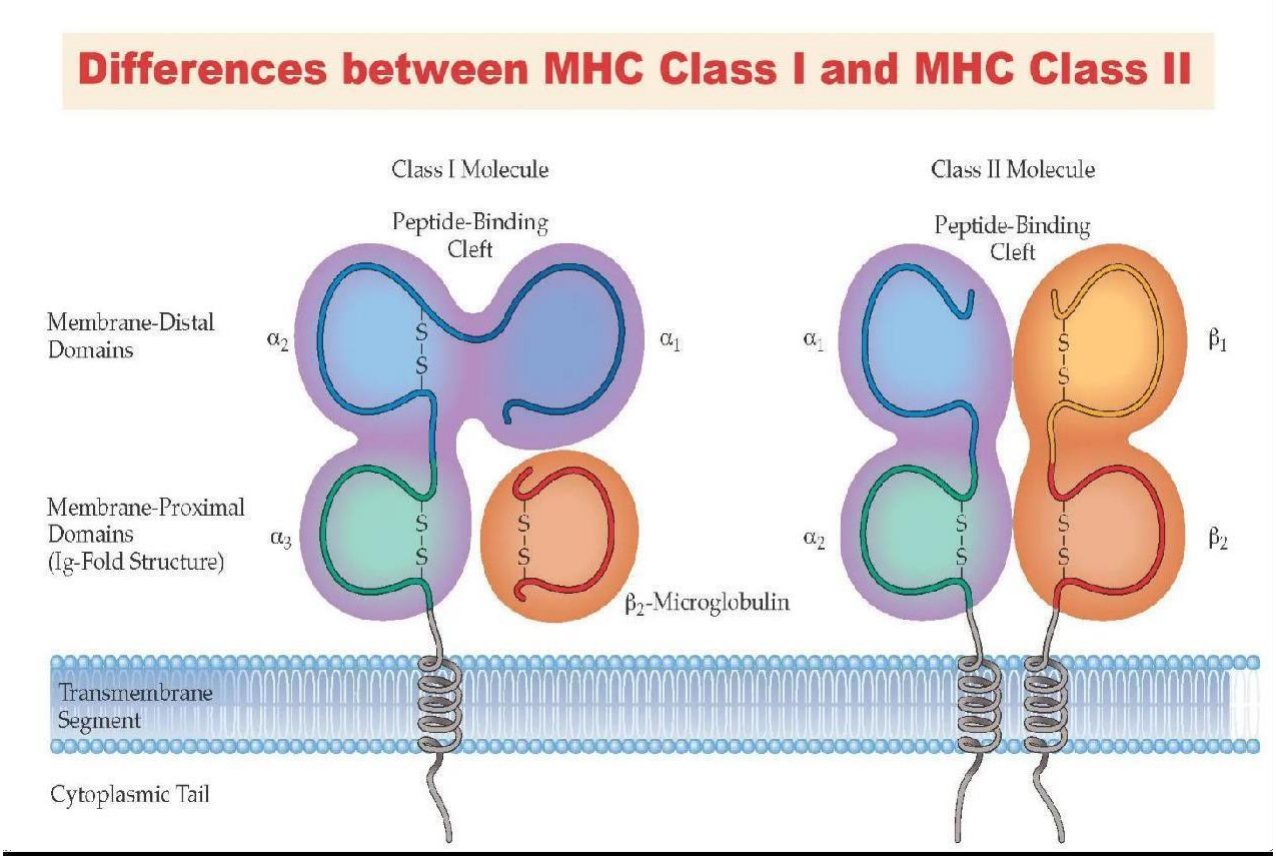

Fig. MHC class I & II

Conclusion: -

The MHC system is fundamental to immune system function, bridging innate and adaptive immunity while providing an evolutionary advantage by enabling diverse responses to pathogens. Its complex structure, function, and genetic diversity make MHC molecules key players in both health and disease, influencing everything from immune defense to transplantation, and even contributing to the pathogenesis of autoimmune diseases. Understanding MHC's diverse roles is critical for advancing immunology, improving therapeutic strategies, and optimizing approaches to vaccination and disease prevention.

SOCIAL BEHAVIOR OF BEES

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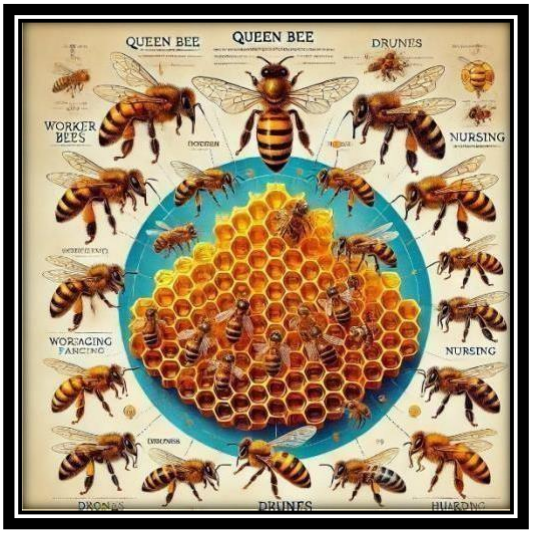
Introduction:

Bees are essential pollinators and a model species for studying social behavior. Their highly organized social structure has evolved over millions of years, allowing them to thrive in diverse environments. This abstract delves into the core elements of their social behavior, including their caste system, communication methods, division of labor, and collective decision-making. Visual aids will accompany each section for clarity and engagement.

The Caste System: Hierarchy and Roles

Bee societies are built around a well-defined caste system, comprising the queen, workers, and drones. The queen, the colony's reproductive center, produces eggs and emits pheromones that influence the colony's harmony and behavior. Worker bees, sterile females, handle all vital tasks: tending to brood, building and maintaining the hive, gathering nectar and pollen, and defending against predators. Drones, the male members, are solely responsible for mating with queens from other colonies. Once their role is fulfilled, they are often expelled from the hive.



Communication: The Language of Bees

Bees have evolved sophisticated communication methods to maintain colony efficiency. The most famous is the "waggle dance," a unique form of movement through which foragers share detailed information about the location of food sources. The dance encodes the direction relative to the sun and the distance to the resource, allowing other bees to navigate precisely. Besides the waggle dance, pheromones play a significant role in communication, influencing tasks such as foraging, reproduction, and alarm signaling.

Division of Labor: Age Polyethism

Worker bees exhibit age-based task specialization, a phenomenon known as age polyethism. Young

workers, called nurse bees, focus on brood care, cleaning, and temperature regulation within the hive. As they age, they transit to tasks such as comb building, guarding the hive, and foraging for nectar and pollen. This dynamic allocation of labor ensures that the hive operates smoothly and efficiently.

Collective Intelligence and Decision-Making

Bee colonies function as a superorganism, where individual actions contribute to the colony's collective goals. This is evident during critical moments, such as choosing a new nest site. Scout bees search for potential sites and communicate their findings through dances. The colony collectively evaluates these options, favoring the site that garners the most support. This process exemplifies democratic decision-making in nature.

Fig. forager honey bee

Altruism and Defense

Self-sacrifice is a defining feature of bee behavior. Worker bees will sting predators to defend the hive, despite the fatal consequence for themselves. This altruistic behavior ensures the survival of the colony as a whole. Bees also collaborate in creating defensive strategies, such as surrounding and overheating invaders like hornets in a "bee ball."

Fig. Altruistic behaviour

Ecological and Evolutionary Importance-

The social behavior of bees extends beyond their colonies, profoundly impacting ecosystems. As pollinators, they support biodiversity and agriculture, ensuring food security for countless species, including humans. Their cooperative strategies and adaptability offer valuable insights into the evolution of sociality and inspire innovations in robotics, artificial intelligence, and organizational systems.

Fig. Bee collecting nectar

SEX DETERMINATION AND DIFFERENTIATION IN HUMAN

NAME – SHRADHANJAL SAHOO

ROLL NO – BS(B)20-330

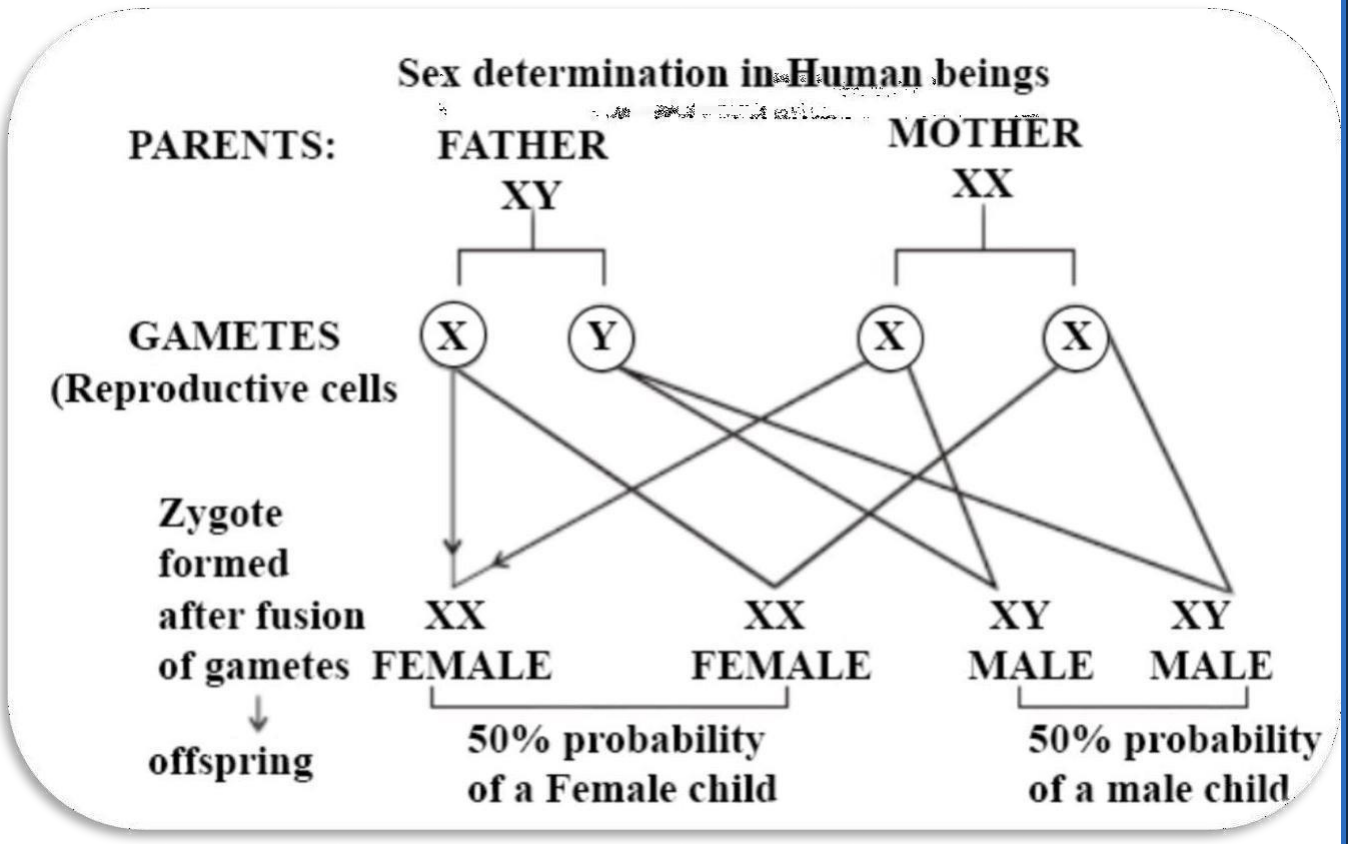
Sex determination and differentiation are fundamental biological processes that dictate the development of an individual's sexual characteristics. These processes are pivotal not only in the formation of reproductive organs but also in influencing the broader scope of organismal development, including physiological, hormonal, and behavioural traits.

Sex Determination:

Sex determination refers to the mechanisms that establish an individual's biological sex—male or female— at the genetic level, typically occurring at the moment of fertilization. In most species, sex determination is regulated by the presence or absence of specific sex chromosomes. For example, in mammals, including humans, sex is determined by the combination of sex chromosomes inherited from the parents. Individuals with two X chromosomes (XX) are female, while individuals with one X and one Y chromosome (XY) are male. The presence of the Y chromosome is crucial for male development, as it carries the SRY (Sex- determining Region Y) gene, which triggers the development of male-specific characteristics. In the absence of the Y chromosome, the default developmental pathway leads to female characteristics.

However, there are several variations to this chromosomal system of sex determination. In some species, such as birds, the ZW system is employed, where females are heterogametic (ZW) and males are homogametic (ZZ). Similarly, in certain reptiles and fish, environmental factors, such as temperature, can determine sex in a process known as temperature-dependent sex determination (TSD). This system is particularly prominent in species like turtles and crocodiles, where incubation temperatures during embryonic development influence whether the offspring will develop as males or females.

Once the genetic sex is established, the process of sex differentiation begins, which refers to the development of primary and secondary sexual characteristics. The initial differentiation of the gonads is pivotal in determining the future sexual phenotype. During early embryonic development, the gonads are undifferentiated and possess the potential to develop into either testes or ovaries. In the presence of a Y chromosome and the SRY gene, the gonads develop into testes, which secrete testosterone and other androgens, leading to the formation of male reproductive organs. Conversely, in the absence of the Y chromosome and the SRY gene, the gonads develop into ovaries, which produce estrogen, promoting the development of female reproductive structures.



Sex Differentiation:

Sex differentiation refers to the process by which organisms develop male or female characteristics, both at the level of their reproductive anatomy and secondary sexual traits. It is a complex biological phenomenon governed by genetic, hormonal, and environmental factors, ensuring that an organism's sex is correctly determined and expressed. The process of sex differentiation occurs in a variety of ways across different species, but in most mammals, including humans, it is a highly regulated event that begins at conception and continues through fetal development, puberty, and adulthood.

In mammals, sex differentiation begins with the determination of genetic sex, which is typically established at fertilization. In most mammals, the presence of two X chromosomes (XX) results in a female, while the presence of one X and one Y chromosome (XY) results in a male. This chromosomal sex is followed by the expression of genes on the sex chromosomes, most notably the SRY gene on the Y chromosome. The SRY gene encodes a transcription factor called the Sex-determining Region Y (SRY) protein, which plays a pivotal role in initiating the development of male sexual characteristics. The SRY protein induces the formation of the testes, which produce testosterone and anti-Müllerian hormone (AMH), leading to the masculinization of the embryo. In the absence of SRY, the default developmental pathway occurs, leading to the formation of ovaries and the subsequent development of female sexual characteristics.

Once gonadal sex is determined, the development of external genitalia and internal reproductive organs follows. In males, testosterone is converted into dihydrotestosterone (DHT) by the enzyme 5α-

reductase, which drives the formation of male external genitalia, such as the penis and scrotum. In females, the absence of high levels of testosterone results in the development of female genitalia, including the vulva and vagina. Additionally, the Müllerian ducts, which are present in both male and female embryos, give rise to female

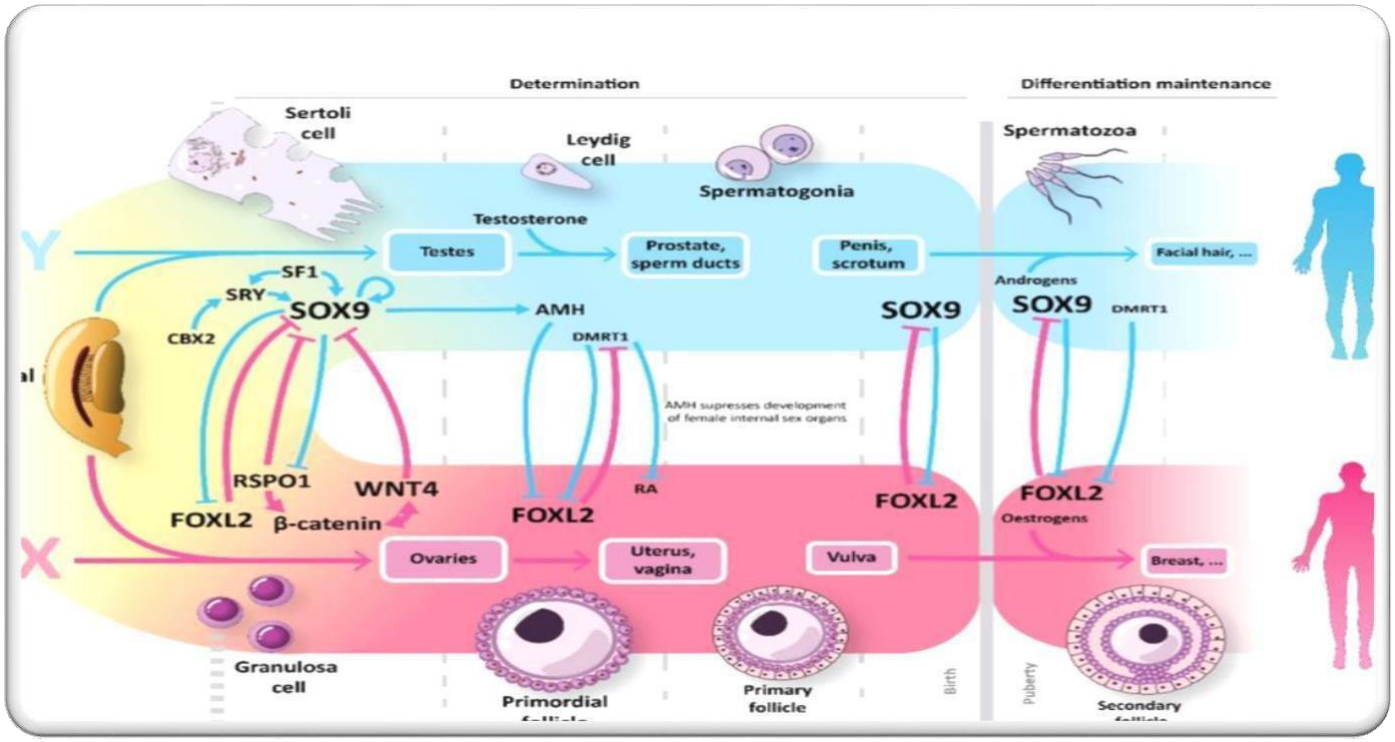


Fig. Molecular pathway involved in sex determination

reproductive structures such as the fallopian tubes, uterus, and upper two-thirds of the vagina in females, while they regress in males due to the action of AMH.

Sex differentiation also extends beyond reproductive anatomy to the development of secondary sexual characteristics, which emerge during puberty. In males, rising levels of testosterone lead to the development of facial hair, deeper voice, and increased muscle mass, while in females, the increased secretion of estrogen promotes breast development, widening of the hips, and the onset of menstruation.

Conclusion

Sex determination and differentiation represent a highly complex interplay of genetic, hormonal, and environmental factors that collectively shape human sexual identity and function. Although most individuals follow a typical pathway of sexual differentiation, those who experience variations or disorders in this process offer valuable insights into the biology of sex and challenge traditional notions of gender and sex identity. As our scientific understanding deepens, we can better address the needs of individuals with DSDs, promoting health, well-being, and inclusivity for all.

DNA REPLICATION IN PROKARYOTES

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Introduction

DNA replication in prokaryotes is a fundamental biological process that ensures the accurate duplication of the organism's genetic material prior to cell division. This process occurs in the cytoplasm, as prokaryotes lack a defined nucleus. It begins at a specific location on the circular DNA molecule known as the origin of replication. The replication process is bidirectional, with two replication forks moving in opposite directions around the DNA loop. Key enzymes involved in prokaryotic DNA replication include DNA helicase, which unwinds the double helix, DNA polymerase, which synthesizes new DNA strands by adding nucleotides complementary to the template strand, and DNA ligase, which seals any gaps between newly synthesized DNA fragments. The simplicity and efficiency of DNA replication in prokaryotes allow for rapid cell division, which is crucial for their survival and adaptability in various environments.

Semi-conservative mode of replication.

The semi-conservative mode of replication is a fundamental mechanism by which DNA is duplicated in cells. During this process, each of the two strands of the original DNA molecule serves as a template for the formation of a new complementary strand. As a result, the two resulting DNA molecules each consist of one original strand and one newly synthesized strand. This method was first demonstrated by the classic Meselson-Stahl experiment in 1958, which provided strong evidence for this model of replication. The semiconservative nature of DNA replication ensures that genetic information is accurately passed on from one generation to the next, maintaining the integrity of the genetic code. This process is crucial for celldivision, growth, and reproduction in living organisms.

Enzyme for DNA replication

DNA replication is a complex process that involves several key enzymes working together to ensure accurate duplication of the genetic material. One of the most crucial enzymes in this process is DNA polymerase. DNA polymerase synthesizes new DNA strands by adding nucleotides complementary to the template strand, ensuring that genetic information is passed accurately from one cell generation to the next. Another vital enzyme is helicase, which unwinds the double-stranded DNA helix into two single strands, allowing each to be copied. Primase, another important enzyme, synthesizes short RNA primers needed to initiate DNA synthesis by DNA polymerase. Additionally, ligase seals any nicks in the DNA backbone, ensuring the continuity and integrity of the newly synthesized DNA strands. Together, these enzymes coordinate to achieve the vital task of DNA replication with high fecundity.

Process of DNA Replication Initiation

The initiation of DNA replication is a critical process that marks the beginning of cell division. It starts

at specific locations on the DNA molecule known as origins of replication. In prokaryotes, such as bacteria, there is typically a single origin, while eukaryotes, like humans, have multiple origins of replication along with their chromosomes. The process begins with the unwinding of the double helix by an enzyme called helicase, creating a replication fork. This unwinding allows for the recruitment of additional proteins such as primase, which synthesizes a short RNA primer. This primer provides a 3' starting point for DNA polymerase to begin adding 5' complementary nucleotides, effectively copying the DNA strands. The regulation of this process ensures that DNA leading strand is replicated accurately and only once per cell cycle, maintaining genomic stability.

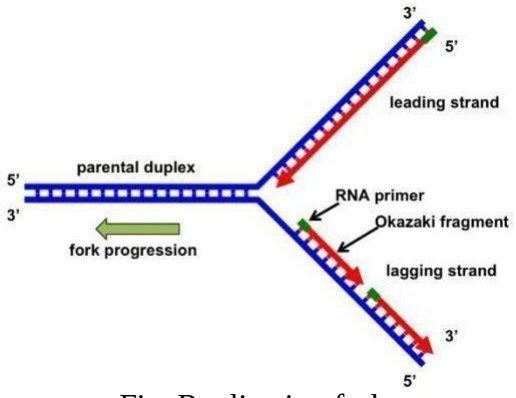

Fig. Replication fork

Elongation

The elongation process in DNA replication is a critical phase during which the DNA polymerase enzyme synthesizes a new strand of DNA complementary to the template strand. This process occurs after the DNA has been unwound and primed. During elongation, DNA polymerase adds nucleotides to the 3’ end of the growing DNA strand in a sequence-specific manner—adenine pairs with thymine, and cytosine pairs with guanine. The leading strand is synthesized continuously, while the lagging strand is synthesized in short, discontinuous segments known as Okazaki fragments. These fragments are later joined together by the enzyme DNA ligase to create a continuous strand. The precision and speed of the elongation process are crucial for ensuring that the genetic material is accurately replicated, thus maintaining the integrity of the organism's genome.

Termination

Termination in DNA replication is a crucial step in the process by which a cell copies its DNA. This stage ensures that replication concludes accurately and completely, preventing genetic instability. In prokaryotes, termination occurs when replication forks, moving from opposite directions, meet at specific termination sites on the circular DNA molecule. These sites contain terminator sequences that signal the end of replication. Proteins such as Tus in E. coli bind to these terminator sequences, halting the replication machinery. In eukaryotes, the process is more complex due to linear chromosomes and multiple replication origins. Termination involves the meeting and merging of replication forks, followed by the resolution of any remaining DNA structures, such as interlinked daughter molecules or telomeres. Accurate termination is essential to maintain genomic integrity and ensure proper cell

division.

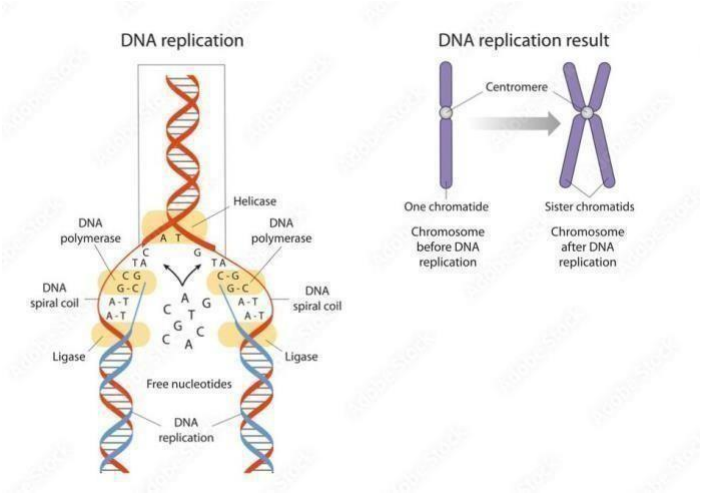

Fig. Replication at replication fork

Conclusion

The conclusion of DNA replication, also known as the termination phase, is a crucial step in the process of duplicating a cell's genetic material. Once the entire length of DNA has been successfully copied, replication comes to a close with the disassembly of the replication machinery. In eukaryotic cells, this involves the replication forks meeting and merging at termination sites, allowing for the deactivation of DNA polymerases and other associated proteins. Any remaining RNA primers are removed and replaced with DNA nucleotides, ensuring the integrity of the newly synthesized strands. Additionally, enzymes like DNA ligase play a vital role in sealing any nicks or gaps in the sugar-phosphate backbone, resulting in two identical double-stranded DNA molecules. This meticulous conclusion not only ensures genetic fidelity but also prepares the DNA for subsequent cellular processes, such as cell division.

CYTOKINES

NAME – SHALINI GOUTAMI
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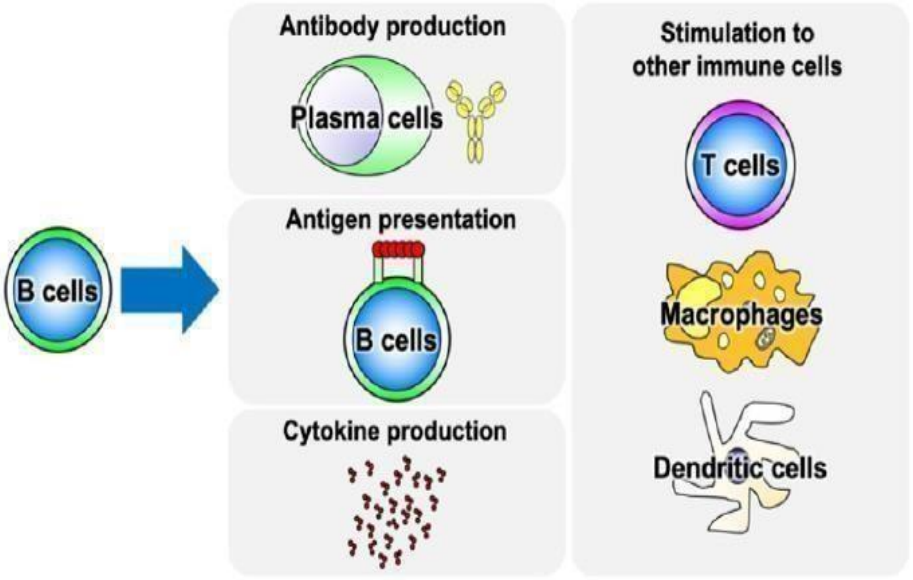
Cytokines are signaling proteins that help control inflammation in our body. They allow our immune system to mount a defense if germs or other substances that can make us sick enter our body. Too many cytokines can lead to excess inflammation and conditions like autoimmune diseases.

What are cytokines?

Cytokines are proteins that function as chemical messengers in our immune system. Our immune system is a network with several parts that work together to protect our body from threats, like germs that can make us sick. It contains immune cells that fight invading pathogens (like viruses and bacteria), allergens and other harmful substances that enter our body. Cytokines signal those immune cells to fight the invaders. Even when there's no threat, cytokines send signals to other cells that keep our immune system functioning.

Function

Cytokines are most known for regulating inflammation in our body. Many people think of inflammation as a pesky symptom that means we are sick or we have allergies. But inflammation is a sign that our body's immune cells are fighting invaders or healing tissue damage. Our body's cells release cytokines when there's a threat. The cytokines tell our immune cells how to fight threats and repair injuries. We can think of cytokines as chemical messengers that tell cells how to behave.



Cytokines signal:
Cell activation: Cytokines tell cells where to go and what to do. For example, cytokines can direct immune cells toward an infectionsite so the cells can fight germs there. They can heighten or lessenthe processes associated with inflammation.

Cell differentiation: Cytokines can tell immature cells to develop into a specific type of cell. For example, cytokines can tell an immature cell to mature into a white blood cell capable of fighting infection.

Cell proliferation: Cytokines can tell a cell to make more cells just like it. For example, cytokines cantell a white blood cell to make more white blood cells to fight infection. Cytokines can also signal

our body's cells to release more cytokines to increase our body's inflammatory response.

Pro-inflammatory cytokines trigger or heighten inflammation. They relay messages that coordinate our body's immune response to fend off attackers, like germs.

Anti-inflammatory cytokines stop or lessen inflammation. They relay messages that prevent an excessive immune response that can lead to tissue damage.

What diseases or conditions involve cytokines?

Cytokines are so essential to our immune system that they play a role in most conditions and diseases that may affect us. Typically, cytokines help keep us infection-free. If our immune system releases too many cytokines in response to an infection or treatments like immunotherapy we may develop cytokine release syndrome (CRS), also called a cytokine storm. We may develop various symptoms that affect multiple body systems. CRS can be life-threatening without treatment. Too many cytokines can create a heightened inflammatory response. Too much inflammation can damage tissue and lead to diseases and conditions, including:

Autoimmune diseases: With autoimmune diseases, our body's immune cells mistakenly attack healthy cells.

Metabolic disorders: Metabolic disorders involve problems with metabolism, the process that allows our body to transform food into energy and remove waste from our body.

Sepsis: With sepsis, our body's inflammatory response is so extreme that we experience reduced blood flow to our major organs. Sepsis can be fatal without emergency medical treatment.

Conclusion

Cytokines are essential to having a healthy immune system. As with many things, moderation is key. Having the right amount of cytokines, signaling correctly, can keep us infection-free. High levels of cytokines may lead to excessive inflammation that can be harmful without treatment.

AMINO ACID

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1. **Definition:** Amino acids are organic compounds containing both amino (-NH2) and carboxyl (-COOH) groups.
2. **Functions:** Building blocks of proteins, energy production, nerve function, and muscle growthand repair.
3. **Types:** 20 standard amino acids, classified into essential (cannot be produced by the body) andnon-essential (can be produced by the body) categories.
4. **Classification** –

Based on structure and chemical nature -.

- Aliphatic side chain -glycine,Alanine, proline, leucine, isoleucine
- OH, groups containing amino acid -serine, threonine
- ” S” containing amino acid- cysteine, methionine
- Acidic Amino -Aspartic acid, Asparagine, glutamic acid, glutamine
- Basic Amino acid- lysine, arginine, histidine
- Aromatic amino acid- phenylalanine, tyrosine, tryptophan

Based on polarity:-

Hydrophobic (non-polar) -Alanine, valine, leucine, isoleucine, proline, methionine, phenylalanine, tryptophan.

Hydrophilic(polar) Amino acid- Aspartic acid, glutamic acid, lysine, arginine, histidine, serine, threonine, tyrosine.

Nutritional requirements: -

Essential Amino acids- These amino acids must be supplied in their diet. Eg- valine, isoleucine, phenylalanine, methionine, leucine, lysine, tryptophan and threonine.
Non-essential amino acid- These amino acids may not be supplied in the diet. Eg- alanine,arginine, tyrosine, asparagine, glutamine, proline.

Proteins

Definition: Proteins are complex biomolecules composed of one or more chains of amino acids.

Functions: Building and repairing tissues, producing enzymes and hormones, maintaining fluid balance, and supporting immune function. Proteins are the primary components of tissue such as muscle, bone, skin and hair. It catalyses chemical reaction and regulate various bodily processes. It plays a crucial role in the immune system helping to fight off infections and diseases.

Structure: Primary (amino acid sequence), secondary (alpha helices and beta sheets), tertiary (3D shape), and quaternary (multiple polypeptide chains) structures.

Relationship Between Amino Acids and Proteins

Amino acids as building blocks: Proteins are synthesized from amino acids through peptide bonds.
Sequence determines function: The specific sequence of amino acids in a protein determines its 3D structure and function.
Protein synthesis and degradation: Proteins are constantly being synthesized and degraded in the body, with amino acids being reused or recycled.

Conclusion: -

Amino acids and proteins are intricately linked, with amino acids serving as the building blocks of proteins. The unique sequence and structure of amino acids determine the function and properties of proteins. Amino acids are essential for human health, serving as the foundation for protein synthesis. Proteins play a vital role in various bodily functions, including tissue growth and repair, enzyme production, and immune function. The specific sequence and structure of amino acids determine the function and properties of proteins. Amino acids and proteins are constantly being synthesized and degraded in the body, highlighting theirdynamic and essential role in human health.

In summary, amino acids and proteins are fundamental components of life, and their unique relationship is essential for maintaining optimal health and function.

THE CARDIOVASCULAR SYSTEM

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The cardiovascular system, also known as the circulatory system, is a complex network responsible for the transport of blood, nutrients, oxygen, carbon dioxide, hormones, and waste products throughout the body. It is vital for maintaining homeostasis and supporting cellular function. Here's an overview

Key Components

1. Heart
    a. A muscular organ that pumps blood throughout the body.
    b. Divided into four chambers:
    c. Right Atrium and Right ventricle : Pump deoxygenated blood to the lungs.
    d. Left Atrium and Left Ventricle: Pump oxygenated blood to the body.
    e. Valves ensure one-way blood flow: Tricuspid, pulmonary, mitral, and aortic valves.
2. Blood Vessels
    a. Arteries: Carry oxygen-rich blood away from the heart (except pulmonary arteries).
    b. Veins: Carry oxygen-poor blood toward the heart (except pulmonary veins).
    c. Capillaries: Microscopic vessels where exchange of gases, nutrients, and waste occurs.
3. Blood

    Composed of:

    i. Red Blood Cells (RBCs): Transport oxygen using haemoglobin.
    ii. White Blood Cells (WBCs): Defend against infection
    iii. Platelets: Aid in clotting.
    iv. Plasma: Carries nutrients, hormones, and waste.
    v. Circulatory Pathways
4. Systemic Circulation

    Delivers oxygen-rich blood from the left ventricle to the body and returns deoxygenated blood to the right atrium.
5. Pulmonary Circulation

    Transports deoxygenated blood from the right ventricle to the lungs for oxygenation and returns oxygenated blood to the left atrium.

Diseases and Disorders

- Atherosclerosis: Narrowing of arteries due to plaque buildup.

  Hypertension: High blood pressure, increasing heart strain.
- Myocardial Infarction (Heart Attack): Blocked blood flow to heart

  muscle.Arrhythmias: Irregular heartbeats.
- Heart Failure: Ineffective pumping of the heart.
- The cardiovascular system, comprising the heart, blood vessels, and blood, is one of the most extensively researched areas in medicine and physiology due to its critical role in maintaininghomeostasis. Below are some major areas of research in the field:

Cardiovascular Diseases

1. Atherosclerosis and Heart Disease: Focus on the buildup of plaque in arteries, its prevention, and treatment, including statins, PCSK9 inhibitors, and novel anti-inflammatory agents (e.g., canakinumab).

2. Hypertension: Research explores mechanisms of blood pressure regulation, new antihypertensive drugs, and non-pharmacological interventions.

3. Heart Failure: Advances in understanding heart failure with reduced ejection fraction (HFrEF) and preserved ejection fraction (HFpEF), and therapies like SGLT2 inhibitors.

4. Arrhythmias: Studies of abnormal heart rhythms, electrophysiology, and development of treatments such as catheter ablation and wearable defibrillators.

Regenerative Medicine

1. Stem Cell Therapy: Investigating the use of induced pluripotent stem cells (iPSCs) and cardiac progenitor cells to repair damaged heart tissue.

2. Tissue Engineering: Development of bioengineered heart tissues or entire organs using 3D bioprinting and biomaterials.

3. Gene Editing: CRISPR-Cas9 technologies to correct genetic mutations causing congenital heart defects or familial cardiomyopathies.

Cardiovascular Imaging and Diagnostics

1. Advanced Imaging Techniques: Innovations in MRI, CT angiography, and PET scans for better visualization of cardiac structures and function.

2. Wearable Technology: Development of devices for real-time monitoring of heart rate, rhythm, and blood pressure.

3. Biomarkers: Identifying new biomarkers for early detection and monitoring of cardiovascular diseases (e.g., troponin, NT-proBNP).

Emerging Therapies-

-Artificial Hearts and Assist Devices: Advances in left ventricular assist devices (LVADs) and total artificial hearts.

-Nanotechnology: Using nanoparticles for targeted drug delivery and imaging in cardiovascular treatments.
RNA-based Therapies: mRNA therapies and RNA silencing for conditions like hyperlipidemia and arrhythmias.

Cardiovascular Risk Factors

- Obesity and Diabetes: Exploring the interconnections between metabolic disorders and cardiovascular health.
- Lifestyle Factors: Impact of smoking, sedentary behavior, and stress on cardiovascular health.
- Nutrition and Microbiome: Effects of diet and gut microbiota on cardiovascular risk and disease progression.
- Pediatric and Congenital Cardiology: Understanding and treating congenital heart defects, long-term outcomes in pediatric cardiac surgeries, and transitional care into adulthood.

Conclusions on the Cardiovascular System

Central Role in Health and Disease:

The cardiovascular system is integral to delivering oxygen and nutrients to tissues, removing waste products, and maintaining homeostasis. Dysfunctions in this system can lead to life-threatening conditions, making it a focal point of medical research.

Chronic Diseases Are Major Contributors:

Cardiovascular diseases (CVDs) such as coronary artery disease, heart failure, and stroke remain leading causes of mortality worldwide. They are often driven by preventable risk factors like smoking, poor diet, physical inactivity, and hypertension.

Impact of Lifestyle and Prevention:

A significant portion of cardiovascular conditions can be mitigated through lifestyle interventions, including regular exercise, healthy eating, and stress management. Preventive medicine is crucial for reducing the global burden of cardiovascular diseases.

Advances in Treatments:

Innovations in pharmaceuticals, such as statins, anticoagulants, and SGLT2 inhibitors, have revolutionized the management of CVDs. Similarly, technological advancements, such as minimally invasive surgeries, wearable monitoring devices, and artificial hearts, have improved patient outcomes.

Importance of Early Detection and Diagnostics:

Early detection of cardiovascular risk factors and diseases is critical. Modern imaging techniques,

biomarkers, and wearable devices enable earlier and more accurate diagnoses, improving the effectiveness of interventions.

Interconnectedness with Other Systems:

The cardiovascular system does not function in isolation. Its interactions with other body systems, such as the endocrine, renal, and nervous systems, are critical to understanding and treating cardiovascular conditions.

Future Directions:

Research continues to explore the molecular mechanisms underlying cardiovascular diseases, aiming to uncover novel targets for treatment. Emphasis is also placed on preventive cardiology, improving public health initiatives, and utilizing artificial intelligence for precision medicine.

ORIGIN AND EVOLUTION OF MAN

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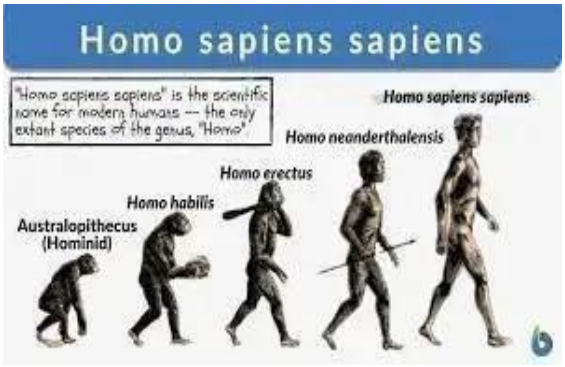
Introduction to Human Evolution:



Human evolution is the lengthy process of change which denotes that human have originated from apelike ancestors. Scientific evidence shows that the physical and behavioural traits shared by all people originated from apelike ancestors and evolved over a period of approximately six million years. One of the earliest defining human traits, bipedalism – the ability to walk on two legs evolved over 4 million years ago. Other important human characteristics – such as a large and complex brain, the ability to make and use tools, and the capacity for language – developed more recently. Many advanced traits including complex symbolic expression, art, and elaborate cultural diversity – emerged mainly during the past 100,000 years.

EARLIEST ANCESTOR

Ardipithecus were one of the earliest ancestors to have been discovered, with fossils dating back more than 4.4 million years old. The details of human evolution are still debated as fossil evidence of many ancestors, is quite vague. In fact, instead of the human evolution tree, a more accurate analogy could have been drawn to an evolutionary bush. Charles Darwin never implied the fact that humans evolved from apes, although many of his fellow contemporaries insisted that he had.

PROCESS OF HUMAN EVOLUTION

The evolution process involves a series of changes that cause the species to either adapt to the environment or become extinct. Evolution is the result of changes in the genetic material of humans. It does not change a single organism, but the entire group of organisms belonging to the same species.

Man originated through several stages:

DRYOPITHECUS

It is the earliest known ancestor of man. They were found in some parts of Africa, Asia and Europe. The evolution of man began with him. Dryopithecus was followed by Australopithecus.

AUSTRALOPITHECUS

These were 1.2 meters tall and could walk upright. They inhabited the African mainland. They had large jaws and human-like teeth.

HOMO HABILIS

They were five feet tall and could make use of tools. They are believed to have been able to speak.

HOMO ERECTUS

They were more evolved beings. They were also upright and had a larger brain size. They had a prominent speech. They invented fire and were carnivorous.

HOMO SAPIENS

These are modern men. They developed the power of thinking, used tools, were omnivorous and produced art. Their brain size was reduced to 1300 cc.

NEANDERTHALS

Homo sapiens is the only extant species of hominin around today, but a few thousand years ago, there were a few other species that existed alongside anatomically modern humans – the Neanderthals,

Denisovans and the Homo floresiensis. Today, scientists consider Neanderthals to be more of a subspecies of humans rather than a completely separate species.

CONCLUSION

Today, human evolution continues to be influenced by both biological factors and cultural practices, with ongoing discoveries further refining our understanding of how we became the species we are. However, key factors that have driven human evolution—natural selection, genetic drift, and migration—have all played vital roles in shaping who we are today, highlighting the dynamic and adaptive nature of human evolution.

ECOSYSTEM

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An **ecosystem** is a dynamic system where both living organisms (**biotic components)** and their physical surroundings (**abiotic components**) take part as a whole and functional unit. It can vary in size from small water pools to large forests, oceans, or our earth. These interactions between living and non-living elements of the ecosystem allow energy and nutrients to move through the system, which are essential for survival of life on earth.

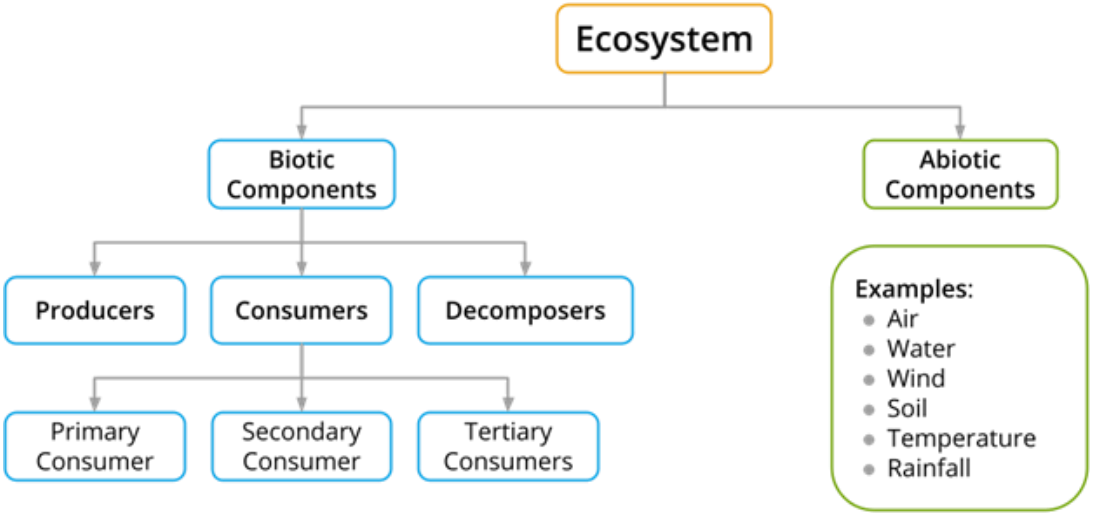
Components of an Ecosystem :

Biotic Components (Living organisms); These include all the living organisms within an ecosystem, such as plants, animals, fungi and microorganisms. They can be classified based on their roles:

1. **Producers** (autotrophs), such as plants and algae, that produce their own food through photosynthesis or chemo-synthesis.
2. **Consumers** (heterotrophs) who depend on other organisms for food. These include herbivores (primary consumers), carnivores (secondary or tertiary consumers), and omnivores.
3. **Decomposers** (detritivores and saprotrophs), such as bacteria and fungi, helps in breakdown of dead organic matter and recycling nutrients back into the ecosystem.

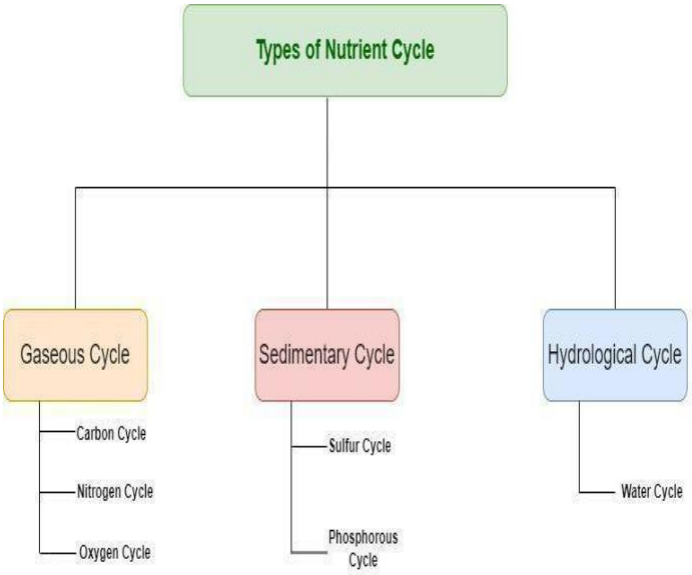
Abiotic Components (non-living elements); Physical factors influencing the functioning of ecosystems and include the following:

- **Climate:** Temperature, precipitation, humidity, and sunlight affect the types of organisms that can live in an area.
- **Soil:** The composition and quality of soil influence plant growth, which in turn impacts the entire food web.
- **Water:** Availability and quality of water are essential for all life forms.
- **Air:** The composition of gases, especially oxygen and carbon dioxide, is crucial for respiration in animals and photosynthesis in plants.



Energy Flow and Nutrient Cycling :

- **Energy flow** describes the passage of energy through the components of an ecosystem. It is introduced into an ecosystem by sunlight and then moves from one trophic level to another as Producers absorb the energy and use it to make glucose which can be stored as starch. Herbivores eat the plants and Carnivores eat the staircase is an illustration of the loss of energy (**Lindemann's 10% Law**).
- **Nutrient cycling** involves the movement of essential elements like carbon, nitrogen, phosphorous and water through the ecosystem. For example, carbon is absorbed by plants during photosynthesis, passed through the food web, and eventually returned to the atmosphere through respiration or decomposition.



Types of Ecosystems :

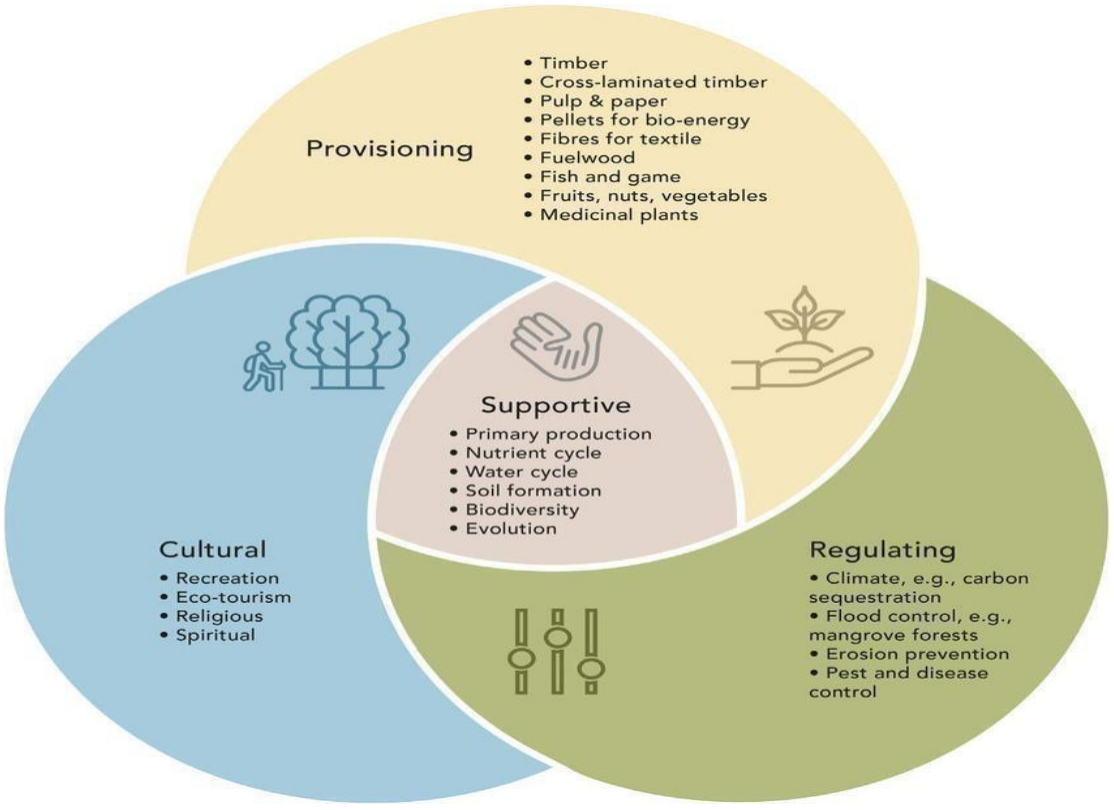
Ecosystems can be classified based on their characteristics;

Terrestrial ecosystems: These include forests, grasslands, deserts, and tundra's, each with different climatic conditions and types of vegetations.

Aquatic ecosystems: These include both freshwater ecosystems like rivers, lakes, and wetlands, and marine ecosystems like oceans, coral reefs, and estuaries.

Ecosystem Services :

There are wide range of ecosystem services that are essential for survival of life which can be depicted by following figure ;



Threats to Ecosystems :

Human activities have significant threats to ecosystems, also known as '**evil quartet**' such as ;

- **Habitat Loss and Fragmentation**: Destruction of natural habitats for agriculture, urbanization, and infrastructure development.
- **Pollution**: Contamination of air, water, and soil with harmful substances.
- **Climate Change**: Altering temperature and precipitation patterns affecting ecosystems.
- **Over-exploitation**: Excessive harvesting of resources for benefit of others.

Conclusion :

To summarize, ecosystems are complex interrelated systems of both biotic and abiotic factors. It is vital for life on Earth, enabling energy to pass and for nutrients to be cycled. As such, they supply a wide range of ecosystem services, including food, water and climate regulation, as well as recreational values. However, many ecosystems are under threat from human activity such as climate and population change and etc. endangering the ecosystems. If we were to survive and thrive in future, we should concern ourselves for maintaining the ecosystems as they used to be.

PENTOSE PHOSPHATE PATHWAY

NAME – ASHIS BENIYA
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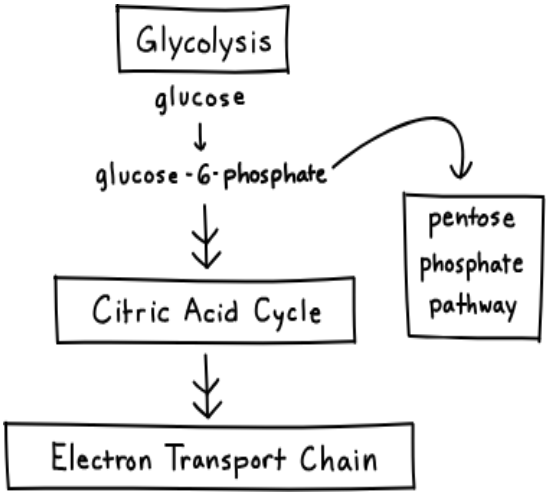
Introduction –



The pentose phosphate pathway is a metabolic pathway parallel to glycolysis which generates NADPH and pentoses (5- carbon sugars) as well as ribose 5-phosphate. The pentose phosphate pathway is also called the phosphogluconate pathway or hexose monophosphate shunt. While it involves glucose oxidation, its primary role is anabolic rather than catabolic. It is an important pathway that generates precursors for nucleotide synthesis and is especially important in red blood cells (erythrocytes). Pentose Phosphate Pathway participates in the breakdown of glucose and is crucial in the production of reducing equivalents and significant intermediates required for cellular biosynthesis. The PPP is necessary to support nucleotide synthesis, preserve cellular redox balance, and guard against oxidative stress. In this essay, we shall examine the reactions, results, phases, and importance of the pentose phosphate pathway, focusing on its function in erythrocytes.

Location –

Pentose Phosphate Pathway occurs in the cytosol of liver cells, adrenal cortex, and lactating mammary glands. Cytosol is the fluid part of the cytoplasm. In plants, most steps take place in plastids.

Reactions –

The Pentose Phosphate Pathway consists of two distinct phases: the oxidative and non-oxidative phases. These phases work in coordination to generate reducing power in the form of NADPH and produce ribose 5-phosphate (R5P), which serves as a precursor for nucleotide synthesis.

The oxidative phase-

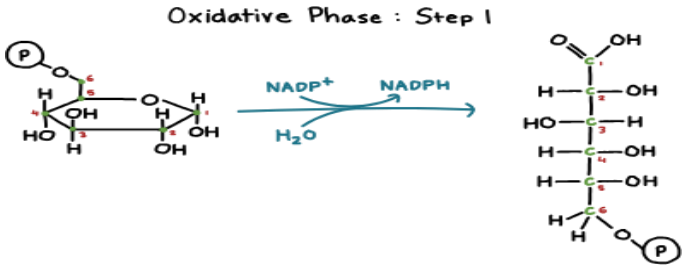
The "oxidative" word of this phase comes from the process of oxidation. Oxidation is the breakdown of a molecule as it loses at least one of its electrons. This phase is made up of 2 irreversible steps:

Step 1:

Glucose-6-phosphate is oxidized to form lactone. NADPH is produced as a byproduct of this reaction as $NADP^+$ is reduced as glucose-6-phosphate is oxidized. Following the oxidation of glucose-6-phosphate, another reaction, catalyzed by a different enzyme, uses water to form 6-

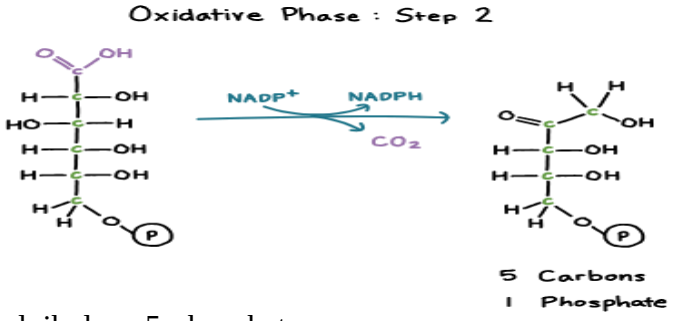
phosphogluconate, the linear product. NADPH is similar in structure and function to the high energy electron shuttle, NADH, mentioned in the cellular respiration articles. NADPH has an added phosphate group and is used in the cell to donate its electrons, just like NADH. Once NADPH has donated its electrons it is said to be oxidized (oxidation = loss of electrons) and is

now symbolized as $NADP^{+\cdot}$ NADPH is often used in reactions that build molecules and occurs in a high concentration in the cell, so that it is readily available for these types of reactions.

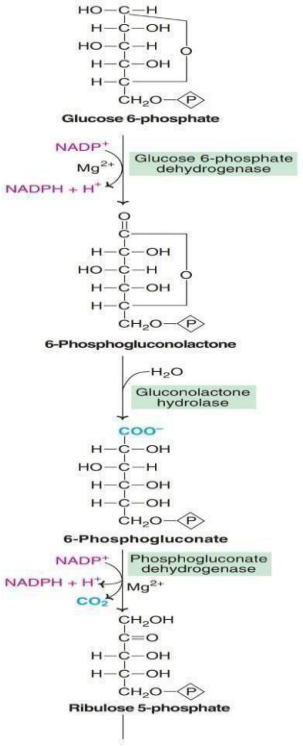


Step 2:

Next, a carbon is removed (cleaved) and CO_2 is released. Once again, the electrons released from this cleavage is used to reduce $NADP^+$ to NADPH. This new 5-carbon



molecule is called ribulose-5-phosphate.



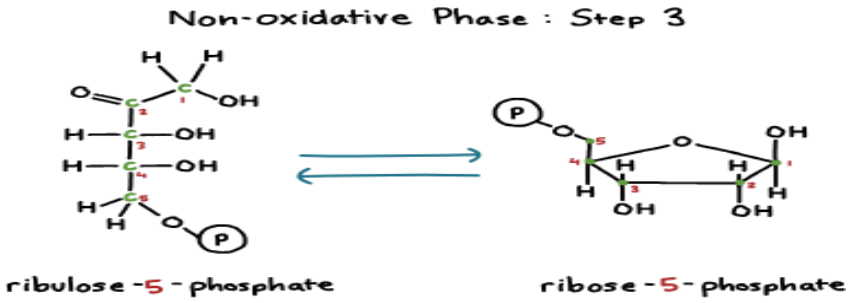
The oxidative phase of the PPP **primarily occurs in the cytoplasm of most cells and is regulated by the enzyme G6PDH**. The activity of G6PDH is tightly regulated by factors such as the availability of NADP+ and the levels of reactive oxygen species (ROS). G6PDH activity is essential for maintaining the balance between NADPH production and the cellular demand for reducing equivalents.

The non-oxidative phase:

The non-oxidative phase is really handy because these reactions are reversible. This allows different molecules to enter the pentose phosphate pathway in different areas of the non-oxidative phase and be transformed up until the first molecule of the non-oxidative phase (ribulose-5-phosphate).
Ribulose-5-phosphate is the precursor to the sugar that makes up DNA and RNA and is also a product of the oxidative stage.

Step 3:

Ribulose-5-phosphate can be converted into two different 5-carbon molecules. One is the sugar used to make up DNA and RNA called, ribose-5-phosphate and this is the molecule we will focus on. Ribulose-5-phosphate isn't being divided because the carbon count is the same in the next step.

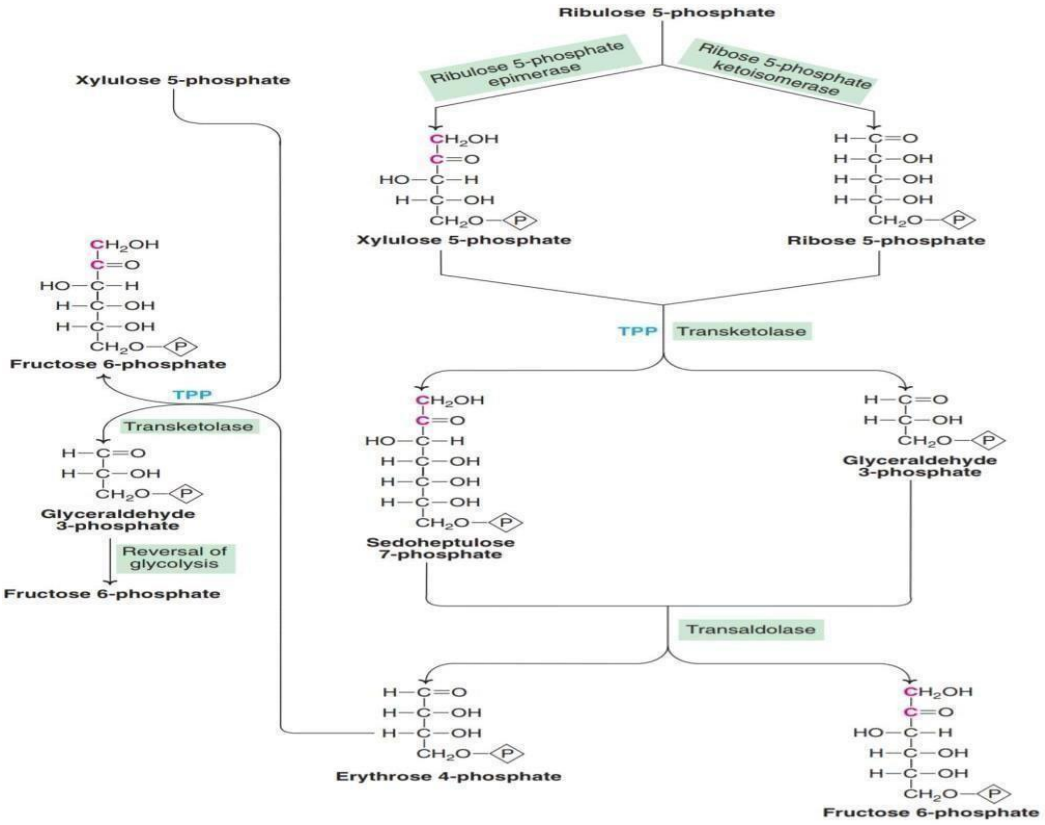


Step 4:

The rest of the cycle is now made up of different options that depend on the cell's needs. The ribose-5-phosphate from step 3 is combined with another molecule of ribose 5-phosphate to make one, 10-carbon molecule. Excess ribose-5-phosphate, which may not be needed for nucleotide biosynthesis, is converted into other sugars that can be used by the cell for metabolism. The 10-carbon molecule is interconverted to create a 3-carbon molecule and a 7-carbon molecule. The 3-carbon product can be shipped over to glycolysis if needed. That being said, recall that we can also work our way back up to another molecule in this phase. So that 3-carbon molecule could also be shipped over from glycolysis and transformed into ribose-5-phosphate for DNA and RNA production.

Step 5:

The 3-carbon molecule and the 7-carbon molecule, from the interconversion above in step 4, interconvert again to make a new 4-carbon molecule and 6-carbon molecule. The 4-carbon molecule is a precursor for amino acids, while the 6-carbon molecule can be used in glycolysis. The same reversal of steps in option 4 can happen here as well.



The overall reaction of the pentose phosphate pathway -

3 Glucose-6-P + 6 $NADP^+$ → 3 ribulose-5-P + 3 CO_2 + 6 NADPH

3 Ribulose-5-P → 2 xylulose-5-P + Ribose-5-P

2 Xylulose-5-P + Ribose-5-P → 2 fructose-6-P + Glyceraldehyde-3-P

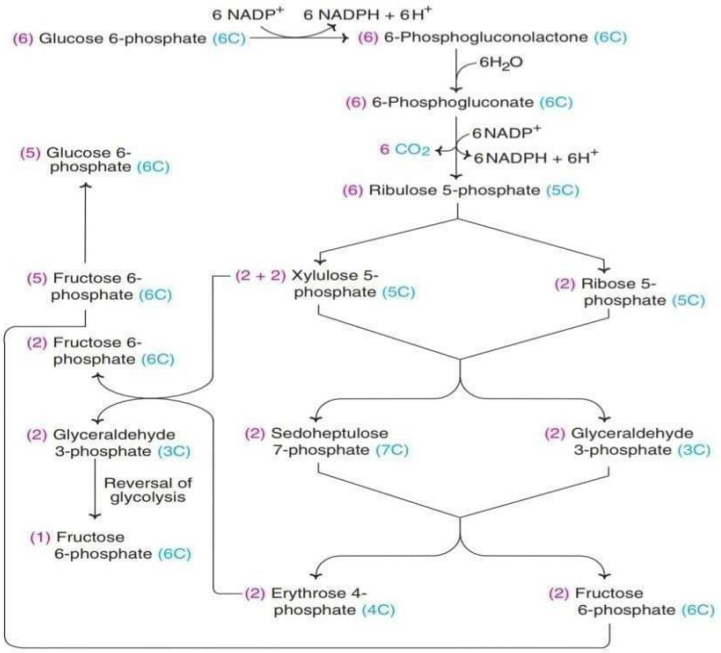


Fig. Overall pentose phosphate pathway

Outcomes of the Pentose Phosphate Pathway –

The Pentose Phosphate Pathway (PPP) produces two major outcomes: the generation of NADPH and the production of ribose-5-phosphate (R5P). These outcomes play essential roles in cellular metabolism and are critical for various cellular processes.

Conclusion –

In conclusion, the Pentose Phosphate Pathway (PPP) is a highly significant metabolic pathway with diverse roles in cellular metabolism. The pathway's two distinct phases, oxidative and non-oxidative, work together to generate NADPH and produce ribose-5-phosphate (R5P), yielding crucial outcomes that impact various cellular processes. The PPP plays a central role in maintaining cellular redox balance. By generating NADPH, the pathway provides reducing equivalents necessary for numerous biosynthetic reactions and facilitates the regeneration of reduced glutathione, an essential antioxidant that protects cells from oxidative damage. The production of NADPH is particularly vital in cells that lack mitochondria, such as erythrocytes, which heavily rely on the PPP to maintain their redox equilibrium and safeguard against oxidative stress.

AIDS

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What is AIDS?

The term AIDS refers to Acquired Immune Deficiency Syndrome caused by the HIV virus. AIDS is a condition in which the person's Immune system weakens to an extent where it is unable to fight any infection. AIDS is commonly considered to be the last stage of HIV infection; the body completely loses its defense system and this further causes illness. Loss of immunity causes organ failure and ultimately death.
HIV is a type of retrovirus. Its genetic material is RNA and is called the human immuno deficiency virus HIV (Human immune Deficiency virus) is the virus or germ that causes AIDS (Acquired Immune Deficiency Syndrome).

Causes of AIDS

HIV is held responsible for affecting the macrophages present in the blood of the human body. HIV was instigated in non-human primates and eventually spread to hominids over the eons. So, what accurately is the distinction between AIDS and HIV? Principally, HIV is the virus that sources AIDS.
It causes destruction on the body's immunity up until it is incompetent of fending off diseases on its own. On infection, the RNA of the virus enters the host cell. Through reverse transcription, DNA production is carried out. This DNA is integrated into the genome of the host here it multiplies exponentially to form RNA copies.These RNA copies turn into virus copies and infect the bloodstream.

How Aids Spreads

- Unprotected sexual contact (including anal and vaginal sex)
- Sharing needles or drug injection equipment
- From mother to child during pregnancy, delivery, or breastfeeding
- Saliva, sweat, and tears do not transmit the virus
- Oral sex has little risk of transmitting the virus

Symptoms of AIDS

As AIDS is a virus infection, the symptoms related to acute HIV infection can be similar to flu or other viral illness, like –

- Fever
- Muscle & Joint Pain
- Chilis
- Headaches
- Sore throat

- Night Sweats
- Red rashes
- Mouth sores
- Tiredness
- Weakness
- Weight Loss
- Diarrhoea

Symptoms of late-stage HIV infection may include –

- Blurred vision
- Persistent or Chronic Diarrhoea
- Dry cough
- Night Sweats
- Permanent tiredness
- Shortness of breath
- Swollen glands lasting for weeks
- Weight loss
- White spots on the tongue or mouth

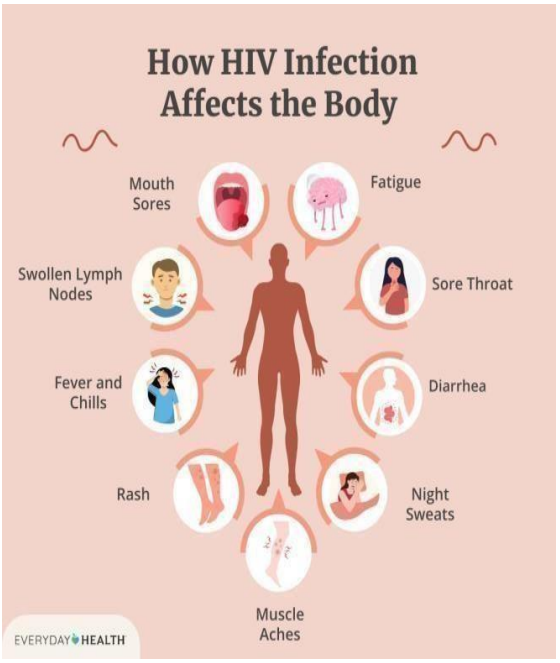

Fig. HIV infecting body parts

Prevention of AIDS

HIV infection can be uncovered with the help of an assessment termed ELISA which is the full form of 'Enzyme-Linked Immunosorbent Assay'. AIDS is fatal; thus, HIV prevention is the most reliable option. For example using one-use needles, practicing protected sex, i.e., use of safety like condoms, regular health check-ups and regulating blood transfusion and pregnancy can help in the prevention of AIDS. One more imperative influence is the awareness of AIDS.

Conclusion

According to the estimates of the Indian government 2.40 million, Indians are living with HIV wherein, the infected ones fall in the age group of 15-49, and 39 % of them that is 9,30,00 of them are women. The numbers are alarming and the rate of increase is not slowing down anytime soon. We as a country must break the traditions and conversations about sex should be open and safe. It is high time we lose our lives to this disease which can be prevented.

SEX DETERMINATION IN DROSOPHILA

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Introduction:

The biological mechanism that determines an organism's sex is known as sex determination. This process typically occurs during the early developmental stages and is influenced by genetic, chromosomal, or environmental factors. These elements play a crucial role in deciding whether an individual will develop into a male or female.

The common fruit fly, *Drosophila melanogaster*, serves as a widely researched model for understanding sex determination in animals. This system has yielded significant insights into the genetic and molecular processes that govern sexual differentiation. Unlike many other organisms, including mammals, which employ chromosomal sex determination methods, *Drosophila* utilizes a unique approach known as the X:A ratio. In this system, the balance between X chromosomes and autosomal sets determines the sex of the organism.

Genotypic Sex Determination:

In genotypic sex determination system the sex chromosomes play the decisive role in the inheritance and determination of sex, and it may occur in one of the two ways:

In the Y-chromosome mechanism of sex determination (ex- human), the Y chromosome of the heterogametic sex is active in determining the sex of an individual. Individuals carrying the Y-chromosome are genetically male, while individuals lacking the Y-chromosomes are genetically female.

In the X-chromosome autosome balance system (e.g. *Drosophila*) the main factor in sex determinationis the ratio between the number of X-chromosomes and the number of sets of autosomes. In this system the Y- chromosomes has no effect on sex determination but is required for male fertility.

Ratio Based Sex Determination:

The number of X chromosomes: sets of autosomes (X:A) ratio determines sex in *Drosophila* .

In Drosophila, there are two sets of autosomes (non-sex chromosomes), numbered chromosomes 2 and 3. The X chromosome is the sex chromosome that carries key genes involved in sex determination.

Females have two X chromosomes (XX) and males typically have only one X chromosome (XY), but the Y chromosome does not play a role in sex determination.

First, the X:A ratio is read during development. For wild-type Drosophila, the ratio that sets the initial switch for development into females (XX) is 2X. 2 sets of autosomes=1.0, and the ratio that sets the initial switch for development into males (XY) is 1X:2 sets of autosomes .

This information is transmitted to the sex determination genes, which make the choice between the alternative female and male developmental pathways, starting with the master regulatory gene Sex-lethal (Sxl).

Loss-of-function mutants of Sxl are lethal for female embryo development (meaning that Sxl needs to be active in females), but they have no effect on male embryo development (meaning that Sxl expression is not necessary for male development). However, gain-of-function mutants are lethal for male embryo development, which means that Sxl needs to be inactive in males

Alternative splicing of the Sxl pre-mRNA in embryos destined to become females or males sets in motion the two different pathways.

Genic Balance Theory:

The Genic Balance Theory of sex determination is a concept initially proposed by A.C. Bridges in 1921 to elucidate the mechanisms of sex determination in *Drosophila melanogaster* (fruit flies). This theory was groundbreaking as it transcended the notion of determining sex based solely on the presence of sex chromosomes (such as the XY system) and instead emphasized the significance of the balance between genes on the X chromosomes and autosomes (non-sex chromosomes) in determining the sex of an organism.
In Drosophila, sex determination is based on the X ratio, where X chromosomes represent the sex chromosomes, and autosomes (non-sex chromosomes) are the chromosomes that do not determine sex.
A ratio of 1.0 (e.g., XX/AA) leads to female development, and a ratio of 0.5 (e.g., XY/AA) leads to male development.

Types are:

- Females have two X chromosomes and two sets of autosomes (XX/AA), giving an X ratio of 1.0.
- Males have one X chromosome and two sets of autosomes (XY/AA), giving an X ratio of 0.5.
- Super male typically results from an X ratio of 0.25, meaning that the individual has only one X chromosome (X) but multiple sets of autosomes (often three sets, giving the genotype XY/AAA).
- Super female occurs when there is an X ratio of 2.0, meaning the individual has more than two X chromosomes (typically four X chromosomes) and two sets of autosomes, giving the genotype XXXX/AA.
- An intersex individual is one whose sex characteristics are intermediate between typical males and females. This can result from a X autosomes (XX/AAA), which results in a ratio that is less than 1.0 but greater than 0.5.

In *Drosophila*, gynandromorphs are typically the result of an abnormality in the sex determination process, most often due to an XY individual with an X chromosome loss during early development. The resulting mosaic individuals have some cells that are genetically male (XY) and others that are genetically female (XX), leading to the development of both male and female tissues in different parts

of the body. The phenomenon is usually caused by mitotic non-disjunction during early cell divisions after fertilization.

Sexual Dimorphism:

- Females are generally larger than males in body size.
- Females typically have a broader abdomen to accommodate ovaries for egg production.
- Males have sex combs (brush-like structures) on their forelegs, which are used to hold onto the female during mating.
- Females may appear darker due to the presence of yolk proteins (more protein storage for egg development). Males tend to have lighter coloration overall.
- Males often have larger eyes relative to their body size compared to females.
- Males have larger and more pronounced bristles on the thorax and legs, particularly around the genital area.

Ratio of X Chromosomes to Autosomes and the Corresponding Phenotype in *Drosophila*

X Chromosomes (X) and Sets of Autosomes (A)	X:A Ratio	Phenotype
1X 2A	0.5	Male
2X 2A	1.0	Female
3X 2A	1.5	Metafemale
4X 3A	1.33	Metafemale
4X 4A	1.0	Tetraploid female
3X 3A	1.0	Triploid female
3X 4A	0.75	Intersex
2X 3A	0.67	Intersex
2X 4A	0.5	Tetraploid male
1X 3A	0.33	Metamale

Conclusion:

To summarize, the sexual dimorphism observed in *Drosophila melanogaster* exemplifies how genetic and molecular mechanisms in nature orchestrate the formation of two distinct sexes. Each sex develops specialized characteristics and behaviors aimed at optimizing reproductive success and ensuring species continuation. Investigating these processes not only enhances our understanding of genetics and developmental biology but also provides insights into the broader concepts of evolutionary biology and sexual selection.

MIGRATION IN EEL

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ROLL NO - BS(B)20-374

Definition of Fish Migration

Fish migration refers to the regular, often seasonal, movement of fish between different habitats for purposes such as feeding, breeding, or avoiding unfavorable environmental conditions. This movement can occur over short distances (within rivers or lakes) or long distances (across oceans or between freshwater and marine environments). Fish migration is a vital part of their life cycle and can involve both diadromous and non- diadromous species.

Eel Migration

Eels, especially the European eel (*Anguilla anguilla*) and American eel (*Anguilla rostrata*) are famous for their long migrations. Their migration is a key part of their life cycle, and it is one of the most fascinating phenomena in the animal kingdom.
Eels are catadromous, meaning they are born in the ocean but migrate to freshwater (Sargasso ocean) for spawning. The life history of European eel is divided into 4 phases.

1. First phase:

The yellow-colored variety inhibiting fresh water represents the feeding and growing form. They spend 10-20 years in the river**.** With the advent of autumn, yellow eel becomes silvery and prepare to undertake migration towards the spawning ground, the Sargas so sea of Atlantic ocean.

2. Second phase:

With the advent of autumn, yellow eel becomes silvery and prepare to undertake migration towards the spawning ground. During the transformation, the yellow eels stop feeding, eyes become greatly enlarged, the snout becomes sharper with thinner lips and the yellow coloration is replaced by metallic silver. They have matured organs and shrunken digestive tract. The development of gonads is the stimulus for the beginning of migration. The silver eel first migrates down to the mouth of rivers then into the Atlantic Ocean spawning takes place in the deeper parts of the Sargasso Sea, and after the completion of spawning the parent die.

3. Third phase:

Eggs are laid at depth of 500-700 meters with temperature ranging between 10-12°C. The fertilized eggs float for some time and begin their life as “leptocephali” larva, which are transparent, leaf-shaped , flat and glassy. These tiny creature bears elongated needle like teeth for feeding, straight tubular gut, the eyes are large and silvery. They now begin their long homeward journey. At the end of 1st summer, the larvae.

attain about 25mm in length, by 2nd summer 50-52 mm in length and in the 3rd summer they become about 73- 75mm in length.

4. Fourth phase:

Once they reach freshwater or estuarine environments, they metamorphose to form "elver" (young eels) or glass eel. During metamorphosis the larvae stop feeding,their flattened body become cylindrical and their needle like teeth is replaced by new one and begin to develop pigmentation. The young eel when become three years old, measures about 15-20cm. long and after spending several years growing and maturing in freshwater or coastal environments, adult eels will migrate back to the Sargasso Sea. The male prefer to stay in the estuaries and the females ascend the rivers in shoals, especially at night during spring to reach suitable resting place. The yellow eel spends 8-10 years on feeding and growing and changes into silver eel and start their perilous journey towards the Sargasso Sea.

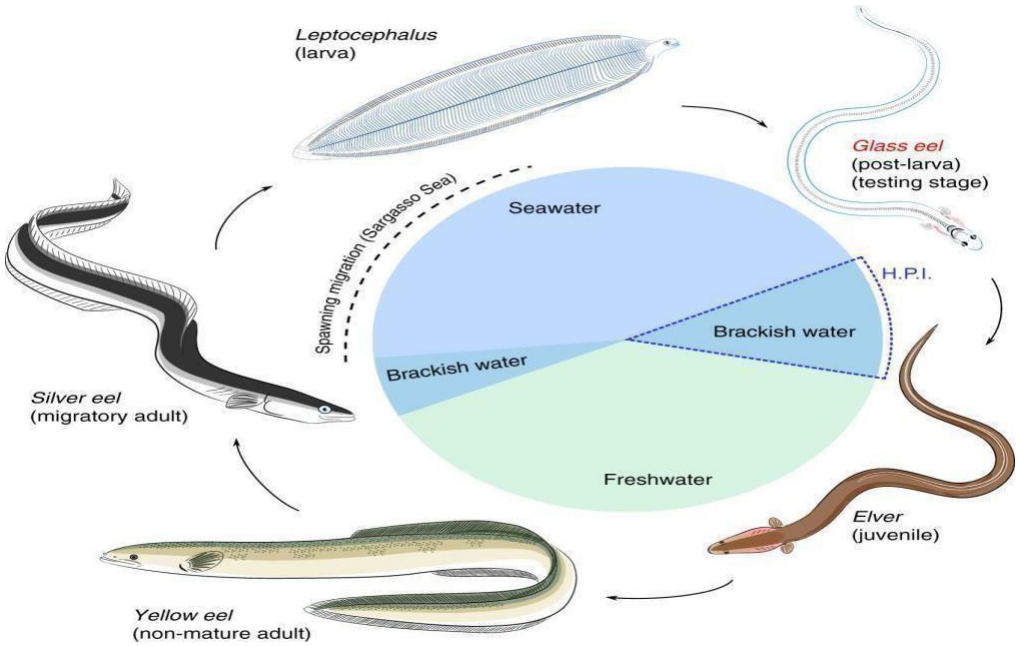

Fig. Life history of eel

Conclusion

The extra mechanisms that eels use to navigate across vast oceans and return to specific spawning grounds is still not fully understood. Unlike many other fish, eels do not exhibit strong homing abilities. Scientists suspect they may use "magnetic fields", "water currents", and other environmental cues to guide them over their extensive journeys.

CANAL SYSTEM IN SPONGES

NAME – PRITI PHALGUNI MISHRA
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Introductions: -

The water circulatory system of sponges also known called as the canal system is the characteristic feature of the phylum Porifera. A canal system also known as aquiferous system is a network of water channels that allows for the movement of water throughout the sponge's body. This system is essential for the sponge's feeding, respiration, and excretion, as sponges lack a true circulatory system. The numerous perforations on thebody surface of the sponges for ingression and egression of water current are the main constituent of the canal system.

A typical canal system is composed by following components: -

(a) Incurrent canal: It opens externally to the outside by a small pore known as incurrent pore or ostium, but internally it ends blindly.

(b) Radial canal or Excurrent canal: it is closed externally but opens internally by minute pores or apopyles into a central cavity or gastric cavity or spongocoel.

(c) Prosopyle: it is a smaller canal or passage way connecting incurrent canal with radial canal.

The arrangement and the complexity of canal system varies considerably in different sponges and has been divided in to four types:

1. **Ascon type**
2. **Sycon type**
3. **Rhagon type**
4. **Leucon type**

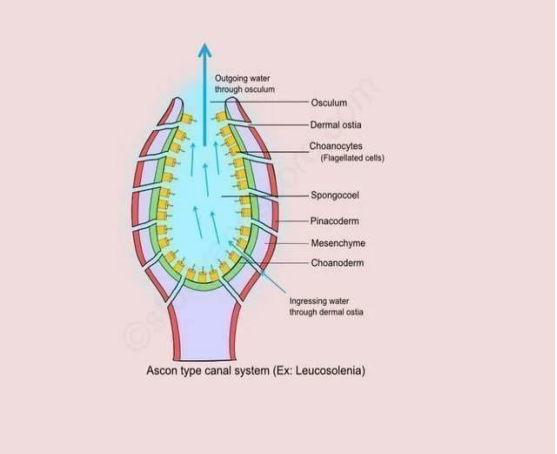

Fig. Asconoid canal system

1. **Asconoid canal system:**

Simplest structure: Found in small, tube-shaped sponges.

Waterflow:

Spongocoel, Choanocytes (collar cells) line the spongocoel and generate water currents with their flagella, trapping food particles. Water exits through a single opening called the osculum.

Example: *Leucosolenia*

2. **Syconoid canal system:**

Structure:

More complex, with folded walls to increase surface area.

Pathway:

Water enters through dermal pores into incurrent canals. Passes through small openings (prosopyles) into radial canals lined with choanocytes (collar cells). Flows into the spongocoel and exits through the osculum.

Example - *Scypha* (formerly Sycon).

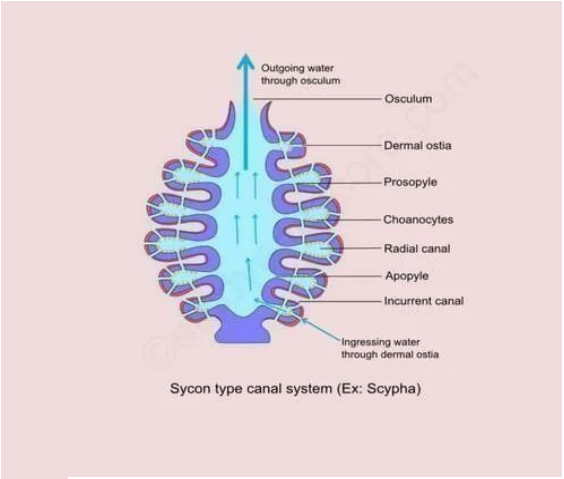

Fig. Syconoid canal system

The course of Water current through the canal system can be represented as follows:

Ingressing water – dermal ostia incurrent canal - prosopyle-radial canal -apopyle-spongocoel - osculum - outside

3. **Leuconoid canal system:**

Structure – The most complex and efficient system, found in large sponges.
Water flow – chambers lined with choanocytes, and exits via excurrent canals to the osculum.
Features - There is no central spongocoel; instead, the flagellated chambers are dispersed throughout thesponge body.
Examples - *Euspongia*, Spongilla

The course of water current is: -

Ingressing water – dermal ostia -incurrent canal – prosopyle - flagellated chambers– apopyle -Excurrentcanals – osculum – outside.

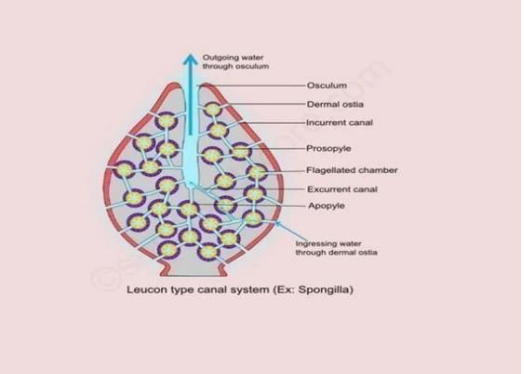

Fig. Leuconoid canal system

4. **Rhagon type canal system:**

This type of canal system is found in larvae of Demospongiae. The ostia open in these spaces which leads in to the incurrent canal. The incurrent canal opens by prosopyle into the flagellated canal which is lined with choanocytes. The flagellated canal opens by apopyles in to Excurrent canal which lead in to par gastric cavity. The Para gastric cavity opens to the outside by the osculum which is present at the apex. The incurrent and Excurrent canal maybe complex and branched in it.

Function of Canal System:

1. **Water circulation:** The canal system allows water to flow through the sponge's body, which is essential for its survival since sponges are sessile (non-motile).
2. **Filter feeding:** Sponges filter microscopic food particles (like plankton and organic matter) from the water. Specialized cells called choanocytes (collar cells) line the canals and use their flagella to create a current, drawing water in and trapping food particles.
3. **Respiration:** Oxygen dissolved in the water is absorbed by the sponge's cells, and carbon dioxide is expelled into the outgoing water. Thus, helps sponges exchange gases by removing carbon dioxide and bringing in oxygen.
4. **Waste removal:** The canal system helps sponges remove waste products like nitrogenous waste, faeces, and carbon dioxide.
5. **Reproduction:** The canal system helps sponges reproduce by carrying sperm from one sponge to another to fertilize ova.

Conclusion:

The canal system in sponges is a remarkable adaptation that facilitates water circulation, enabling essential processes like feeding, respiration, and waste removal. Its evolution from simple to complex types (asconoid, syconoid, and leuconoid) reflects increased efficiency in nutrient absorption and filtration. This system not only supports the sponge's sessile lifestyle but also plays a vital role in maintaining aquatic ecosystem health by filtering large volumes of water. Thus, the canal system is a key feature contributing to the survival and ecological significance of sponges.

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