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General Characteristic of Invertebrates

Invertebrates are animal that neither possess nor develop a vertebral column (Backbone or spine) derived from notochord.

The majority of animal species are invertebrates (approx~97%)

Some of the general characteristics of invertebrates will be discussed here. They are as follows:

(i) Organisation: It is the way in which body of an organism is organised. It can be cellular level of organisation, tissue level of organisation and organ-system level of organisation.

Ex. Cellular level — porifera

Tissue level— coelenterate

Organ- system level— platyhelminthes to hemichordates

(ii) Symmetry - It can be defined as the quality of being made up of exactly similar parts facing each other or around an axis.

- Assymmetrical - no symmetry

Ex. Some poriferans.

- Radial – it generates identical body halves around the central axis

Ex. Cnidaria, aduets of echinoderms.

- Bilateral – It generates identical body halves around the central axis.

Ex. platyhelminthes to hemichordates.

- Biradial— It is combination of bilateral and radial (except some mollusk and echinoderms)

Ex. some cnidarians.

3. Germ Layer: It is a group of cells in an embryo that interact with each other as the embryo develops and contribute to the fomation of all organs & tissue. They develop through the process of gastrulation.

- Diploblastic:- Animal possessing two major tissue layers. outer layer (ectoderm) & inner layar (endoderm)

Ex. porifera, cnidarians

- Triploblastic: 3 layers are present.

Ex. Platyhelminthes to hemichordates.

4. Body coelom: Acoelom is a cavity bined by an epithelium derived from mesoderm organism formed inside the coelom can freely, move, grow, develop independently of the body wall while fluid protects them from shockes

- Acoelomates :- No coelom present

Ex. Porifera, cnideria, platyhelminthes.

- Pseudocoelomates:- Body cavity is not derived from mesoderm. It is derived from blastocoel.

Ex. Nematodes

- Schizocoelom - In this body cavity is formed by splitting of mesoderm.

Ex. annelida, mollusca, Arthropoda.

- Enterocelom;- In this coelom formed from pouches pinched off of the digestive tract.

Ex. Echinodermata, Hemichordata.

5. Segmentation- it is the division of body plans into a series of repetitive segements

- Insegmented - no segments

Ex. porifera, cnideria, nematodes, mollusca, echinodermata, and hemichordata,

- Pseudometamerism - in those either the segmentation is only external or the segments behave independently not as a unit

Ex. Platyhelminthes.

- Metamerism:- In this, body is composed of repeating segments attached to make a whole.

Ex. Annelids, arthropoda.

6. Protostomic and deuterostomic

Protostomic:- These are animals in which mouth develops from blastopore.

Ex. Nematoda, annelida, mollusca, Arthropoda

Deuterostomic:- These are animals in which anus develops from blastopore.

Ex. aschinodeumata, hemichordata.

7. Digestive tract.

- Incomplete - it consists of digestive cavity with a single opening. it serves both as mouth and anus.

Ex. Echinodermata, platyhelminthes.

- Complete :- It consists of digestive tract with two openings one serve as mouth, other as anus.

Ex. Nematoda to Hemichordates.

8. Respiratory system:- helps in exchange of gases, Different structures are present in diff. phyla.

- Cutaneous:- gas exchange occurs through skin or outer integument of organism

Ex:- some annelids.

- Branchial respiration using gills.

Ex- some annelids.

- Ctenidia :- gills in molluscs are called ctenidia due to their comb-like shape.

Ex:- molluscs.

- Book lungs: it is a type of respiration organ found internally.

Ex. some arthropods (scorpion & spiders)

- Book gills: - It is a gill like organ used for respiration. it is found externally

Ex. some arthropods.

9. Circulatory system : Blood vascular system is well developed in higher vertebrates. It can be of open or closed type.

- open circulatory system:- It is a system where blood and interstitial fluid are allowed to mix in an organism, blood is not sealed in arteries & veins.

Ex. Arthropoda, Echinodermata, Hemichordata

- Closed circulatory system:- In this blood is closed within vessels of different size & wall thickness. Blood is pumped by heart through vessels.

Ex. Annelida, Mollusca

10. Excretory system: Different types of excretory organs are present in different invertebrates. They are discussed as follows:

- Direct diffusion:- In some lower invertebrates, products are excreted directly by diffusion.

Ex. Protozoans, porifera

- Flame cells:- It is specialized excretory cell found in the simplest freshwater invertebrates.

Also called protonephridia.

Ex- platyhelminthes.

- Nephridia:- It is an invertebrate organ which occurs in pairs and performs a function similar to the kidney of vertebrates.

Ex. Annelids

- Organ of Bojanus:-They are excretory glands that serve function of kidney.

Ex. Molluscs.

- Malpighian tubules :- They consist of branching tubules extending from alimentary canal that absorbs solutes, water & waste from surrounding hemolymph.

Ex. Arthropods (Arachnids etc)

- Coxal gland :- It is found in some arthropods, for collecting and excreting urine.

Ex:- Arachnids, chelicerates.

11. Nervous system:- This system consists of networks of nerve cells and fibres which transmits nerve impulses between parts of the body. It is quite primitive in invertebrates.

- Porifera- absent
- Cnidaria (primitive nerve cells and their processes.)
- Platyhelminthes- ladder like brain and longitudinal nerve cords.
- Nematodes - Circumpharyngeal nerve ring and nerves.
- Annelida- Nerve ring solid, double mid ventral cord and ganglia.
- Mollusc - It consists of a pair of ganglia and nerve cords with statocyst (balance organs) and eyes as major sense organ
- Arthropods-It consists of a dorsal brain and a ventral, ganglionated longitudinal nerve cord from which lateral nerve extend in each segment.
- Echinoderms- It consists of a central nervous system made up of a nerve ring connected to a series of radial nerve cord.
- Hemichordata- It is primitive consisting of intra-epidermal nerve plexus.

12. Reproduction & Sex

- Unisexual- male and female reproductive organs are present in different bodies.

Ex. Nematoda etc.

- Bisexual - male and female reproductive organs are present in same body.

Ex. porifera

- Asexual reproduction :- offspring arise from a single organism and inherit the genes of that parent only.

Ex. Some poriferans & coelenterates.

- Sexual reproduction :- Production of new living organism by combining genetic information from two individuals of different sexes (male & female)

Ex. Nematodes, molluscs, arthropods etc.

13. Fertilization :- Union of egg and sperm for producing zygote.

- Cross fertilization :- Fusion of male & female gametes from different individuals of same species.

Ex. Most of the phylum.

- **Internal fertilization**

Fertilization occurs

inside female body

- **Extranal fertilization**

Fertilization occurs

in external environment.

14. Development:

- Direct development:- Development without metamorphosis- There are no larval stages

Ex. Nematoda, some, annelids molluscs & arthropods.

- Indirect development :- Development includes metamorphosis of larval stages to form adult.

Ex. Porifera, coelenterata platyhelminthis, some (annelids, molluscs) echinodermata, hemichordata.

SOLVED EXAMPLS

1. If an animal has biradial symmtry then it has [IIT-JAM-2007]
 (a) Only one plane of symmetry
 (b) Two axes of rotational symmetry
 (c) Two planes of symmetry, which have no specific relation to each other
 (d) Two plane of symmetry, which are at right angles to each other.
- Soln.** There are two planes of symmetry in biradial animal, one passing through anteroposterior axis and sagittal axes and other through the anteroposterior and transverse axes.
 Ex. Comb jellies
Correct option (d)
2. Animals in which blastopore becomes mouth are called [BHU-2012]
 (a) Stomates (b) deutrostomates (c) Protostomates (d) Echinostomates
- Soln.** In protostomes, the first opening i.e blastopore becomes mouth while in deutrostomes it becomes anus.
Correct option is (c)

ASSIGNMENT

1. Coelom which is developed from mesoderm cells is called
 (a) enterocoel (b) pseudocoel (c) Hydrocoel (d) schizocoel
2. Blind sac body plan is present in
 (a) porifera (b) Coelenterates (c) annelids (d) Arthropods
3. Animal living in burrows are called
 (a) Carsorial (b) Fossorial (c) Cave dwellers (d) Scansorial
4. Cursorial level of organization is present in
 (a) protozoa (b) Hydra (c) Sycon (d) Taenia
5. Branchial respiration takes place through
 (a) Skin (b) gills (c) lungs (d) Trachea
6. Most vertebrate exhibit
 (a) Bilateral symmetry (b) Radial symmetry (c) Biradial symmetry (d) spherical symmetry
7. Roundworms are
 (a) Acoelomate (b) Pseudocoelomate (c) Eucoelomate (d) Hemocoelomate
8. Mammals are
 (a) Endothermal (b) cytothermal (c) Mesothermal (d) None of the above
9. Green glands are organs of excretion in
 (a) platyhelminthes (b) crustaceans (c) Molluscs (d) Annelids
10. Ladder type nervous system is present in
 (a) earthworm (b) Molluscs (c) Coelenterates (d) Flat worms.
11. Tissue grade of organisation originate from
 (a) Protozoa (b) porifera (c) Cnidarians (d) Platyhelminthes
12. Animals which lay eggs are
 (a) Viviparous (b) oviparous (c) Ovoviviparous (d) None of these
13. The coelom derived from blastocoel is called
 (a) Schizocoel (b) Haemocoel (c) Entrocoel (d) Pseudocoel

Classical Zoology

14. First enterocoel coelomates are
 (a) Chordates (b) Arthropods (c) Echinoderms (d) Annelids
15. In tetrapods, respiration is
 (a) cutaneous (b) pulmonary (c) tracheal (d) Branchial
16. Coelom is produced by splitting of mesoderm in
 (a) Schizocoel (b) enterocoel (c) Hydrocoel (d) None of the above.
17. True coelom is covered by
 (a) Ectoderm (b) Endoderm (c) Mesoderm. (d) Ectoderm & Endoderm
18. Body cavity lined by mesoderm is
 (a) Coelenteron (b) Blastocoel (c) Pseudocoel (d) Coelom
19. Which one is devoid of coelom
 (a) Platyhelminthes (b) Annelida (c) Arthropoda (d) Echinoderms
20. Maximum diversity is found in phylum.
 (a) Protozoa (b) Arthropoda (c) Annelida (d) Chordata

ANSWER KEY

- | | | | | |
|---------|---------|---------|---------|---------|
| 1. (d) | 2. (b) | 3. (c) | 4. (c) | 5. (b) |
| 6. (a) | 7. (b) | 8. (a) | 9. (b) | 10. (d) |
| 11. (c) | 12. (b) | 13. (d) | 14. (c) | 15. (b) |
| 16. (a) | 17. (c) | 18. (d) | 19. (a) | 20. (d) |



CAREER ENDEAVOUR

General Characteristics

- They can be terrestrial or aquatic
- They are too small and can be seen only through microscope.
- They are colorless and body is naked
- Locomotion occurs by pseudopodia, cilia or flagella
- Symmetry can be radial, bilateral spherical or irregular
- They are holozoic or saprozoic or holophytic in nutrition.
- Respiration and excretion occurs through body surface
- Asexual reproduction is by binary fission, multiple fission, budding or cyst formation.
- Sexual reproduction is by syngamy or conjugation
- Body is not differentiated into somatoplasm & germplasm, so there is no natural death.

Study of Protozoa— protozoology

Difference b/w protozoa & porifera

Protozoa

- Belongs to kingdom protista
- Single-celled organisms
- Can be free-living or parasitic

Porifera

- Belongs to kingdom animalia
- Multicellular
- Generally sessile organism with pores on body

Classification

- Protozoa can be classified into four subphylum on the basis of locomotary organs
 - Zooflagellata
 - Sarcodina
 - Sporozoa
 - Ciliophora

The important characteristics of these are discussed with important examples.

I. Zooflagellata

- Locomotion is by flagella
- They are mostly uninucleated except *Giardia*, *Opalina*.
- Asexual reproduction – Binary fission or cyst formation
- Sexual reproduction- absent

Examples

- *Trichomonas vaginalis*: - causes leucorrhoea in females
- *Giardia lamblia*/ grand old man of intestine-diarrh or
- *Trypanosoma gambiense*-sleeping sickness
- *Mastigamoeba* - connecting link b/w zooflagellates and sarcodina

Classical Zoology

II. Sarcodina

- Single nucleated
- Locomotion is by pseudo podia
- Asexual reproduction is by binary fission multiple fission, budding and spore formation.
- Sexual reproduction is by syngamy
- Divide into classes:-

Actinopodea

- Pseudopodia is filopodia or axopodia
- Ex. Actinophrys- the sun animal cule

Rhizopodea

- Pseudopodia is lobopodia or reticulopodia
- Ex. – *Amoeba proteus*
– *Entamoeba histolytica*

III. Sporozoa

- Uninucleated
- No locomotary organs
- Asexual reproduction is by binary fission
- Sexual reproduction is by gamogony
- Divided into different classes

(a) Telosporea

- Spores are naked
- Ex. *Gregarina*, *Monocystis*

(b) Toxoplasmea

- spores are absent in them
- Ex. *Toxoplasma*

(c) Haplosporea

- Spores are present
- E.x *Ichthyosporidium*

IV Cilophora

- Binucleated
- Locomotion is by cilia
- Asexual reproductive – binary fission
- sexual reproduction – conjugation
- Divided into different classes

(a) Holotrichia

- Cilia are simple & uniform
- Ex. *Paramecium* :- slipper animalcule

(b) Peritricha

- No cilia on body. Cilia on ends
- Ex– *Vorticella*: - Bell organism

(c) Suctoria

- Adults with tentacles. Only young ones ciliated
- Ex– *Ephelota*

(d) Spirotricha

- Buccal cilia are enhanced, Body cilia reduced
- Ex- *Bursaria*



Locomotion in Protozoa

Locomotion in protozoa occur by different methods on the basis of which they are divided into different subphylum.

The methods of locomotion:-

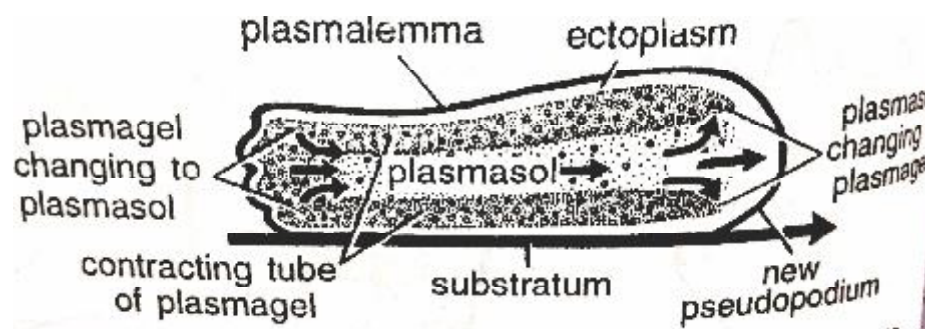
→ Amoeboid movement

- It occurs only on surface
- Consists in formation of pseudopodia by the streaming flow of cytoplasm in direction of movement.

SoL- gel theory or change of viscosity

- ◆ The cytoplasm consists of a central fluid plasmasol surrounded by more viscous plasmagel
- ◆ Active contraction of plasmagel at posterior and which leads to flow of plasmasol to anterior end into expanding pseudopodium.
- ◆ continuous solution at posterior end and gelation

Ex- Amoeba



Amoeba showing amoeboid movement acc. to sol- gel theory.

Flagellar Movement

- ◆ Needs liquid medium

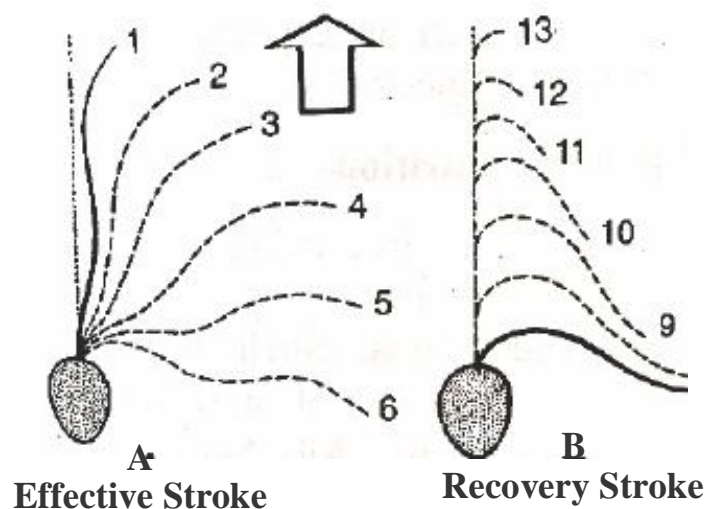
(a) Paddle stroke

- ◆ It consists of an effective down stroke with flagellum held out rigidly
- ◆ And a relaxed recovery stroke in which flagellum is curved and brought forward again
- ◆ Animal move forward, gyrate & also rotate on longitudinal axis

(b) Undulation movement

–It consists of wave- like undulation in flagellum.

– when waves proceed from tip to base- pull animal forward, if vice-versa then backward

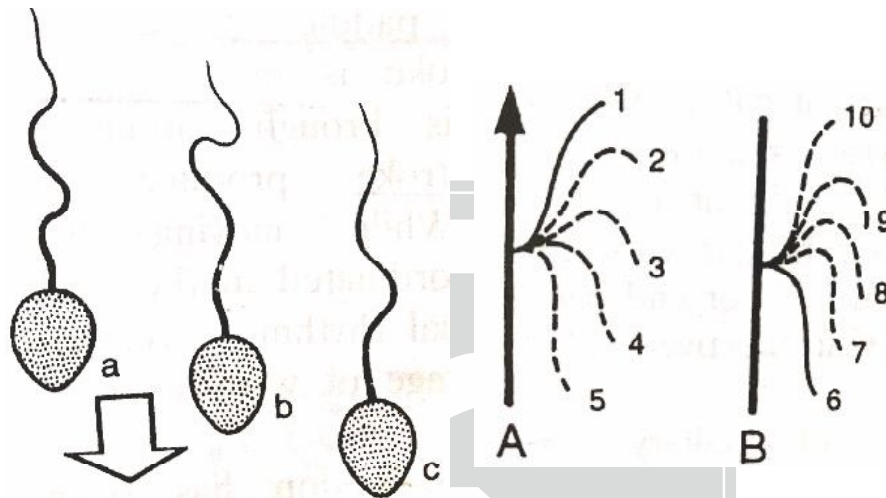


(c) **Simple conical gyration**

- In this, a spiral turning of flagellum occurs like a screw.
- This exerts a propelling action pulling the animal forward through water with spiral rotation as well as gyration around axis of movement.

• **Ciliary movement**

- Cilium oscillates like a pendulum
- Each oscillation consists of
 - a fast effective stroke
 - a slow recovery stroke
- During fast effective stroke, cilium becomes curved and rigid and strike the water like an arc and body moves forward in opposite direction of stroke.
- During slow recovery stroke, cilia comes back to original position.



Dia: Showing ciliary movement of single cilium

Reproduction in Paramecium

Reproduction in paramecium occurs by following ways

Asexual

- Binary fission (transverse)
- Endomixis

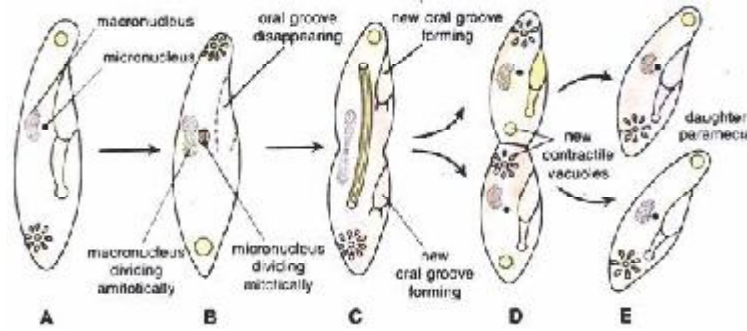
Sexual

- Cytogamy
- Autogamy
- Conjugation

All of these are discussed in detail

1. Binary fission

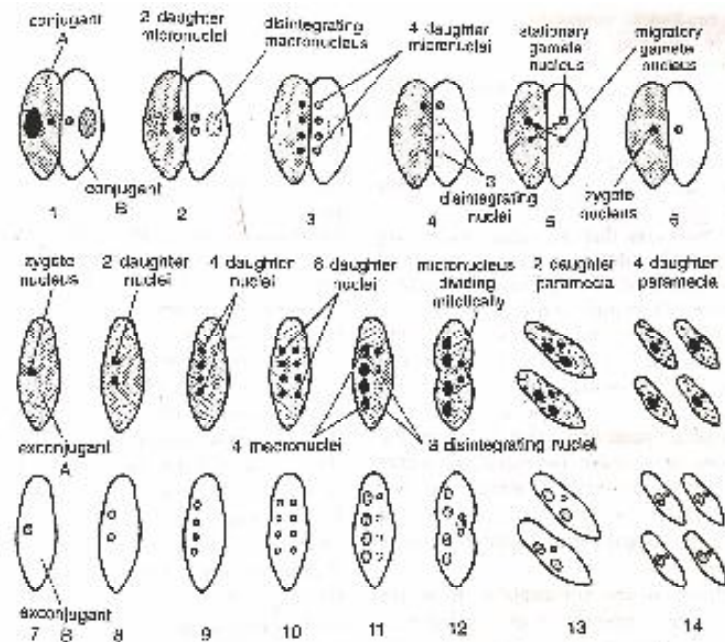
- ◆ It occurs in favorable environment when there is no shortage of food.
- ◆ Animal stop feeding and become spindle shaped
- ◆ Micro nucleus divide mitotically while macronucleus divide amitotically
- ◆ Nuclear division is followed by cytokinesis i.e. division of cytoplasm.
- ◆ Oral groove start disappearing and a new ingestory apparatus daughter is called proter with original contractile vacuole.
- ◆ Posterior daughter is called opisthe with vacuole produced by budding.



Binary Fission in Paramecium

2. Endomixis

- ◆ Macronucleus divides amitotically
- ◆ Micronucleus divides mitotically twice to form a daughter nuclei out of which 6 disintegrate.
- ◆ Now paramecium divides and each daughter nuclei receives single nucleus which undergo division and form 4 daughter nuclei.
- ◆ Out of these 2 because macronuclei 8 become micronuclei.
- ◆ Now each daughter divides into two, each gets one macronucleus & 2 micronucleus.



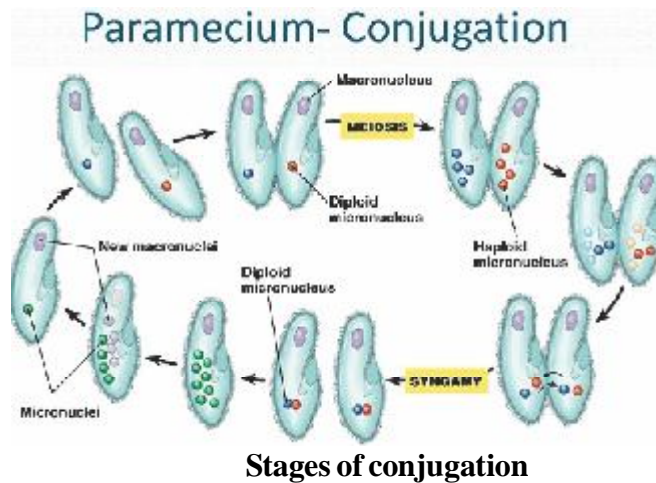
Stages in endomixis

Conjugation:-

It is a modified form of cross-fertilization. Which involves union of two individuals for exchanging their micro-nuclear material.

- ◆ Conjugates stop feeding before conjugate. Most of the apparatus disappear gradually.
- ◆ Endoplasmic bridge is formed b/w 2 conjugate.
- ◆ Macronucleus dissolves micronucleus ending meiosis & form 4 haploid nuclei.
- ◆ 3 of the haploid nuclei disintegrate and one left divides again into two pronuclei- gametic nuclei male pronuclei of one conjugant cross to other conjugant and fuses with stationary female pronucleo to form zygote/ synkaryon
- ◆ Conjugants separate.
- ◆ Now, synkaryon divides by three successive mitotic divisions into 8 daughter nuclei called-amphinucleus
- ◆ Four of these become macronuclei & other 4, micronuclei

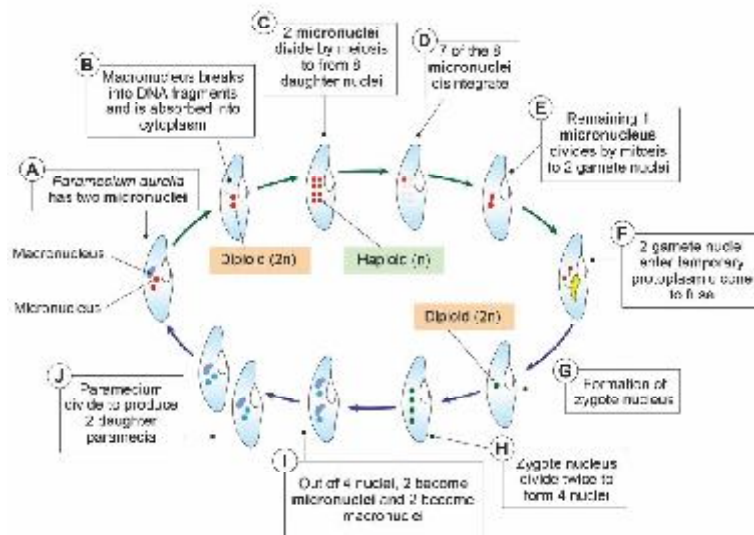
- ◆ Three micronuclei dis-integrate.
- ◆ These ex- conjugants divide by 2 successive division and form 4 daughter nuclei.
- ◆ Each daughter nuclei cures one macronucleus (by distribution) and one micronucleus (By division.)



4. Autogamy:

- ◆ It is a modified form of self fertilization
- ◆ The macronucleus breaks & disintegrates.
- ◆ The micronuclei divide once by meiosis & then by mitosis to form 8 daughter nuclei.
- ◆ Now, 7 daughter nuclei disintegrate and remaining one divide into male & female pronuclei Both of them fuse to form synkaryon
- ◆ Nuclei divide by mitosis to form 4 amphinuclei two become macro & two become micro nuclei
- ◆ Animal divides into two daughters receiving one macronuclei & 2 micronuclei.

Autogamy of Paramecium



Stages in Autogamy

5. Cytogamy

- ◆ In this, the conjugants unite but there is no exchange of pronuclei.
- ◆ Male & Female pronuclei of same individual fuse to form synkaryon like autogamy.
- ◆ Intermediate b/w conjugation & autogamy

Life History of Plasmodium

The plasmodium is a malarial parasite. It has 2 hosts.

1st host- female anopheles mosquito

2nd host man.

- ◆ The life cycle consists of three phases:-
 - (a) Infection of human with sporozoites
 - (b) Asexual Reproduction
 - (c) Sexual Reproduction

(1) State of infection:

The human infection begins when an infected female anopheles bites a person and injects sporozoite saliva into the blood circulation.

(2) Asexual reproduction

It divide into

- (i) Exerythrocytic cycle
- (ii) Erythrocytic cycle

(i) Exerythrocytic cycle :-

- Within 30-60 mins of parasite inoculation, sporozoite find their way to first target i.e. liver- the sporozoite enter liver cells and start dividing leading to schizont creation in 6-7 days.
- Each schizont gives rise to thousands of merozoites that are released into the blood stream and end the exerythrocytic phase of sexual reproduction.

(ii) Erythrocytic cycle:- Merozoites released in blood stream enter the RBCs

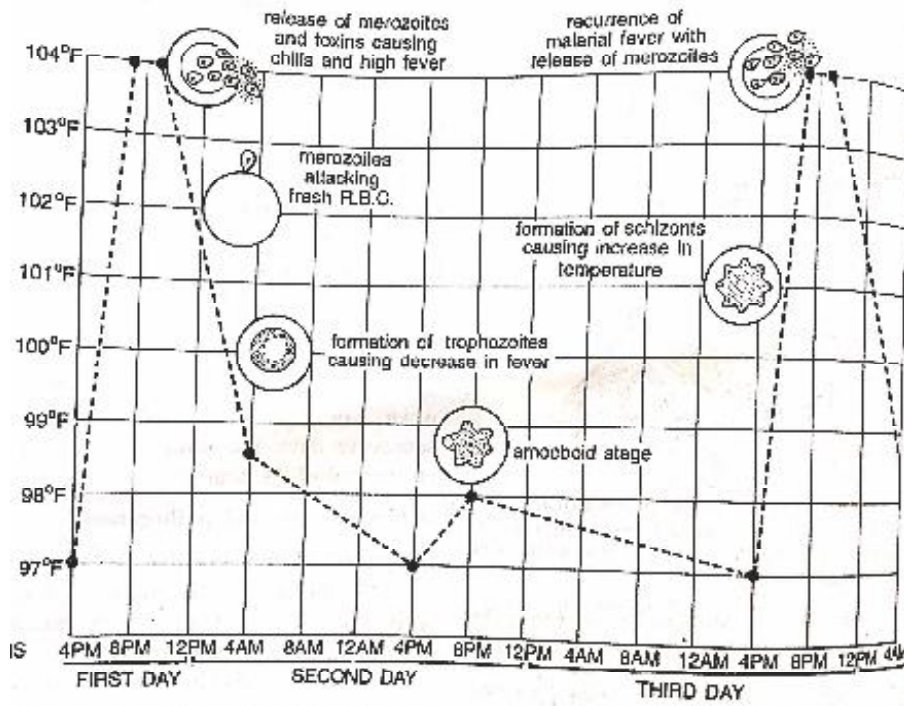
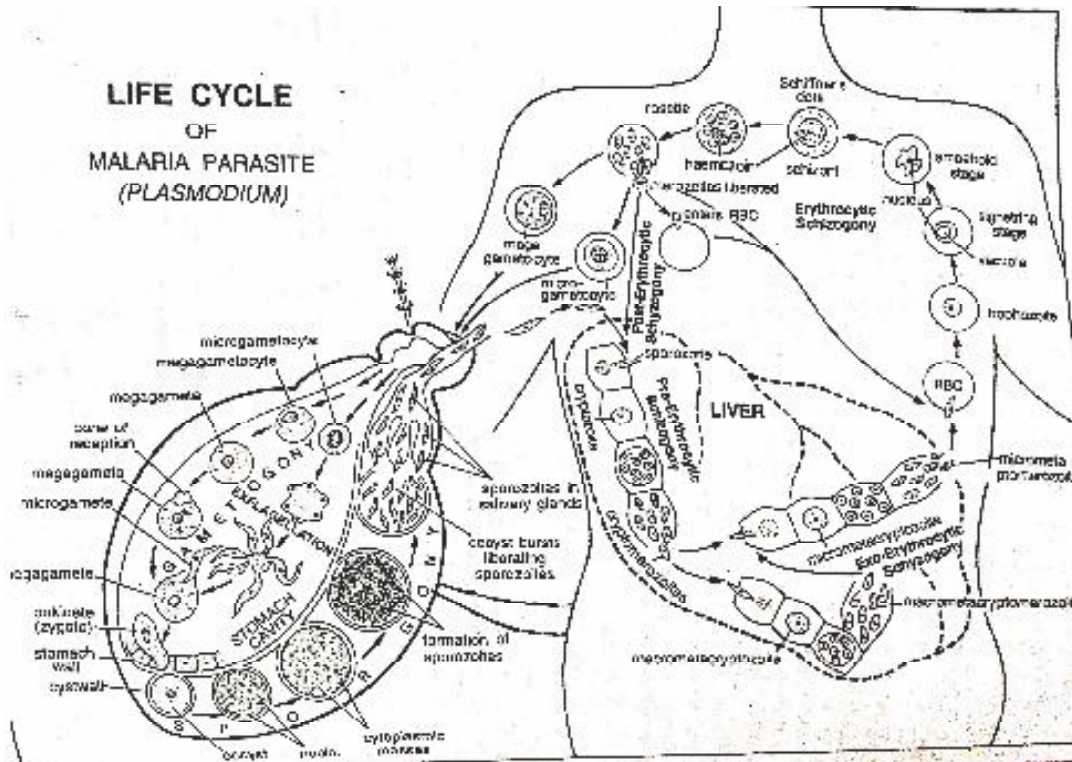
- The first stage after invasion is a ring stage that evolves into a trophozoite. As it grows, a large non-contractile vacuole appears in center and pushes the nucleus towards side forming a signet- ring.
- Soon, the vacuole disappears and trophozoites become amoeboid. It acquires brownish-black hemozoin granules.
- In 2-3 days, trophozoite grows into adult, almost entire RBC. A number of granules appear called Schuffner's dot in *P. vivax*.
- Now adult trophozoite undergo repeated mitotic division to form uninucleated merozoites. A small amount of residual cytoplasm with hemozoin granules is left in the centre of schizont. This accumulation of hemozoin granules causes the characteristic attack of malarial fever.
- After a no. of erythrocytic cycle, merozoites invade fresh RBC and grow into a different kind of round forms called gametocytes or gamonts.
- Fully formed gametocytes are dimorphic- smaller microgamete & larger macrogamete.

Sexual Reproduction:

- It starts when a female anopheles suck the blood of infected human host.
- In the mosquito gut, the microgamete nucleus divide three times producing eight nucleus, each nucleus fertiliser a macrogamete forming a zygote.
- The zygote after fusion of nuclei & fertilization becomes the so-called ookinete. The ookinete, then penetrate the mid-wall of mosquito, where it encysts into formation of oocyst.
- Inside oocyst, the ookinete nucleus divides to produce thousands of sporozoites (sporogony)
- The oocyst rupture & sporozoites are released inside the mosquito cavity & find their way to the salivary gland of mosquito

Plasmodium Species

	P. Virax	P. ORALE	P. MALARIAL	P. FALCIPAR UM
Pro-exoerythoeytic (Days)	6-8	9	14-16	5-7
Erythrocytic cycle hours	48	50	72	48
Incubation period (days)	12-17 or more	16-18 or more	18-40 or more	9-14
Sporogony (day)	8-10	12-14	14-16	9-10



SOLVED EXAMPLES

1. Protozoa is classified into sporozoa, ciliophora etc on the basis of
- (a) nutrition (b) locomotor structures
(c) nucleus (d) reproduction

Soln. On the basis of locomotary structures, protozoa is classified into sub phylum.

- (a) Zoo flagellata (b) Sarcodina (c) Sporozoa (d) Ciliophora

Which are further divided into classes

Correct option is (b)

2. Chaga'S disease is caused by
- (a) Trypanosoma gambiense (b) T. cruzi
(c) T. rhodesiense (d) T. brucei

Soln. Chagas diseases is also known as american typonosomiasis is caused by Trypanosoma cruzi. It is mostly spread by insects called as kissing bugs.

Correct option is (b)

3. Sleeping sickness occurs due to
- (a) euglena (b) Plasmodium (c) crustacea (d) protozoa

Soln. Sleeping sickness is caused by the protozoan named Trypanosoma gambiense.

Correct option is (d)

ASSIGNMENT

1. The basis of classification of protozoa is
- (a) size (b) Locomotary organelles
(c) shape (d) Number of nuclei
2. Class sporozoa of phylum protozoa is characterised by
- (a) Flagella (b) cilia (c) shape (d) Number of nuclei
3. Structure for regulation of osmotic pressure of the body in aquatic single celled animals are
- (a) central vacuole (b) Contractile Vacuole (d) Food vacuole (d) water vacuole
4. Single celled animals reproduce by
- (a) Fission (b) fusion (c) Budding (d) Regeneration
5. Which is not a locomotary organalle in protozoan
- (a) cilia (b) Flagella (c) Pseudopodia (d) Setae
6. Maligant malaria is caused by
- (a) Plasmodium ovale (b) P.falciparum (c) p.vivax (d) P. malarial
7. Gametocytes of malarial parasite are formed in
- (a) stomach of female anopheles (b) Stomach of male Anopheles
(c) Blood of man (d) Salivary gland of anopheles
8. Schizogomy stage in life history of plasmodium occurs in
- (a) RBCs & liver (b) Stomach of anopheles
(c) liver cells only (d) Blood of anopheles
9. Sporogony of plasmodium occur in
- (a) Liver cells (b) RBC's of man (c) Blood of mosquto (d) Stomach of mosquto

Classical Zoology

10. Which among these have single host
 (a) Taenia (b) Trypanosoma (c) Plasmodium (d) Entamoeba
11. Sexual phase in life cycle of Plasmodium occurs in
 (a) Female Anopheles (b) Male Anopheles
 (c) Culex blood (d) Culex stomach
12. Infective stage of Plasmodium is
 (a) Sporozoite (b) Schizont (c) Amoeboid (d) All of these
13. Types of asexual reproduction during schizogony in malarial parasite is
 (a) Binary (b) Multiple (c) Fragmentation (d) Budding
14. Which stage of Plasmodium escapes during digestion in alimentary canal of mosquito
 (a) Sporozoite (b) Gametocyte (c) Merozoite (d) Trophozoite
15. Fertilized egg of malarial parasite on the outside of mosquito stomach is
 (a) Oocyst (b) ookinete (c) Sporocyst (d) Gametocyst
16. Exflagellation in Plasmodium occurs in
 (a) Cavity of stomach (b) Wall of stomach (c) RBC's (d) Liver
17. Incubation period of Plasmodium vivax is
 (a) 16-18 days (b) 28-35 days (c) 7-12 days (d) 12-14 days
18. Exchange of genetic material in Paramecium occurs by
 (a) Binary fission (b) Conjugation (c) Encystment (d) Endomixis fission
19. Conjugation is a type of
 (a) Asexual reproduction (b) sexual reproduction
 (c) Binary fission (d) Fragmentation
20. The substance which causes malarial fever is
 (a) Haematin (b) Heme (c) Haemozoin (d) Globin

ANSWER KEY

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|---------|---------|---------|---------|---------|
| 1. (b) | 2. (d) | 3. (a) | 4. (a) | 5. (b) |
| 6. (b) | 7. (c) | 8. (a) | 9. (d) | 10. (d) |
| 11. (a) | 12. (a) | 13. (b) | 14. (b) | 15. (a) |
| 16. (a) | 17. (d) | 18. (b) | 19. (b) | 20. (c) |