Sectioning Materials

Ulva Thallus

The given material is identified as thallus of *Ulva*

Reason: The given material is green in colour, flat and resembles garden lettuce. In cross section shows two layers of cell with cup shaped chloroplast.

Description: *Ulva* is a green alga, common inhabitant marine environment and it prefers nutrient rich environment. Some species of *Ulva* are also found in brackish water and polluted estuaries. *Ulva* is commonly known as 'sea lettuce'. Thallus is macroscopic and it appear sheath like structures with two cells thick (distromatic). Thallus is lithophytic, epiphytic and some of them are free floating. Holdfast is formed by the cells of the thallus, sending down long slender filaments (like Rhizoids) that join together to form the holdfast. Growth of the thallus is diffuse (Cell division may occur anywhere in the thallus).

In cross section of the thallus shows distromatic structure, each cell is isodiametric in shape, uninucleate with one parietal laminate to cup shaped chloroplast and a single pyrenoid.

Reproduction in *Ulva* occurs by all three means: vegetative, asexual as well as sexual. *Ulva* has an isomorphic alternation of generations, with the gametophyte forming biflagellate gametes and the sporophyte producing quadriflagellate zoospores.

Sargassum – Stem

The given material is identified as the 'Stem" of *Sargassum*.

Reason: The given material is brown in colour, firm, in cross section shows three regions, viz., meristoderm, cortex and medulla composed of thick walled cells.

Description:

Division: Chromopycota Class: Phaeophyceae

Order: Fucales Family: Sargassaceae

Cross section of the given material shows three regions. The outer most layer is a meristoderm formed of small isodiametric, columnar or angular cells, compactly arranged without any intercellular spaces. These cells are packed with plastids indicating their photosynthetic function. Next to the meristoderm occur several layers of cortex formed of this walled spherical cells, loosely arranged with intercellular space. Cells of the cortex are provided

with fucosan vesicles which function as storage structures that store the reserve food materials such as laminarin and mannitol. Medulla occurs in center. Medullary cells are thick walled cells, comparatively smaller than cortical cells. It shows pores in the end plate similar to sieve element. It helps in the transport of food materials and also provides mechanical support to the 'stem'.

Cell of *Sargassum* is uninucleated, have a cell wall formed of cellulose and alginic acid. Presences of alginic acid in the cell wall of this alga make it economically important. *Sargassum* is a marine alga, growing extensively in subtidal regions of the rocky shores of our country.

***Sargassum* - Receptacle**

The given material is identified as the receptacle of *Sargassum*.

Reason:

The given material is small, brown in colour, freely branched and triangular or oblong in cross section. Conceptacles are seen in cross sections of the receptacle.

Description:

Division: Chromopycota Class: Phaeophyceae

Order: Fucales Family: Sargassaceae

Receptacles of *Sargassum* are the structures that bear oogonia and antheridia in separate conceptacles. The conceptacles are always unisexual. These are flask shaped structures with an opening called ostiole and are deeply embedded in the receptacle. Just below the ostiole occur hairs characteristic of the class Phaeophyceae.

Male conceptacles bear antheridial branches. Antheridia are formed alternately in an an theridial branch. These are similar to unilocular sporangia, bear 64 antherozoids. Each antherozoids is a male gamete, pyriform, bear two flagella that are laterally attached. Of these the anteriorily forwarding flagellum is long and tinsel type and the posteriorily forwarding flagellum is of short and whip-lash type. Antherozoids at maturity are released from the antheridium and dispersed through the ostiole.

Female conceptacles bear oogonia. Oogonia are large structure, at time filing the entire cavity of the conceptacle. Oogonium consists of a single egg. Young oogonium consists of three layered covering, viz., outer exochite, middle mesochite and inner endochite. At maturity the exochite ruptures, mesochite radially elongates to form a mucilaginous stalk to which attached

egg surrounded only by endochite. The fertilized egg starts further development without any resting stage and at the time while still attached to the base of the female conceptacle by mesochite.

***Gracilaria* thallus**

The material identified as *Gracilaria*

Reason:

The thallus flat thick, repeatedly dichotomously branched and found with hemispherical cystocarp on its surface. In Cross section, it shows cortex and medulla. These characters indicate that the given alga belongs to *Gracilaria.*

Description:

Division: Rhodophycota Class: Rhodophyceae

Order: Gigartinales Family: Gracilariaceae.

Gracilaria is a red alga, growing in brackish water and marine environment. It is a thick, leathery alga with parenchymatous construction. In cross section the thallus shows cortex and medulla. The cortex is made of one to two layers of isodiametric cells, compactly arranged without any intercellular space. These cells are provided with plenty of plastids indicating their photosynthetic function. Inner to the cortex medulla is present. It is formed of abruptly enlarged cells arranged with intercellular space. The cells are polygonal with pit connections connecting them to the neighboring cells. The medullary cells represent axial filaments. Since *Gracilaria* is multiaxially constricted thallus there are many axial filaments, each grows by mean of its own apical cell. The given material is identified as the female gametophytic thallus by the presence of large hemispherical cystocarp found distributed all over its surface.

***Gracilaria* with Cystocarp:**

The figure kept in at spotter/ the given material shows vertical section of cystocarp of *Gracilaria.*

Division: Rhodophycota Class: Rhodophyceae

Order: Gigartinales Family: Gracilariaceae.

Cystocarp: Cross section of thallus shows vertical section of cystocarp. The median longitudinal section of the cystocarp is provided wth an outer covering. It is a multilayered structure called pericarp, formed by a female gametoohytic tissue that over grow on developing carposporophyte. The pericarp is incomplete towards the distal portion of the cystocarp to form an opening called ostiole through which the carpospores are liberated at maturity. The central portion of the cystocarp contains carposporophyte. The carposporophyte is characteristic of having a large placental cell at the center, gonimoblast filaments developed from the placental cell and gonemonemata filamentous structures connecting the carposporophyte with pericarp – that are nutritive in function. Carposporangia are produced in series from the gonimoblast filaments.

This alga shows a triphasic lifecycle with gametophyte (male and female gametophytic thalli), carposporophyte and tetrasporophyte. The life cycle is called as diplobiontic life cycle or sporic life cycle.

Gracilaria is a marine alga growing in the lower places of intertidal regions of coast of Tamil Nadu in general and at rocks of Kovalam in particular. This alga is economically useful as agar-agar is extracted from it.

***Caulerpa* Rhizome/stolon**

The spotter is identified as the rhizome of *Caulerpa*

Reason: It is cyclindrical, tubular structure with rhizoids. The cross section shows cell wall trabeculae and cytoplasmic masses. These characters confirm that the given material as that of *Caulerpa* rhizome.

Description:

Division:	Chlorophycota	Class: Chlorophyceae
Order:	Bryopsidales	Family: Caulerpaceae.

Caulerpa has assimilators, rhizome and rhizoids. Rhizome is a siphonous strucute, growing parallel to the substratum. Towards the lower regions of the rhizome arises the rhizoids and towards the upper region arise assimilators. Assimilators are of many kinds in different species of *Caulerpa.* Assimilators and rhizome are provided with stratified, thick wall of two layers, viz., inner layer and outer layer. The inner layer produces a number of tubular, freely branched structures that traverse the cytoplasm. These structures are named as **trabeculae**. The trabeculae give mechanical support to siphonous thalli of *Caulerpa.* The cytoplasm in *Caulerpa* contains

numerous nuclei and lot of cytoplasmic masses. The latter include amyloplasts and amylogenic leucoplasts that store reserved food material.

The lenticular cell division takes place in the assimilator at the time of reproduction to differentiate a lens shaped cell towards the peripheral portion of assimilator. This uninucleated cells act as a gametangium, whose nucleus undergoes meiotic division to form numerous haploid gametes which are discharged forcibly through a beak like projection formed on the surface of assimilators. It is a marine alga, found abundantly on the coast of Tamil Nadu.

Spotters

Volvox

The spotter identified as thallus of *Volvox*.

Division:	Chlorophycota	Class: Chlorophyceae
Order:	Volvocales	Family: Volvocaceae

Reason: Thallus of volvox is spherical up to millimeter in diameter. A definite number of cells join together to form a defiantly shaped colony called a coenobium. Individual cells are Chalamydomonas like in having spherical cells, cup shaped chloroplast, two flagella. Cells are polygonal due to mutual compression. Neighboring cells are interconnected by cytoplasmic connections through which exchange of substances take place. Flagella of all cells show coordinated movement by which the coenobium is spin around in its longitudinal axis that moves the coenobium either move forward or backward. Reproductive structures such as daughter colonies, antheridia and oogonia and subsequently zygospores are all formed and found only towards the posterior region of the coenobium.

Hydrodictyon

Division:	Chlorophycota	Class: Chlorophyceae
Order:	Chlorococcales	Family: Hydrodictyaceae

The spotter identified as thallus of *Hydrodictyon. Hydrodictyon* forms a colony of definite shape with a fixed number of cells. Such a colony is called as a coenobium. Here the cells of coenobium are non-motile. Hence the thallus is called as a non-motile coenobium. The mature

coenobia are composed of large cylindrical cells joined together in three to form polygonal structures. The whole colonu is cylindrical when young. The young cells are uninucleated. Mature cells enlarge several times; develop numerous nuclei and large central vacuoles which force the cytoplasm towards the periphery of the cell, Chloroplast of *Hydrodictyon* is reticulate. It reproduces by asexual and sexual methods involving the formation of zoospores that are retained within the cell wall and arrange themselves to form a micronet before released out. It is found in nutrient rich water bodies.

Volvox

The Spotter is identified as thallus of *Volvox*

Reasons: Thallus is spherical in shape and is considered as a coenobium. The thallus is seen with number of daughter colonies.

Description: Thallus of *Volvox* is spherical up to a millimeter in diameter. A definite number of cells join together to form a definitely shaped colony called coenobum. Individual cells are *Chlamydomonas* like in having spherical cells, cup shaped chloroplase, two flagella. Cells are polygonal due to mutual compression. Neighboring cells are interconnected by cytoplasmic connections through which exchange of substances take place. Flagella of all cells shows coordinated movement by which the coenobium is spin around in its longitudinal axis that moves the coenobium either move forward or backward Reproductive structures such as daughter colonies, antheridia and oogonia and subsequently zygospores are all formed and found only towards and found only towards the posterior region of the coenobium. It is a green alga belonging to the family Volvocaceae and the order Volvocales. It is found in freshwater environments rich in nutrients.

***Sphacelaria* – Propagules**

The spotter kept here is a propagule of filaments of *Sphacelaria*. Species of *Sphacelaria* reproduce propagules as a means of vegetative reproduction. Propagules are formed from the branches of main axis. These are bi-radiate, tri-radiate or wedge shaped in structure. Triradiate propagules are produced in *Sphacelaria furcigera* and wedge shaped propagules are formed in *Sphacelaria tribuloides.* When these are liberated at maturity the distal cells of the arms of propagule functions as apical cell of future filaments of *Sphacelaria.* Similar propagules such as

stellate propagules and hook shaped propagules are formed in red algae such *as Hypnea valentiae* and *Hypnea musiformis* respectively. Propagules are also formed in *Hildenbrandia rivularis* and *Polysiphonia* sp.

***Hincksia* – Plurilocular sporangium / Unilocular sporangium**

Plurilocular sporangium: Plurilocular sporangium in *Hincksia* is cylindrical contains number of locules or compartments. Each of these locules is provided with nucleus and cytoplasm that metamorphoses into a biflagellate zoospore. Zoospores at maturity are liberated by dissolution of cross walls of locules and then by the formation of an opening at the distal region of the sporangium. Zoospores are pyriform in shape, biflagellated with laterally attached flagella. The anteriorily forwarding flagellum is long and tinsel and the posteriorily forwarded flagellum is short and whiplash type. Plurilocular sporangia are produced in both haploid and diploid sporophytic generations.

Unilocular sporangium: Unilocular sporangium in *Hincksia* is oblong in shape. It is produced only on diploid sporophytic generations. Unilocular sporangia are always stalked. The diploid nucleus of this sporangium first undergoes a reduction division (meiosis) followed by mitotic divisions to form up to 256 haploid daughter nuclei. These with accumulated cytoplasm are called as protoplasmic units. Protoplasmic units develop into swarmers. These are always haploid. Swamers are pyriform in shape, biflagellated with laterally attached flagella. The anteriorily forwarding flagellum is long and tinsel and the posteriorily forwarded flagellum is short and whiplash type. Swamers on liberation always develop into gametophytic thalli.

Laminaria: Vertical section of lamina showing unilocular sporangia:

Vegetative structure: Thallus of Laminaria in vertical section of the lamina shows the following structures:

1. Meristoderm: This is the outermost layer formed of one or two rows of angular cells compactly arranged. Cells of this layer are stuffed with plastids indicating photosynthetic function. At maturity, Unilocular sporangia are produced from this layer.
2. Cortex: This layer is present next to meristoderm. Cortex is divided into outer cortex and inner cortex. Cells of the outer cortex are polygonal in shape and are compactly arranged.

Cells of the inner cortex are also compactly arranged but are slightly elongated. Cells of the cortex are storage in function.

3. Medulla: This is the middle layer of the lamina. Here the cells are elongated and filaments like. These are called as hyphae. There are two types of hyphae. One is a normal hypha formed of elongated cells. The other one is trumpet hypha having a porous cross wall comparable to that of sieve elements of higher plants and there is also the presence of swelling on either side of the cross wall. These hyphae are conducting in function.

Chara – Nucule and Globule

Sexual reproduction in Chara is carried out by the formation of male and female reproductive structures such as globules and nucules respectively. Globules are terminal and nucules are laterals. These structures are produced at one of few basal nodes of primary lateral.

Antheridium:

Antheridium or globule is a spherical structure externally surrounded by four or eight shield cells. The inner layers of shield cells are ruminate as they are provided with infoldings. From the centre of each of the shield cell arises a radially elongated manubrium. On the distal region of the manubrium occurs a primary capitular cell which underges successive longitudinal divisions to form capitular cells. Each of these secondary capitular cells undergoes transverse division to form antheridial filaments. Antheridial filaments contain discoids cells called antheridia. Each of these antheridia metamorphoses into an antherozoid. The mature antherozoid is spirally coiled with two sub-apically inserted flagella. The body of the antherozoids and flagella are covered with scales.

Oogonium:

Oogonium or nucule is ovate in shape. Oogonia are produced from the peripheral cell of the basal node of the antheridium. A mature oogonium is attached to the basal node of the antheridium by a stalk cell. It contains a basal node and the five peripheral cells of the basal node undergo two successive transverse divisions to form basal tube cells and coronary cells. The five tube cells grow spirally over the egg which brings the coronary cells to the distal region of the nucules. The mature egg produces lot of mucilage which exudates through the space created by pushing apart of the coronary cells.

Batrachospermum –Carposporophyte

The photograph kept is the carposporophyte of Batrachospermum. It is formed by the fertilized carpogonium. The diploid nucleus undergoes mitotic division to form numerous nuclei which are incorporated into small protrusions formed all over the fertilized carpogonium. When a cross

wall formed at the base of each of these protrusions they become gonimoblast initials. These develop into small filaments of few cells in height called gonimoblast filaments. The distal cell of these filaments are enlarged with dense content and called as carposporangia. The content of the carposporangia are liberated as carpospores. Hence the fertilized carposporangium, gonimoblast filaments and carposporangia all together constitute carposporophyte of Batrachospermum. This represents one of the three phases in the life cycle of Batrachospermum and it is considered to be growing on the gametophytes as a parasite.

Spot at Site

S. No	Class	Order	Family	**Genus**
1.	Cyanophyceae	Chroococcales	Chroococcaceae	***Aphanothece***
2.				***Chroococcus***
3.				***Merismopedia***
4.				***Microcystis***
5.		Nostocales	Oscillatoriaceae	***Arthrospira***
6.				***Spirulina***
7.				***Lyngbya***
8.			Scytonemataceae	***Scytonema***
9.		Stigonematales	Stigonemataceae	***Westiellopsis***
10.	Chlorophyceae	Chlorococcales		***Chlorella***
11.				***Chlamydomonas***
12.		Chlorococcales	Hydrodictyaceae	***Hydrodictyon***
13.				***Pediastrum***
14.		Volvocales	Volvocaceae	***Volvox***
15.		Ulotrichales	Ulotrichaceae	***Ulothrix***
16.		Oedogoniales	Oedogoniaceae	***Oedogonium***
17.		Cladophorales	Cladophoraceae	***Pithophora***
18.		Bryopsidales	Caulerpaceae	***Caulerpa***
19.		Zygnematales	Peniaceae/ Desmidiaceae	***Closterium***
20.			Desmidiaceae	***Cosmarium***
21.				***Micrasterias***
22.			Zygnemataceae	***Spirogyra***
23.			Zygnemataceae	***Zygnema***
24.	Charophyceae	Charales	Characeae	***Chara***
25.	Phaeophyceae	Ectocarpales	Ectocarpaceae	***Hincksia***
26.		Sphacelariales	Sphacelariaceae	***Sphacelaria***
27.		Laminariales	Laminariaceae	***Laminaria***
28.		Fucales	Sargassaceae	***Sargassum***
29.				***Turbnaria***
30.	Rhodophyceae	Gigartinales	Gracilariaceae	***Gracilaria***

Spirulina

Spirulina contains 60-70% of protein when compared to the total constituents of cells on dry weight basis. It has B-complex vitamins besides having vitamin C and vitamin E. For a long time *Spirulina* is consumed in the Lake Tehad region of North America. Two 500 mg tablets of *Spirulina* consists of substances equivalent to 1 kg of assorted vegetables with reference to its minerals and vitamins. *Spirulina* for life force, Slimolin and Miraculin are marketed in USA. These are being prescribed for persons who would like to shed weight without any side effect. *Spirulina* is an excellent source of fatty acids such as Levulenic acid, Palmitic acid, Linoleic acid & Oleic acid. These are of commercial value and used as pharmaceutical agents. *Spirulina* has high amount of β-carotene, when consumed it acts as provitamin-a and will meet the requirement of vitamin a.

Agmenellum, Anacystis & ***Spirulina*** are capable of growing at high cell density. Hence these are grown on substrates such as CO_2 enriched with ^{13}C & ^{14}C. The resulting labelled compounds upon purifications can be utilized as tracers in biology, medicine, medical diagnosis and analytic chemistry. Eg. ^{2}H, ^{3}H, ^{13}C, ^{14}C and ^{15}N – labelled sugars, lipids, l-aminoacids and protein fractions.

Spirulina can be cultivated in large quantity even using waste water containing lot of nutrients. This is helpful to us in two ways. i.e., the nutrients in the waste water like sewage is removed and utilized for the growth of *Spirulina* and the nutrient depleted waste water can safely discharged in to natural water bodies. The harvested biomass of *Spirulina* can be used as cattle, poultry and fish feed.

PORPHYRA

Porphyra (Bangiophyceae) is popularly known as Nori in Japan, Kim in Korea, and Zicai in China, (see Chapter 1, Figure 1.24). It is among the most nutritious macroalgae, with a protein content of 25–50%, and about 75% of which is digestible. This alga is an excellent source of iodine, other trace minerals, and dietary fibers. Sugars are low (0.1%), and the vitamin content very high, with significant amounts of vitamins A, complex B, and C, but the shelf life of vitamin C can be short in the dried product. During processing to produce the sheets of nori, most salt is washed away, so the sodium content is low. The characteristic taste of nori is caused by the large amounts of three amino acids: alanine, glutamic acid, and glycine. It also contains taurine, which controls blood cholesterol levels. The alga is a preferred source of the red pigment r-phycoerythrin, which is utilized as a fluorescent “tag” in the medical diagnostic industry.Porphyra has been cultivated in Japan and the Republic of Korea since the 17th century, because even at that time natural stocks were insufficient to meet demand. Today Porphyra is one of the largest aquaculture industries in Japan, Korea, and China. Because of its economic importance and other health benefits, Porphyra cultivation is now being expanded to other countries.