现代生物学精要速览

Instant Notes in ANIMAL BIOLOGY

动物生物学

（影印版）

Richard D.Jurd

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2000

内 容 简 介

本套丛书是国外优秀教材畅销榜的上榜教材，面向大学生，由英国著名大学具丰富教学经验的一流教授编写。它以一种风格独特的描述方式，全面、系统地概括了学科的核心内容和前沿动态，并以一种便于学习、利于复习的形式，使学生能快速、准确地掌握知识，很好地指导学习和考试。书中英文使用最为自然、易懂的语句，是提高专业外语的最佳套书。本书是该系列中的动物生物学分册，涵盖了动物的分类、解剖、生理、发育、生态等内容。

Richard D. Jurd

Instant Notes in Animal Biology

Original edition published in the United Kingdom under the title of Instant Notes in Animal Biology

图字:01-99-0192

科学出版社 出版
北京东黄城根北街16号
邮政编码:100717

北京双青印刷厂 印刷

新华书店北京发行所发行 各地新华书店经售

*

1999年3月第 一 版 开本:787×1092 1/16
2000年4月第二次印刷 印张:19
印数:3 001—6 000 字数:451 000

ISBN 7-03-007306-1/Q·848

定价:38.00元

(如有印装质量问题，我社负责调换〈科印〉)

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ABBREVIATIONS

ACTH	adrenocorticotropic hormone
ADH	antidiuretic hormone
ADP	adenosine diphosphate
AMDF	anti-Müllerian duct factor
APC	antigen-presenting cell
ATP	adenosine triphosphate
ATPase	adenosine triphosphatase
cAMP	cyclic adenosine monophosphate
CCK	cholecystekinin
CNS	central nervous system
CoA	coenzyme A
CRF	corticotropin-releasing factor
CSF	cerebrospinal fluid
DNA	deoxyribonucleic acid
FSH	follicle-stimulating hormone
GABA	γ-aminobutyric acid
GH	growth hormone
GIP	gastrin-inhibitory polypeptide
GnRH	gonadotropin-releasing hormone
Hb	hemoglobin
HbA	adult hemoglobin
HbF	fetal hemoglobin
HRT	hormone replacement therapy
Ig	immunoglobulin
JGA	juxtaglomerular apparatus
LDL	low-density lipoprotein
LH	luteinizing hormone
MHC	major histocompatibility complex
PIF	prolactin-inhibiting factor
PRL	prolactin
PZ	pancreozymin
Rh	Rhesus factor
RNA	ribonucleic acid
T_4	thyroxine
TCA	tricarboxylic acid
TDF	testicular-determining factor
TMAO	trimethylamine oxide
TRF	thyrotropin-releasing factor
TSH	thyroid-stimulating hormone

PREFACE

This book is designed to provide accessible information on animal biology in a compact form for undergraduate students in biology and related life sciences. It is intended to be particularly helpful for revision. The book will be useful for both beginning students and those who are more advanced. In addition, busy lecturers who require a quick reference compendium will find it useful, particularly for tutorial planning.

Instant Notes in Animal Biology is not designed to replace the large comprehensive texts in zoology, comparative physiology or developmental biology which already exist. Nor is it a substitute for lectures, seminars, tutorials or laboratory classes. Rather it is a supplement to all of these, to provide a compendium of core information in a readily accessible form for both ease of learning and rapid revision.

For the student reader, it must be said that no two animal biology courses are the same. Therefore, some of the topics in this book may not be directly relevant to the course being studied. However, scanning through them will certainly help to broaden student insight into the subject. The emphasis of the book is on animal biology. Thus, cell biology, genetics, ecology and animal behavior are not covered here. Readers interested in these subjects are strongly encouraged to read other books in the *Instant Notes* series which address these subjects.

The book is divided into four Sections, each covering a major aspect of animal biology and containing a number of related Topics. Each Topic has main text that describes the subject which is preceded by a list of Key Notes that summarize the main points. The most productive way to use the book is to turn to the Topic of interest and read the main text. Use the Key Notes on that Topic as a memory prompt for revision. Another feature is that each set of Key Notes ends with a list of citations that refer to related Topics. This is an easy way for student readers to navigate the book in a logical way. Finally a list of further reading is provided at the end of the book to guide readers to the literature.

Section A reviews the Animal Kingdom, phylum by phylum. The type of organism is described, followed by the body plan, feeding, locomotion, the skeleton, respiration and the vascular system, osmoregulation and excretion, co-ordination and reproduction, as appropriate, in turn. This is followed by paragraphs on the major groups within the phylum. Examples of animals are given where appropriate. For some phyla there are notes on related, 'minor' animal phyla. A few minor phyla are omitted, and for these students are advised to consult relevant specialist texts. Most biologists now consider that the protozoans belong to their own Kingdom, the Protoctista: I have included them in this book because the heterotrophic protozoans have traditionally been studied with the Animalia.

Zoologists frequently disagree about classification. For example, some consider a particular group as constituting a sub-phylum while others promote it to a phylum or demote it to a class. There is also often disagreement about names (e.g. Monotremata or Prototheria) and even spellings (e.g. Nemertea or Nemertina). The classification used in this book is not necessarily the best one (the only true taxonomic group is the species), and the classifications of others may have equal validity. However, any differences will be quite small and the classification used here is the one I would recommend.

Section B covers a number of co-ordinating principles such as body plans and cavities, skeletal arrangements and symmetry, together with evolutionary issues such as protostomy and deuterostomy, neoteny and pedogenesis, and phylogenetic relationships and origins. Section C describes aspects of comparative physiology, beginning with homeostasis, a unifying concept in physiology. Examples are taken from across the Animal Kingdom, although, for some subjects there is an emphasis on mammals or humans. Functional topics such as locomotion are also reviewed. The topics in Section D review reproductive physiology and developmental biology which here is considered not to end with hatching or birth but to continue into aging.

Simple, yet hopefully clear, Figures and Tables are provided throughout the book. These are not intended to substitute for the more detailed, often multi-colored, illustrations frequently found in large textbooks, but they will be much easier to learn and reproduce. After nearly 30 years of teaching in universities, I am still dismayed by how reluctant some students are to use diagrams, charts and tables in continually assessed work and examinations, yet they are often an easy and very effective way of communicating information. The diagrams included here will give students ideas for producing other diagrams of their own.

The overriding goal of this book, and indeed of the whole *Instant Notes* series, is to present the essential information concerning animal biology in a compact, readily accessible form which lends itself to student learning and revision. If, as a student reader, you use the book for browsing and for revision – and it helps you to understand the subject better and pass those all-too-important examinations and assessments – it will have fulfilled its prime role. Now – read on!

Acknowledgments

I am grateful to many friends at Essex and elsewhere for their forbearance and their helpful discussions and answers to my questions. Particular thanks are due to my colleague and teaching collaborator, Dr Martin Sellens, for his perceptive and critical advice and also to Professor Christopher Bayne, Oregon State University for reviewing the manuscript. My research student, Michael-Anthony Price, and my elder son, Peter (studying Biology as an undergraduate at Southampton University) have read and commented on a number of chapters from a consumer's viewpoint. I must emphasize, however, that any shortcomings remaining in the book are my responsibility: I should be pleased to receive readers' comments. Lastly, I thank Elizabeth, and Peter, Andrew and Mary for their patience and understanding during a year when 'the book' has occupied a large chunk of my life!

Richard D. Jurd

Geological time ladder

ERA	Period	Millions of years ago (approx.)
QUATERNARY	Holocene (recent)	0 – 0.01
	Pleistocene	0.01 – 2
TERTIARY	Pliocene	2 – 7
	Miocene	7 – 26
	Oligocene	26 – 38
	Eocene	38 – 54
	Palaeocene	54 – 65
MESOZOIC	Cretaceous	65 – 136
	Jurassic	136 – 195
	Triassic	195 – 225
PALAEOZOIC	Permian	225 – 280
	Carboniferous	280 – 345
	Devonian	345 – 395
	Silurian	395 – 440
	Ordovician	440 – 500
	Cambrian	500 – 570
ARCHAEOZOIC	Pre-Cambrian (? Origin of life 3500)	570 – 4500 (Origin of Earth)

NOT TO LINEAR SCALE (0.01 – 570)

(Quaternary + Tertiary = Caenozoic period)

CONTENTS

A1 THE PROTOZOA

Classification: Kingdom Protoctista (Protista), Protozoa

Key Notes

Features	*Type of organism*: unicellular (or 'noncellular') organisms which belong to several phyla; they probably have a polyphyletic origin. *Feeding*: usually heterotrophic. Food is assimilated from a food vacuole. *Locomotion*: often, but not always motile. *Osmoregulation*: osmoregulate by means of a contractile vacuole. *Reproduction*: usually both asexual and sexual.
Phylum Sarcomastigophora	*Sub-phylum Mastigophora* (with flagella): phytoflagellates are autotrophic, zoöflagellates are heterotrophic. *Sub-phylum Sarcodina* (with pseudopodia): these often possess sophisticated skeletal structures.
Phylum Apicomplexa	Members of this phylum are parasites (mainly sporozoans). They have tubular or filamentous organelles at the apical end of the body.
Phylum Microspora	These are also parasitic, with polar filaments in a spore-like stage.
Phylum Ciliophora	Members are ciliated. They have an outer pellicle with ciliary basal granules and trichocysts and they possess macronuclei (control somatic, nonreproductive functions) and micronuclei (control sexual reproduction).

Related topics Phylum Porifera (A2) Nonmuscular movement (C28)

Features

Type of organism

Today the Protozoa are usually separated from the Animalia and are placed in the Kingdom Protoctista (Protista), with some algae. However, protozoans possess numerous **animal-like features** and they are therefore included here.

Protozoans are **unicellular** (occasionally described as 'acellular') **eukaryotes**. A few algal protoctistans are multicellular, but the gametes, if they are present, are not produced in gonads, nor do the zygotes develop into embryos.

There are several protozoan phyla, and the classification of the group is rather controversial. Key features in the problematical classification of the protozoans include organelle ultrastructure, locomotory and reproductive strategies, and nucleic acid sequences. At least 60 000 species have been described; sizes range from 2–3 μm to 3 mm, and many protozoans are organizationally very complex, as befits organisms in which one cell performs every function of a living creature.

The ancestral protoctistans were probably amoeboid but lacked many eukaryotic organelles such as mitochondria, chloroplasts and flagella. These may have been acquired later by **differentiation** or by **endosymbiosis** of prokaryotic organisms. Evolution from differing points on a path leading to increased complexity could account for the range of protoctistan/protozoan forms.

Feeding
Most protoctistans are **heterotrophs** in which food is assimilated from a food vacuole.

Locomotion
Many protoctistans are motile, using pseudopodia, cilia or flagella. Many forms are sessile.

Osmoregulation
Osmoregulation in marine forms is usually by means of a contractile vacuole.

Reproduction
Reproduction is usually both asexual and sexual, although some species are known which do not exhibit sexual reproduction (e.g. some amoebas).

Phylum Sarcomastigophora

Sarcomastigophorans comprise approximately 48 000 species; one nucleus is present. Flagella or pseudopodia are used for feeding and/or locomotion.

Sub-phylum Mastigophora
Mastigophorans possess a **flagellum** (= whip) (*Fig. 1*) which beats in one or two planes, with a wave of motion passing from the base to the tip, or vice versa, and generating a reactive, propulsive force. Reproduction is typically by longitudinal binary fission; sexual reproduction is unknown in many species.

Phytoflagellates (which are also claimed by the plant biologists!) such as *Euglena* spp. often have spindle-shaped bodies covered by a **pellicle.** There is one long, principal flagellum and often a second, short flagellum borne at the anterior end. Chlorophyll in chloroplasts is usually present, and a nonliving cell wall is frequently found. *Paranema* has an anterior cell mouth (**cytostome**) and is a heterotroph similar in form to the autotrophic *Euglena*; *Phacus* (*Fig. 1*) lives in the guts of tadpoles. Other autotrophic phytoflagellates include the solitary *Chlamydomonas* and the colonial *Volvox*, and the **dinoflagellates** (which also include heterotrophic forms such as the photoluminescent *Noctiluca*).

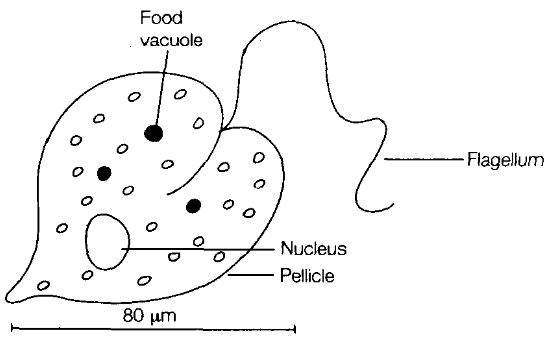

Fig. 1. Phacus, *a heterotrophic euglenoid phytoflagellate.*

Zoöflagellates lack chlorophyll and are heterotrophic. They include the free-living **choanoflagellates**, with a collar of microvilli around the flagellum base (e.g. the colonial *Codosiga*), and the parasitic **trypanosomatids**. The latter are common parasites of mammals, particularly in tropical countries. They live in the blood and other tissues. The intracellular stage of the life cycle lacks a flagellum, but the extracellular stage has a flagellum extending laterally along the body and anteriorly. The parasites are transmitted by blood-sucking insects. *Trypanosoma brucei* is a cause of African **sleeping sickness** and is transmitted by the tsetse fly. Zoöflagellate hindgut symbionts of termites [e.g. *Barbulanympha* sp. (*Fig. 2*), *Trichonympha* sp.] are among the most complex of protozoans: their cellulases digest wood eaten by their hosts, producing glucose which the termite can then assimilate.

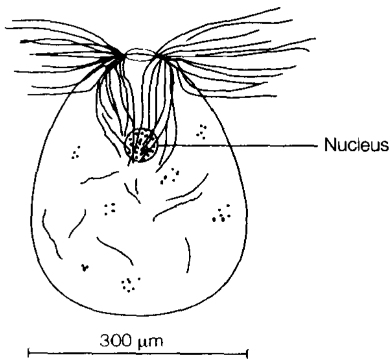

Fig. 2. Barbulanympha, *a zoöflagellate symbiont from termite guts.*

Sub-phylum Sarcodina

The sub-phylum Sarcodina includes **amoebas** and their relatives which possess **pseudopodia**. The pseudopodial condition may be ancestral or may reflect a secondary development from a flagellate stage.

Amoebas may be naked or may be enclosed within a shell which is either secreted or is composed of cemented accretions of minerals, for example *Difflugia* sp. The pseudopodia have a thick outer **ectoplasm** layer which bounds a fluid **endoplasm**. Shape changes reflect changes in the molecular composition of the pseudopodium tip. The pseudopodia surround food particles to form a **food vacuole**; in freshwater species osmoregulation is effected by a **contractile vacuole**.

Some amoebas are commensals or parasites, inhabiting the alimentary tracts of higher animals. *Entamoeba histolytica* (*Fig. 3*) invades human intestinal tissues and causes amoebic dysentry.

Foramenifera, Heliozoa and **Radiolaria** are sarcodine protozoans which possess shells or skeletal structures, often with very elaborate and sophisticated architectures. Long narrow pseudopodia, **axopodia**, are frequently present. The skeletons of these groups are important constituents of some sedimentary rocks.

Asexual reproduction is usually by binary fission. The shells or skeletons of sarcodine protozoans, where present, may be divided or may be given to one of the daughter progeny. Sexual reproduction entails the fusion of two similar

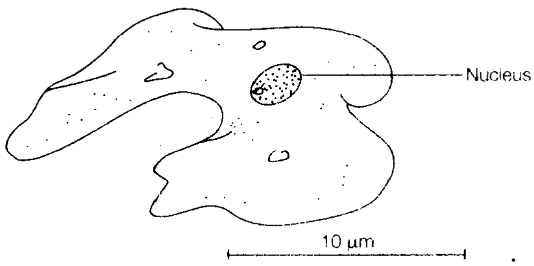

Fig. 3. Entamoeba, *an amoeboid sarcodine.*

gametes. In Foraminifera there may be an alternation of sexual and asexual reproduction stages.

Phylum Apicomplexa

The Apicomplexa is so named because its members have a complex of organelles at the apical end of the organism: these are associated with the protozoans' entry into the cells which they parasitize. Most members of the phylum belong to the taxon formerly known as the **Sporozoa**. Feeding is by **micropores**.

Reproduction usually includes asexual and sexual phases. The infective **sporozoite** invades the host and undergoes asexual fission to form **merozoites**. Merozoites can undergo further multiple fission (**schizogony**), eventually forming gametes which fuse to give a zygote. Meiosis in the zygote results in new sporozoites.

Plasmodium spp. are sporozoans. Four species which parasitize erythrocytes in humans cause malaria: anopheline mosquitos act as intermediate hosts.

Phylum Microspora

These intracellular parasites, common in Arthropoda, lack the apical complex present in sporozoans. There is a spore-like stage, characterized by a polar filament which everts when the spore enters the host. The filament provides a route for the amoeboid sporoplasm to leave the spore. Related phyla include the **Myxozoa** and the **Ascetospora**.

Phylum Ciliophora

The Ciliophora is a large, relatively homogeneous phylum (with about 7000 species); its members all possess **cilia** at some stage in their life histories. The cilia can be used for locomotion and/or feeding. It is speculated that their origins may lie in a group of multiflagellate, multinucleate mastigophorans.

The size of ciliates can extend to 3 mm in length. Most forms are free living in aquatic environments or in the water film microhabitats around soil particles. A few are symbionts (e.g. in the alimentary tracts of vertebrates).

Primitive species can be radially symmetrical (e.g. *Pronodon*), but most are asymmetrical with a distinguishable anterior end. An outer **pellicle** of dense cytoplasm containing the surface organelles maintains the ciliate's shape. Cilia arise from **kinetosomes** beneath the surface of the pellicle. The kinetosomes are connected in long rows by fibrils, the whole assemblage being termed a **kinety**. The surface (somatic) ciliature is primitively found in long rows covering the whole pellicle, but the rows may be reduced to bands, tufts or be absent altogether during some stages in the life cycle. **Trichocysts** in the pellicle can be discharged to transform into threads which can be used for anchorage or for the capture of prey.

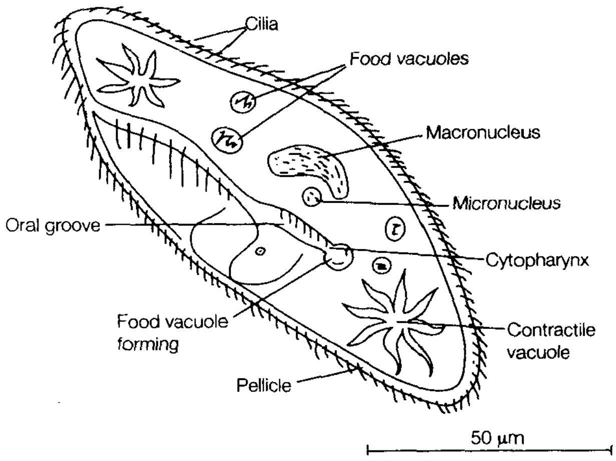

Fig. 4. Paramecium, *a ciliate.*

Locomotion is by synchronized, metachronal waves of ciliary beating down the length of the body, as in *Paramecium* spp. (*Fig. 4*). Some forms, such as *Stentor*, are sessile, the beating of the cilia setting up feeding currents in the water.

Feeding is via a mouth and a **cytopharynx**, leading to the fluid, interior cytoplasm where the food vacuoles are formed. Some ciliates capture their prey directly and can expand their mouths enormously; filter-feeders tend to have more complex buccal apparatus.

Osmoregulation is effected by **contractile vacuoles** at fixed positions within the body. The vacuoles have a ring of radiating tubules which drain water into a central vesicle which rapidly empties, on reaching a certain size, via a pore in the pellicle. Many ciliates can survive drought conditions by **encystment** in which the organism is enclosed in a tough waterproof cyst.

Ciliates have one or more large **macronuclei** which control the non-reproductive, somatic functions of the body. Macronuclei are polyploid and are the main source of ribonucleic acid (RNA). **Micronuclei** are diploid and are involved in reproduction. Ciliates reproduce asexually by transverse fission; the number of asexual divisions seems to be limited before a form of senescence occurs. Organelles may themselves divide, or be resorbed and then re-form.

Sexual reproduction is by **conjugation** involving an exchange and consequent reshuffling of genetic material. Conjugation is necessary to 'rejuvenate' individuals of a clone of asexually produced ciliates, otherwise the organisms are incapable of further asexual division. Conjugation can occur without reproduction, i.e. only the exchange of genetic material takes place. The macronucleus disappears. The micronucleus undergoes two meiotic divisions; all but one of the haploid micronuclei disappear. The remaining micronucleus divides by mitosis to form two 'gametes', one of which migrates to the other conjugating individual to fuse with its stationary micronucleus, thus forming a zygote. The conjugants separate. The zygote nucleus divides by mitosis, one of the products forming the macronucleus.

A2 PHYLUM PORIFERA

Classification: Kingdom Animalia, Sub-Kingdom Parazoa, Phylum Porifera

Key Notes

Features

Type of organism: irregular, asymmetrical organisms, with no head, gut or discrete organs; mostly marine but a few freshwater species.
Feeding: heterotrophic. Water flows through canals and chambers lined with collar cells in chambers, which generates water currents and traps food particles.
Locomotion: mostly sessile; a few free swimming.
Skeleton: skeletons of silica (SiO_2) or calcium carbonate ($CaCO_3$) spicules, may or may not contain spongin (protein) fibers.
Respiration: this is effected by simple diffusion.
Osmoregulation: this occurs by means of a contractile vacuole.
Reproduction: most are hermaphrodite but a few sponges have separate sexes; vegetative reproduction is also common. They produce flagellate, free-living larvae.

Classes

Calcarea (calcium carbonate spicules); Demospongiae [spongin (protein) skeleton; silica spicules often present]; Sclerospongiae (spongin fibers with calcium carbonate spicules and often silica spicules too); Hexactinellida (glass sponges with silica spicules).

Related topic

The Protozoa (A1)

Features

Type of organism

There are about 10 000 species of sponges, mostly marine, but about 150 species are freshwater. Sizes range from a few millimeters to over 1 m. Grades of sponge structure are recognized (*Fig. 1*), from simple vase-like **asconoid** sponges, through the folded **syconoid** condition to the **leuconoid** condition with elaborate, ramifying channels and chambers: here the surface area for feeding and substance exchange is vastly increased.

Sponges have an irregular, asymmetrical body architecture; there are **two cell layers** separated by a gelatinous **mesenchyme** containing **amoeboid cells** and **skeletal spicules** and **fibers.** There is a hollow interior cavity (**spongocoel**) connecting to the outside by numerous, small **incurrent pores** (**ostia**) and fewer large **excurrent pores** (**oscula**).

Feeding

The spongocoel is lined with flagellate **choanocytes** which move water through the ostia and along the incurrent canals. Food adheres to the collars of the choanocytes and is passed to the cell body, or is engulfed by amoeboid cells

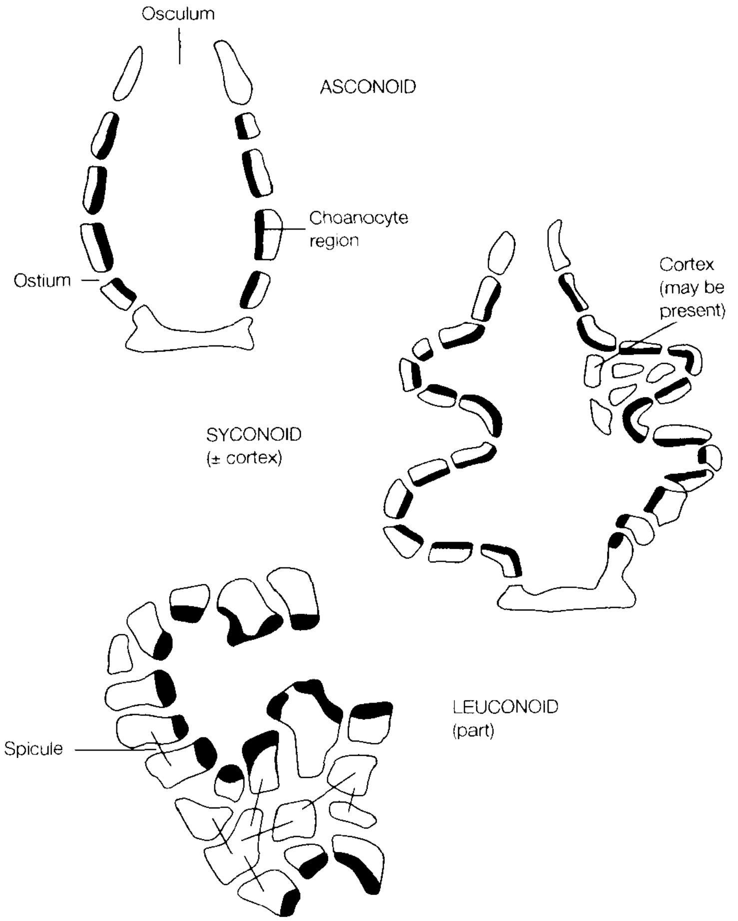

Fig. 1. Structure of a sponge.

lining the canals. Food products partly digested in the choanocytes may be passed to amoeboid cells, and soluble products diffuse through the sponge.

Locomotion
Almost all sponges are sessile, although a few are free swimming.

Skeleton
Sponges are supported by silica or calcium carbonate spicules, with or without spongin (protein) fibers.

Respiration
Gas exchange takes place through the membranes of the cells by simple diffusion.

Osmoregulation
Freshwater sponges osmoregulate using contractile vacuoles in each cell. Simple diffusion removes other waste substances.