Phylum: Echinodermata

means "prickly skin"
6225 living species; >20,000 fossil species

Characteristics of Phylum:

1. most with **pentamerous** (=pentaradial) **radial symmetry**
2. no distinct head or brain (no cephalization)
3. most have **endoskeleton** of calcium plates
4. unique **water vascular system** for feeding and movement
5. **dermal branchiae** for gas exchange
6. no real circulatory system
7. no excretory system
8. sense organs poorly developed
9. **pedicellariae** for protection

Classification

Class: Asteroidea
(starfish, sea stars, sea daisies),
1500 living species

Class: Ophiuroidea
(brittle stars, basket stars, serpent stars)
>2,000 living species;

Class: Echinoidea
(sea urchins, heart urchins, sand dollars & sea biscuits)
950 living species

Class: Holothuroidea
(Sea Cucumbers)
1150 living species

Class: Crinoidea
(sea lilies, feather stars)
625 living species

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Body Form

most evident feature: **radial symmetry**
no distinct head □**oral** vs **aboral** surface
radial symmetry is a secondary trait
larvae are bilateral then after
metamorphosis they become radial
in most its **pentamerous radial symmetry**

Body Wall

epidermis
outer surface covered by **epidermis**
made up of: epithelial cells
ciliated mucous cells
ciliated sensory cells
nerve plexus in basal part of epidermis

dermis
below epidermis is thick dermis
made of connective tissues
lots of collagen fibers
secretes skeletal pieces = **ossicles** = **endoskeleton**
ossicles are bony plates made of **calcium crystals**
each ossicle represents a single crystal of magnesium
rich calcite (6(Ca,Mg)C03) formed within cells of dermis
in many classes ossicles have bony projections for defense unlike
any other phylum, echinoderms can vary
rigidity of dermis pliability of collagen fibers is under nervous
control beneath dermis is layer of outer **circular** and inner
longitudinal muscle true **coelom** lined with **peritoneum**

Movement

movement & food gathering done predominantly by
water vascular system
a second, separate coelomic compartment unique to echinoderms
derived from coelom and lined with ciliated epithelium
the whole system operates hydraulically
filled with fluid (mainly sea water and some
proteins and cells internal canals connect ot the outside through the
madreporite
leads to **stone canal** (contains calcareous
deposits) joins **ring canal** just inside and around the mouth long
radial canals extend into each arm in arm, **lateral canals** branch
off radial canals have valves to prevent backflow

lead to small muscular sacs that serve as fluidreservoirs=
ampullae connected to muscular **tube feet**
tube feet are concentrated in **ambulacral**
groove the tip of the tube feet are flattened, forming **suckers**
suctionlike cups can produce strong force **tube feet** used to cling to substrates, move and to feed most echinoderms don't have large muscles
muscles mainly used to move **tube feet**

but some also attached to ossicles to allow them to bend and flex water vascular system also compensates for the absence of a blood circulatory system (In sea stars, water enters the system through a sieve-like structure on the upper surface of the animal, called the madreporite. This overlies a small sac, or ampulla connected to a duct termed the stone canal, which is, as its name implies, commonly lined with calcareous material. The stone canal runs to a circular ring canal, from which radial canals run outwards along the ambulacral grooves. Each arm of a sea star has one such groove on its underside, while, in sea urchins, they run along the outside of the body.

Each side of the radial canals gives rise to a row of bulb-like ampullae, which are connected via lateral canals. In sea stars these are always staggered, so that an ampulla on the left follows one on the right, and so on down the length of the radial canal. The ampullae are connected to suckerlike podia. The entire structure is called a tube foot. In most cases, the small lateral canals connecting the ampullae to the radial canal are of equal length, so that the tube feet are arranged in two rows, one along each side of the groove. In some species, however, there are alternately long and short lateral canals, giving the appearance of two rows on each side of the groove, for four in total.

Contraction of the ampullae causes the podia to stretch as water is brought into them. This whole process allows for movement, and is quite powerful but extremely slow.

The central ring canal, in addition to connecting the radial canals to each other and to the stone canal, also has a number of other specialised structures on the inner surface. In between each radial canal, in many sea star species, there lies a muscular sac called a polian vesicle. The radial canal also has four or five pairs of complex pouches, called Tiedemann's bodies. These apparently produce coelomocytes, amoeboid cells somewhat similar to the blood cells of vertebrates.

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Although the contents of the water vascular system are essentially sea water, apart from coelomocytes, the fluid also contains some protein and high levels of potassium salt

Feeding & Digestion

echinoderms are particle feeders, scavengers or predatorsno parasitic species
simple, usually complete digestive tract
but functional anus is often reduced
stomach has 2 chambers: **cardiac** & **pyloric**
digestive enzymes are secreted into stomach by**pyloric caecae**

Respiration

tiny saclike projections extend through epidermis= **dermal branchae** (or papulae)
☐☐exchange respiratory gasses
☐☐get rid of ammonia (N-wastes)
the same functions are also shared by **tube feet** in most groups

Circulation

echinoderms rely mainly on **coelomic circulation** for transport of gasses and nutrients
ciliated lining circulates fluids around body cavity and into dermal branchiae
coelomic fluid contains amoeboid cells
they do have a blood vascular system (= **hemal system**)with heart but its usually rudimentary is rudimentary
and its function unclear
☐☐may play some role in distributing nutrients

Nervous System

no brain or centralized processing area
circumoral ring and **radial nerves** branching from it helps coordinate movement of arms and movement of the starfish in general
tube feet are innervated by nervous sysem
☐☐enables all feet to move in single direction
if circumoral ring is cut, podia in all arms become uncoordinated; no movement is possible
few specialized sense organs
have some simple **tactile**, **chemical** and **photoreceptors** and **statocysts**

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Protection

in many starfish the body surface bears small jaw-like **pedicellariae**
some are stalked, some sessile (unstalked)
□□protect against animals and debris that settle on the animals surface . pedicellariae contain from three calcareous pieces (one piece called basilar and two pieces called valves or jaws and they joins with by adductor muscles and abductor muscles they open and close them) , and there are two type of pedicellariae :

1-Forceps or Straight type .
2-Scissors or crossed type .

Excretion

removal of nitrogen wastes (mainly ammonia) is through the **body surface, dermal branchiae** and **tube feet**
some amoebold cells can also engulf nitrogen wastes and move them to the outside through the dermal branchiae or tube feet

Reproduction & Development

sexes typically separate □□dioecious
external fertilization
produce characteristic ciliated, free-swimming, planktonic larva = **bipinnaria**
bilateral symmetry undergoes metamorphosis to become radially symmetrical adult early developmental stages are similar in all classes
some can also reproduce **asexually** by **fragmentation**
many also have excellent powers of **regeneration**
□□can regenerate from 1/5th of oral disc & a single arm but may require up to a year
some deliberately cast of an arm as a means of asexual reproduction
don't seem to age □□can liver forever?

Ecology

a wide variety of other animals make their homes in or on echinoderms, including:
algae, protozoa, ctenophores, turbellaria, barnacles, copepods, decapods, snails, clams, polychaetes, fish and other echinoderm

Class Asteroidea
(sea stars, starfish)

~1500 species free moving inhabit all seas except low salinity areas
bottom dwellers mostly found on hard rocky surfaces
many live in deep ocean also common along littoral zone in coastal waters where they may congregate in very large numbers
1 cm to 1 M diameter
eg. giant *Pycnopodia* has over 20 arms and is the size of a manhole cover
often brightly colored: red, orange, blue, purple, green etc best representatives of the basic features of the phylum
body composed of rays (arms) projecting from a central disc arms not sharply set off from central disc in some arms are very short
eg. *Culcita* □□a pentagon with no arms
mouth and 100's of tube feet underneath typically pentamerous symmetry most with 5 arms sunstar up to 40 arms some have up to 50 arms

Oral Surface

mouth in center of oral surface
wide furrows project from mouth into each arm = **ambulacral grooves**
each groove contains 2-4 rows of **podia** (=**tube feet**) margins of each groove are guarded by moveable **spines**
tip of each arm has 1 or more tentacle-like sensory tube feet and a red pigment spot (=eye spot)

Aboral Surface

inconspicuous **anus** in center of disc large sievelike **madreporite**
toward one side aboral surface bears numerous **pedicellariae** keeps integument free of sponges, corals also used in feeding and defense

Movement

mainly by tube feet can adhere to any solid surface by the **suction** created and slowly creep along ~few cm/minute

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Feeding and Digestion

many sea stars are **scavengers** a few are **suspension feeders** feed on small plankton and organic debris mucous strands carry food to the mouth most asteroids are **carnivores** feed on molluscs, crustaceans, polychaetes and other echinoderms use **chemoreceoptors** to detect and locate prey some can locate buried prey and dig down to get them eg. some swallow prey whole and regurgitate undigested ossicles & spines, etc
eg. some attack larger seastars and begin eating the end of an arm and work their way up
eg. many are able to evert their stomachs through the mouth to engulf and eat prey
eg. some feed exclusively on bivalves
□□some, such as asterias, are notorious predators of oysters wraps itself around its prey exert steady pull on valves [force of 12.75 newtons (equivalent to human lifting 1000lbs wit 1 hand)] ~ a half hour the adductor muscles of bivalve fatigue and relax slightly only need 0.1mm gap to insert stomach and digest oyster takes 2.5 - 8 hrs to digest a bivalve

digestive system

Is arranged radially **mouth** at the center of the disc leads to short **esophagus**
opens to large **stomach** that fills most of the inside of the oral disc stomach divided into large **cardiac region** and small, aboral **pyloric region pyloric ceca** (digestive glands) , 2 per arm, drain into pyloric region
products of digestion in stomach are carried to pyloric caecae to complete digestion and absorption
short tubular **intestine** opens through the **anus** on aboral side

Respiration

dermal branchiae (papulae) extend through ossicles to surface of the skin these plus **tube feet** provide most of the gas exchange for sea stars in burrowing species, dermal branchiae are protected in channels below umbrella-like spines

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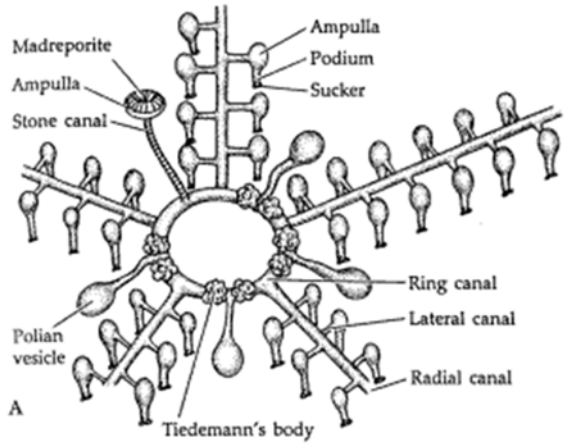
Reproduction & Development

Asexual reproduction

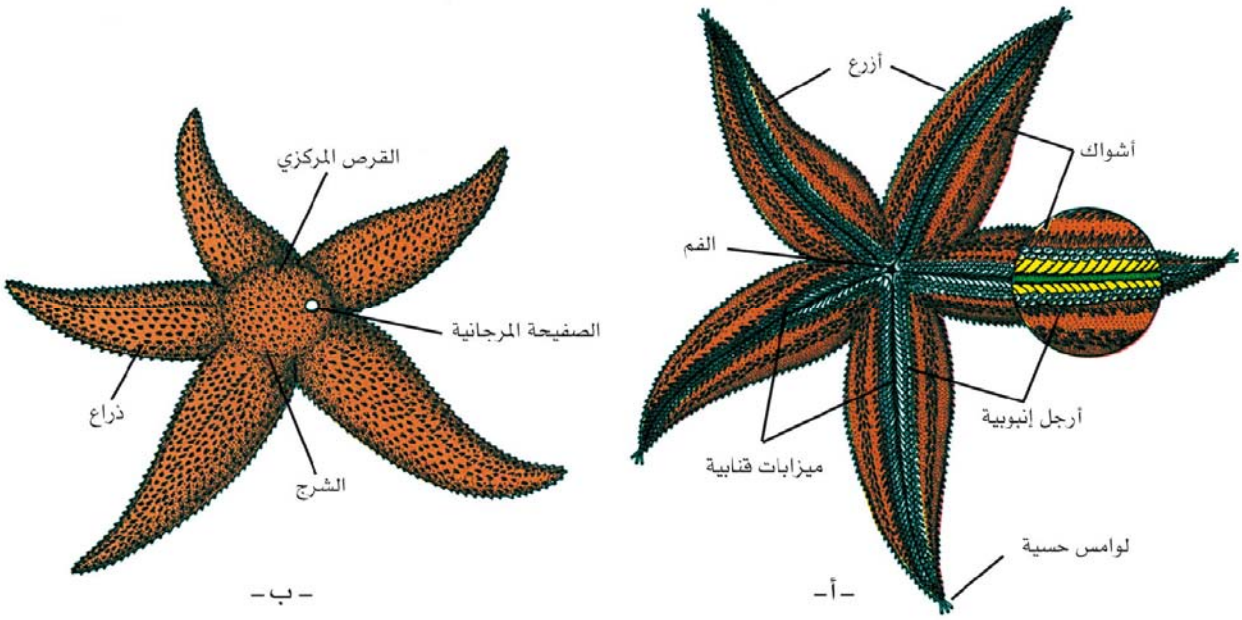
many starfish regularly reproduce asexually
□□central disc divides in half and animal breaks into two parts; each regrows missing part starfish can also **regenerate** from an arm or others an arm and a small piece of the central disc

Sexual Reproduction

most are dioecious gonads in small area at base of each arm when filled with eggs sor sperm they almost completely fill arm
some lay egg masses·others brood eggs
a few are **viviparous** but most produce free swimming larvae
gametes released through pores near base of each arm
1 breeding season per year
1 female may shed 2.5 M eggs
larvae are planktonic, free swimming **bipinnaria** larva
metamorphosis converts bilateral larva to radial juvenile



الجهاز الوعائي المائي لنجم البحر



الشكل الخارجي لنجوم البحر

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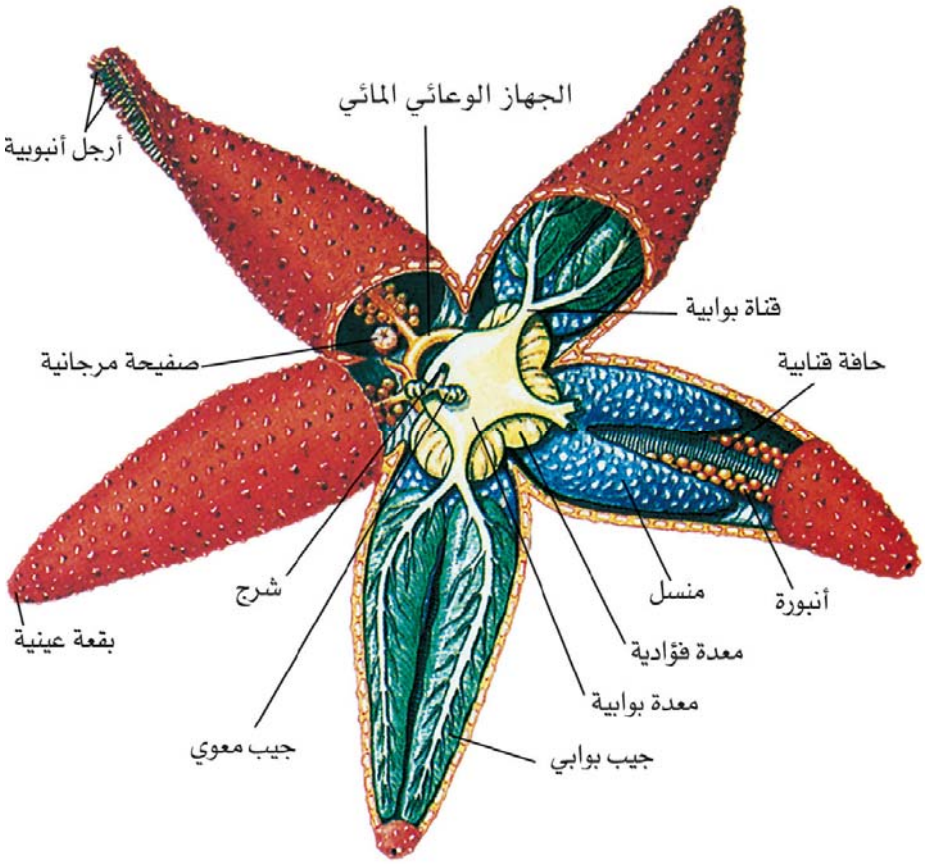

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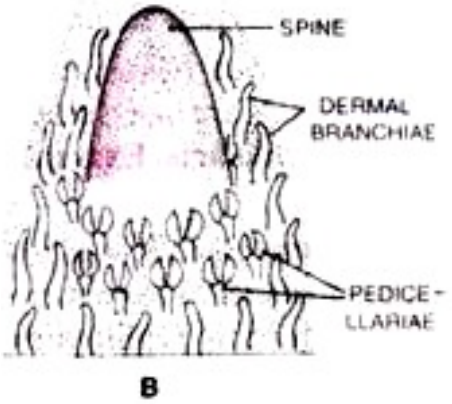
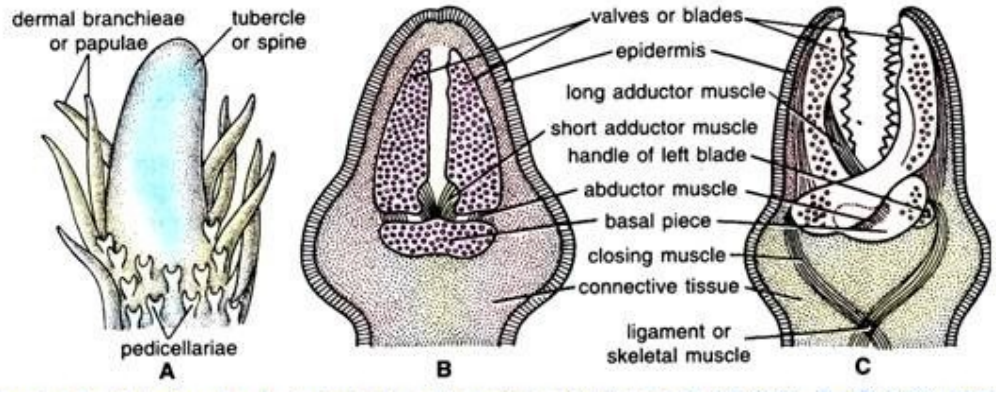


الشكل يوضح الاقدام الملقطية و الغلاصم الجلدية المحيطة بشوكة كبيرة ثابتة



الشكل يوضح الاقدام الملقطية (b) الطراز المستقيم (الملقطي)

(c) الطراز المقصي (المتصالب)