

**BSC 201/Study Guide 3** 10/08

**Exam 3** covers all material discussed in Chapters 20-24 (**plus any material from Study Guide 2 not covered in the previous exam**).

*STUDY RECOMMENDATIONS:*

- review your class notes; re-read each chapter ahead of time (focus on the introductory paragraphs and the Summary)
- take the online practice quizzes after we complete each chapter
- work on the Review Questions in the Study Guide after we complete each chapter

*STUDY GUIDE*

1. Be able to answer the following **Review Questions** from the text:

Ch. 20: 1, 3-7, 9-12, 14

Ch. 21: 1-3, 7-8, 10, 21

Ch. 22: 1-8, 10-12, 14, 18

Ch. 23: 1-10, 12-13

Ch. 24: 1-7, 11, 13-16, 18, 20, 22

2. Be able to define or identify the following terms:

**Topic X** (Crustacea)

abdomen	exuvium, -a	nauplius larva
antenna, -ae	gills	parasitic castration
antennal glands	head	photophores
antennules	hemocoel	rostrum
biramous	instar	sinus
carapace	mandible	statocyst
cephalothorax	maxilla, -ae	thorax
chela, -ae	maxillary gland	uropods
chelipeds	maxillules	vascular system
compound eye	metamorphosis	
ecdysis	molting cycle	

**Topic XI** (Hexopoda)

elytra	Malpighian tubules	trachea, -ae
halteres	pupa, -ae	uniramous
hemimetabolous	spiracle	wings
holometabolous		

**Topic XII** (Chaetognaths and Echinoderms)

*Chaetognatha*

fins	spines	teeth
hood		

*Echinoderms*

aboral side	disc	radial canal
ambulacral groove	hydropore	rays
ambulacral system	lateral canal	respiratory tree
ampulla, -ae	madreporite	ring canal

Aristotle's lantern	ossicles	spicules
arms	oral side	spines
autotomy	papula, -ae	stalk
bursa, -ae	pedicellaria, -ae	stone canal
calyx	pentamerous	sucker
cirrus, -i	petaloids	test
cloaca	pinnules	tube feet
dermal branchia, -ae	podium, -a	water vascular system

### Topic XIII (Chordates)

agnatha	gnathostomata	post-anal tail
amphioxus	incurrent siphon	sea squirt
atrium	larvacean house	spiracle
cranium	myomeres	tadpole larva
endoskeleton	neoteny	tetrapod
endostyle	notochord	thyroid gland
excurrent siphon	paedomorphosis	tubular nerve cord
fin rays	pharyngeal basket	tunic
gill bars	pharyngeal pouches	tunicin
gill slits	pisces	vertebra, -ae

### Topic XIV (Fishes)

ammocoete larva	diphycercal tail	oviparous
ampullae of Lorenzini	double circulation	ovoviviparous
anadromous	fin rays	pectoral fins
anal fin	ganoid scales	pelagic
bony fish	gas gland	pelvic fins
buccal funnel	gill bars	placoderm
cartilaginous fish	gill slits	placoid scales
catadromous	heterocercal tail	resorptive area
caudal fin	homocercal tail	rete mirabile
caudal peduncle	jawless fish	slime glands
claspers	lateral line system	spiracle
cloaca	leptocephalus, -i	spiral valve
ctenoid scales	lobe-finned fish	swim bladder
cycloid scales	operculum	viviparous
demersal	ostracoderm	

3. Know the diagnostic/key characters and the biology of the animals discussed in class.

NOTE: The following summary considers several attributes, including the key characters.

#### I. Metazoa—cont'd

##### Ib. Grade Bilateria – cont'd

##### Division Protostomia (“mouth first”) – cont'd

Ib.i Acoelomates – see Study Guide 1

Ib.ii Pseudocoelomates (“false cavity”) / Blastocoelomates (“sprout cavity”) – Study Guide 2

Ib.iii Eucoelomates – cont'd

- A. **Phylum Arthropoda** (“joint foot”), arthropods – on Study Guide 2 and cont’d
4. **Subphylum Crustacea** (“shell group”), crustaceans
- tagmata: – **head and trunk**
    - **head, thorax, abdomen**
    - **cephalothorax and abdomen**
  - head appendages: **2 prs. antennae, 1 pr. mandibles, 2 prs. maxillae**
  - **biramous appendages**, modified for specialized functions
  - **nauplius**, primitive larval type
    - a. **Class Branchiopoda** (“gill foot”), fairy shrimp & brine shrimp; tadpole shrimp; clam shrimp & water fleas
      - **thoracic appendages flattened**; function in respiration, locomotion, feeding
      - no abdominal appendages
      - primitive; important members of FW plankton; many in ephemeral ponds
    - b. **Class Maxillopoda** (“jaw foot”)
      - head (5 segments), thorax (6 segments), abdomen (4 segments)
      - [ no abdominal appendages ]
      - unique naupliar eye
        - 1). **Subclass Copepoda** (“oar foot”), copepods
          - naupliar eye retained in adults
          - 4-5 pairs swimming legs
          - free-living species dominate primary consumer level in aquatic communities
        - 2). **Subclass Cirripedia** (“curly-hair foot”), barnacles
          - EITHER **sessile** adults, covered by a carapace that secretes **calcareous plates** OR parasitic and highly modified
          - free living spp. have reduced head, thoracic **cirri**, rudimentary abdomen
    - c. **Class Malacostraca** (“soft shell”)
      - head (5 segments), thorax (8 segments), abdomen (6 segments)
        - 1). **Order Isopoda** (“equal feet”), pillbugs, rollie-pollies
          - lack carapace
          - sessile compound eyes
          - **dorsoventrally flattened**
          - **abdominal gills**
        - 2). **Order Amphipoda** (“feet on both sides”), beach fleas, scuds
          - lack carapace
          - sessile compound eyes
          - **laterally flattened**
          - **thoracic gills**
          - anterior and posterior limbs **modified for different functions**
        - 3). **Order Euphausiacea** (“shining bright”), krill
          - shrimp like, but **carapace does not cover gills**
          - most bioluminescent

- 4). **Order Decapoda** (“ten feet”), lobsters & crawfish, shrimps, crabs
- dorsal carapace
  - posterior 5 (of 8) pairs of thoracic limbs are often used for walking; of these, the 1<sup>st</sup> pair often chelate
5. **Subphylum Hexapoda** (“six feet”), entognaths and insects
- tagmata: **head** (5 segments), **thorax**, **abdomen**
  - head appendages: **1 pair antennae**, **1 pair mandibles**, **1-2 pairs maxillae**
  - **three pairs thoracic appendages**
  - all appendages **uniramous** (having one branch)
- a. **Class Insecta** (“cut or saw into; notched”), insects
- **tagmata** of head, thorax (3 segments), and abdomen (usually 11 segments)
  - thorax with **3 pairs walking legs**
  - thorax usually with **2 pairs wings**, sometimes 1 pair or none
- |            |                             |   |
|------------|-----------------------------|---|
| -1 pair:   | Diptera (flies)             | 2 <sup>nd</sup> pair modified as <b>halteres</b> (balance structures) |
|            | Coleoptera (beetles)        | 1 <sup>st</sup> pair modified as <b>elytra</b> (wing covers)          |
| -no wings: | primitive (1 <sup>o</sup> ) | silverfish  |
|            | advanced (2 <sup>o</sup> )  | fleas, lice   |

Ib. **Grade Bilateria** – cont’d

**Division Deuterostomia** (“mouth second”)

- blastopore does not become the mouth
- **radial cleavage**
- coelom formation in mesoderm by **enterocoely**
- regulative embryo; **indeterminant cell fate** (can produce twins)

B. **Phylum Chaetognatha** (“bristle jaw”), arrow worms

- elongate body of head, trunk, postanal tail
- head with **grasping teeth and spines** for prey capture; **hood**
- lateral and caudal **fins**, supported by rays
- transparent

C. **Phylum Echinodermata** (“hedgehog/prickly skin”), echinoderms

- unsegmented body, with **radial, pentamerous symmetry**
  - body has 5 or more radiating areas (**ambulacra**) alternating with interambulacral areas
- **endoskeleton** of **dermal calcareous ossicles** w/ **spines** OR calcareous **spicules** in dermis
- some with **pedicellariae**, specialized structures to prevent settling of fouling organisms
- unique **water-vascular system (ambulacral system)** of coelomic origin extending from body surface as radiating series of **podia (tube feet)**; usually with an opening to exterior (**madreporite** or **hydropore**)
- locomotion by podia, spines, or arms
- **no head or brain**
- nervous system with circumoral ring and radial nerves
  - sensory organs include chemoreceptors, photoreceptors, statocysts, tactile receptors
- respiration by diffusion using **dermal branchiae**, **tube feet**, **respiratory tree** (holothuroids), or **bursae** (ophiuroids)
- **autotomy** and regeneration of lost parts common
- **free-swimming, bilateral larval stages**; some with direct development

1. **Class Asteroidea** (“star form”), sea stars
  - star-shaped; central disc gradually merges with tapering arms/rays; most with 5 arms
  - anus and madreporite on aboral surface
  - ambulacral grooves open, with tube feet on oral side
  - tube feet often with suckers (on hard substrate); some lack suckers (soft substrate)
  - oral surface is directed toward the substrate; central mouth
  - pedicellariae present
  
2. **Concentricycloids** (“together having a central circle form”), sea daisies  
 [ derived members of a Family in Class Asteroidea ]
  - disclike body, with marginal spines but no arms
  - concentrically arranged ossicles
  - suckerless podia in a ring around body margin
    - tube feet **not** in ambulacra
  - unique ambulacral system
    - ambulacral system w/ 2 concentric rings
    - **hydropore** is analogous to madreporite
  - gut EITHER incomplete (no intestine or anus) w/ mouth directed toward substrate OR reduced/absent
  
3. **Class Ophiuroidea** (“snaketail form”), brittle stars and basket stars
  - star-shaped; slender arms sharply set off from central disc; arms branched or unbranched
  - ambulacral grooves closed, covered by ossicles; look jointed
  - tube feet w/o suckers; used for feeding, not used for locomotion
  - madreporite on oral surface, directed toward substrate
  - no anus (2° lost)
  - no pedicellariae or papulae
  
4. **Class Echinoidea** (“hedgehog form”), sea urchins, sea biscuits and sand dollars
  - body globular or disc shaped; no arms
  - armor-like internal **test** of fused ossicles
  - moveable spines, which aid locomotion
  - closed ambulacral grooves
  - madreporite aboral; mouth directed toward substrate
  - tube feet with suckers, used in respiration (irregular spp.) or feeding (regular spp.)
  - pedicellariae present
  
5. **Class Holothuroidea** (“sea cucumber form”), sea cucumbers
  - fleshy, bag-shaped body; no arms, no spines
  - elongate on oral/aboral axis; mouth at one end and anus at other; look bilaterally symmetrical
  - tiny ossicles embedded in thick muscular body wall; body wall soft or leathery
  - ambulacral grooves closed
  - tube feet with suckers; many with only 3 rows of functional tube feet, on one side
  - oral tentacles are modified, retractile tube feet around the mouth
  - internal madreporite
  - no pedicellariae

6. **Class Crinoidea** (“lily form”), sea lilies and feather stars

- body disc (**calyx**), five arms branch at base and bear lateral **pinnules**
- sessile spp. w/ **stalk**; most w/ **cirri**
- open, ciliated ambulacral grooves on oral surface
- tentaclelike tube feet for food gathering
- **U-shaped gut**
- mouth and anus directed upward, toward water column
- spines, madreporite, pedicellariae absent

D. **Phylum Chordata** (“cord”), chordates

- **notochord**, skeletal axis for muscle attachment, present at some stage in life cycle
- **single, dorsal, tubular nerve cord**; anterior end usually enlarged to form brain
- **pharyngeal pouches**, formed by inpocketing of ectoderm (pharyngeal groove) and outpocketing of endoderm (pharyngeal pouches)
  - in aquatic chordates, the pockets form **pharyngeal slits** which are 1° used as a filter-feeding device (protochordates); and 2° for respiration (internal gills evolved from remaining gill bars in fishes)
  - in tetrapod vertebrates, pharyngeal pouches give rise to different structures (1<sup>st</sup> pair of pouches, form jaw and inner ear; 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup> pairs, contribute to tonsils, parathyroid gland, thymus)
- **post-anal tail**, for locomotion in water (1°)
- **endostyle OR thyroid gland**  
endostyle, in floor of pharynx; secretes mucus to trap food particles (protochordates & lamprey larvae)  
thyroid gland, in neck of vertebrates; a derivative of endostyle; an endocrine gland

1. **Subphylum Urochordata** (“tail cord”), tunicates

- body covered by **tunic** (test) of cellulose-like polysaccharide (**tunicin**)
- **notochord restricted to tail**; occurs only in larvae
- pharynx usually with **numerous gill slits**
- most with **U-shaped gut**
  - a. **Class Ascidiacea** (“little bag”), sea squirts
    - planktonic “**tadpole larva**”; benthic, solitary/colonial, sessile adults
    - incurrent and excurrent siphons directed upward, toward water column
  - b. **Class Thaliacea** (“luxuriance”), salps
    - planktonic; solitary or colonial
    - transparent, gelatinous
    - circular muscles bands
    - incurrent and excurrent siphons at opposite ends, for feeding & locomotion
    - no larval stage; eggs are brooded
  - c. **Class Larvacea** (“ghost”) (=Appendicularia), larvaceans or appendicularians
    - planktonic; all solitary
    - **neotenous adults**
    - body enclosed in complex, transparent, gelatinous **house** that is involved in feeding

2. **Subphylum Cephalochordata** (“head cord”), lancelets or amphioxus

- “fish-like” chordates lacking vertebrae and cranium
- **notochord extends length of body, including head**
- have all chordate features as adults

3. **Subphylum Vertebrata** (“backboned”) [= **Craniata** (“brain case”) ]

**Superclass Myxiniomorphi**

Class Myxini

**Superclass Petromyzontomorphi**

Class Petromyzontida

**Superclass Gnathostomata** (“jaw mouths”)

Class Chondrichthyes

Class Actinopterygii

Class Sarcopterygii

Class Amphibia

Class Reptilia

Class Aves

Class Mammalia

**Subphylum Craniata**

- **endoskeleton** of cartilage, bone, or both
  - **cranium** (brain case); vertebrae; usually two pairs of limbs (pectoral, pelvic)
  - notochord typically replaced during embryonic development by vertebrae of cartilage, bone, or both
- **muscular, perforated pharynx**
  - in fishes, pharyngeal slits include gills and aortic arches
  - in tetrapods, pharyngeal pouches are reduced and are a source of embryonic glandular tissue
- body of **head, trunk, post-anal tail**; **neck** present in some, especially terrestrial forms
- body of **head, trunk, post-anal tail**; **neck** present in some, esp. terrestrial forms; usually two pairs of appendages (pectoral, pelvic)

a. **Superclass Myxiniomorphi**

1). **Class Myxini** (“slime”), hagfishes

- slender, eel-like body with **naked skin containing slime glands**
- **no paired appendages; no dorsal fin**
- **cartilaginous skeleton**; notochord persists
- has a partial cranium, but no vertebrae
- terminal biting mouth with two rows teeth, **no jaws**; 4 pairs of sensory tentacles surround mouth
- 5-16 pairs gill pouches; **gill openings variable in number and pore-like**
- eyes degenerate
- monoecious, but functionally dioecious; **no larval stage**

b. **Superclass Petromyzontomorphi**

1). **Class Petromyzontida** (“stone sucking”), lampreys

- slender, eel-like body with **naked skin**
- **1 or 2 median dorsal fins; no paired appendages**
- **cartilaginous skeleton**; notochord persists
- complete cranium, and rudimentary vertebrae
- **sucker-like buccal funnel** and tongue with well-developed teeth; **no jaws**
- 7 pairs gills, each with external opening
- well-developed eyes
- dioecious; **ammocoete larva**

c. **Superclass Gnathostomata** (“jaw mouth”), vertebrates with jaws

- have jaws
- two pairs appendages (pectoral, pelvic) for locomotion

1). **Class Chondrichthyes** (“cartilage fish”), sharks, skates and rays, chimeras

- **cartilaginous endoskeleton**; persistent, reduced notochord
- body fusiform (sharks) OR dorsoventrally flattened (skates and rays); usually **heterocercal caudal fin**; 1-2 dorsal median fins; paired pectoral & pelvic fins; ♂ pelvic fins modified as claspers; some w/ anal fin
- skin with **placoid scales** (naked in chimeras); teeth of modified placoid scales
- 5-7 pairs gills with exposed gill slits in sharks and rays; 4 pairs gills covered by operculum in chimeras
- ventral mouth; nostrils do not open into mouth cavity except in chimeras
- digestive tract with **J-shaped stomach** (absent in chimeras); intestine with **spiral valves**
- well-developed senses of smell, vibration reception (lateral line system) and electroreception; vision moderately developed
- high concentrations urea and trimethylamine oxide in blood

The Bony Fishes (formerly Class Osteichthyes, a paraphyletic group)

2). **Class Actinopterygii** (“ray fin”), ray-finned fishes

- **bony** skeleton (of endochondral origin)
- body primitively fusiform, variously modified; caudal fin **homocercal** (advanced) or heterocercal (ancestral)
- skin with mucous glands and with **embedded dermal scales**; some advanced spp. lack scales
- **median and paired fins** both supported by long dermal fin rays of cartilage or bone; limb musculature within body
- jaws present; teeth with enamel covering
- gills supported by bony gill arches and covered by **operculum**
- **swim bladder** often present and used for buoyancy

3). **Class Sarcopterygii** (“flesh fin”), lobe-finned fishes

- **bony** skeleton (of endochondral origin)
- fusiform body; caudal fin **diphycercal** (living spp.) or heterocercal (ancestral)
- skin with **embedded dermal scales**
- **median and paired fins**; paired fins with single basal skeletal element and short dermal rays; musculature within limb
- jaws present; teeth with enamel covering
- gills supported by bony gill arches and covered by **operculum**
- lunglike **swim bladder** used for respiration and/or buoyancy