Name _____

Bio 362
Marine Biology
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Exam 2 – KEY

Total points:

Multiple choice _____/40

Matching _____/10

Definitions _____/10

Short answer _____/20

Long answer _____/10

Subtotal _____/90

Curve _____

Bonus _____/4

Total _____/90

_____%

Part I - Multiple Choice: Answer ALL 20 questions.
Answer these questions on the scantron!
(2 pts each = 40 pts total)

1) Coral reefs that are ring shaped and are associated with subsiding seamounts in deep water, far away from land are called _____.

a) barrier reefs
b) fringing reefs
c) atolls
d) patch reefs

2) Coral bleaching may be caused by exposure to _____.

a) high temperatures
b) high pH
c) high light levels
d) a & c
e) a & b

3) Which of these is not a proposed hypothesis to explain adaptive bleaching in corals?

a) symbiont shuffling
b) selective mortality
c) temperature-dependent heterotrophy
d) physiological acclimation
e) all of the above are possible explanations

4) The taxonomic group containing hermatypic corals is

a) Scleractinia
b) Gorgonia
c) Octocorallia
d) Hydrozoa
e) none of the above

5) The type of corals typically found on the high-energy reef crest are:

a) heavy branching *Acropora*
b) plate corals (e.g. *Agaricia*)
c) finely branched *Acropora*
d) massive boulder corals
e) none of the above

6) *Littoraria irrorata* can decimate stands of *Spartina alterniflora* by

a) grazing on *Spartina* leaves in the absence of predators
b) attracting predators that damage *Spartina* when feeding on *Littoraria*
c) cultivating and feeding on fungi that infect *Spartina* tissues
d) disrupting sediments around *Spartina* roots, destabilizing the plants

7) The Neuse River – Pamlico sound estuary in North Carolina are enclosed by the Outer Banks, and are best described as a ____ estuary:

a) bar-built
b) delta front
c) drowned river
d) ria
e) negative

8) Which of the following is not an adaptation of a mangrove species to saltwater inundation?

a) lenticels
b) urea in tissues allows iso-osmolarity with seawater
c) prop roots
d) vivipary

9) American freshwater eels, *Anguilla rostrata*, spends most of its adult life in rivers and estuaries and migrates to the central Atlantic ocean to spawn. This life history is known as

a) catadromy
b) anadromy
c) antadromy
d) ontodromy

10) In the Cape Fear River estuary, salinity is typically constant with depth, but oxygen is often limited at the sediment surface. How would you classify this estuary?

a) positive
b) negative
c) partially mixed
d) well-mixed

11) What is the phenomenon that initiates nearly all gravity waves in the ocean?

a) capillarity
b) plate tectonics

c) wind
d) Coriolis force
e) upwelling

12) Elasmobranchs primarily use the following strategy for osmoregulation:

a) long loop of Henle in the kidneys
b) salt excretion using chloride cells
c) isoosmolarity using urea
d) salt sequestration using squalene

13) A coastline with a semidiurnal tidal regime would experience:

a) one high tide per day
b) two high tides per day
c) one high tide per day, except during spring tides
d) two high tides per day, except during neap tides

14) Which statement is true regarding larval development?

a) Planktotrophic nauplius larvae of the planktonic copepod *Acartia tonsa* are prominent in the meroplankton.
b) Lecithotrophic larvae generally spend the longest time in the water column.
c) Planktotrophic larvae are provisioned with greater energetic reserves by their parents than are lecithotrophic larvae.
d) Direct developing larvae spend little or no time in the water column.

15) What is the the Redox Potential Discontinuity Zone?

a) The boundary between oxygenated and anoxic sediments.
b) The lowest point that photosynthesis can occur in the sediments.
c) The level of groundwater in the soil at low tide.
d) The deepest point to which organisms can burrow in the sediment.
e) none of the above

16) Which of the following is a strategy commonly used by planktonic larvae to return to adult habitats in an estuary?

a) passive drifting
b) vertical migration to take advantage of differences in current flow with depth
c) active swimming upstream
d) active swimming towards surface waters

17) Which resource is typically most limiting on rocky intertidal shores?

a) Inorganic nutrients (e.g. nitrate)
b) Mates
c) Space
d) Light
e) None of the above

18) Two species of infaunal polychaetes (worms) occupy similar fine grained sediments and feed on detritus deposited on the sediments. Which statement is true concerning competition between these two species?

a) The dominant competitor is likely to live deeper in the sediments away from infaunal predators.
b) The weaker competitor is likely to live on the sediment surface due to direct interactions with the stronger competitor.
c) The weaker and stronger competitor are likely to occupy the same depth in the sediment
d) The weaker competitor is likely to live deeper in the sediments where it experiences adverse oxygen and chemical conditions.

19) Perhaps the most important difference in the food webs of intertidal mudflats and sandy beaches is:

a) the presence of burrowing infauna in beaches but not mudflats
b) the presence of suspension feeders on beaches but not mudflats
c) predation by crabs on mudflats but not on beaches
d) primary production by benthic diatoms on mudflats but not on beaches

20) What best explains why mangrove forests do not occur in North Carolina?

a) symbiotic cyanobacteria are not present
b) coastal waters are too saline
c) competitive exclusion by *Spartina*
d) freezing winter temperatures

Part II - Matching: Match the following groups with their identifying characteristics. (1 Pt each = 10 Pts Total). Each question has a single correct match, but not every letter will be used.

a) Isopoda
b) Littoraria
c) Spartina alterniflora
d) Juncus sp.
e) Salicornia sp.
f) Iva sp.
g) Hexacorallia
h) Octocorallia
i) Decapoda
j) Amphipoda
k) Gastropoda
l) Bivalvia
m) Cirripeda
n) Asteroidea
o) Red mangrove
p) Black mangrove
q) White mangrove

___i____ 1) Group including shrimp and crabs

___l____ 2) Primarily sessile suspension feeders that sort food using cilia and a palp

___o____ 3) Most salt-tolerant of the common neotropical mangrove trees

___k____ 4) Mollusc group that possess a feeding structure termed a radula

___j____ 5) Benthic crustaceans with some differentiated appendages, often laterally compressed in shape

___n____ 6) Larval stages include a bipinnaria

___d____ 7) A grass-like species that is restricted to the upper salt marsh

___e____ 8) Halophyte and fugitive species in intertidal mud flats

___a____ 9) Benthic crustaceans in which most appendages are similar in structure; often dorsoventrally compressed

___m____ 10) Important sessile invertebrates of the rocky intertidal and fouling communities; use their appendages for suspension feeding when immersed underwater

___c____ 11) Dominant salt marsh grass that is highly salt tolerant

___h____ 12) Group that includes sea fans and soft corals

___p___ 13) Moderately salt-tolerant neotropical mangrove that utlilizes pneumatophores

___m____ 14) Larval stages include nauplius and cypris

Part III - Definitions: Provide a complete definition in 1-2 sentences of ALL of the following terms. (2.5 pts each = 10 pts total). You may include a sketch if that helps you define the term

1) Retention time (in an estuary)

The time it takes a parcel of water to travel from the upstream (freshwater) end of the estuary to the mouth of the estuary.

Most common error was an answer that described the time spent by a parcel of water moving into the estuary on the high tide and then leaving on the next outgoing tide. Most estuaries don't fully flush in a single tidal cycle, and retention time is more about the transport of riverine material through the estuary.

The second most common error was defining this in terms of the time an organism (or larva) spent in the estuary. That is more about the organisms' life cycle than the hydrodynamics of the estuary.

2) Microbial stripping hypothesis

This hypothesis states that many deposit feeders are unable to efficiently assimilate particulate organic matter that they consume, so instead they derive most of their energy from consuming and assimilating the various microbes that are decomposing that organic matter.

3) Trait-mediated predator effect

This is the effect predators have on prey due to avoidance behaviors by the prey rather than due to actual consumption. For example, prey may cease feeding or move to safer habitats when they detect predators.

The 'trait' refers to the predator cue that the prey are responding to (e.g., odor). It does not refer to an anti-predator trait developed by the prey.

4) Protogyny

The form of sequential hermaphroditism in which fish begin life as females, then change sex when they become older, larger, and/or socially dominant.

Part IV - Short Answer: Answer ALL of the following questions. Please be as brief and concise as possible. (5 pts each = 20 pts total)

1) Coral reefs are exclusively found in nutrient-poor, oligotrophic waters. Why are reefs not found in more nutrient-rich coastal waters? How do corals and their zooxanthellae overcome the problem of nutrient limitation?

If the water had higher nutrient content, it would support phytoplankton and macroalgal growth which would shade the corals, killing them.

Corals overcome nutrient limitation in several ways: heterotrophic feeding,highly rugose surface that enhances absorption, nutrient recycling with their zooxanthellae, etc. However, nutrient recycling alone is not sufficient to explain this; after all the nutrients have to come from someplace if the colony is going to grow. Full credit required a solution that would actually result in net nutrient uptake.

At least one fully and correctly explain answer was required. Note that saying "zooxanthellae provide nutrients" is not correct or suffiicient – the zooxanthellae provide carbohydrates (photosynthate) but still require nitrogen and other inorganic nutrients. Many answers also suggested that nutrient rich coastal waters are very cold, and that would limit coral growth. I gave partial credit for this because it is pretty creative, but remember that it is possible to have high nutrients in warm waters, particularly near estuaries. Similarly, simply saying that nutrient-rich waters are 'turbid' or will shade out corals was not sufficient without explaining why: that type of water will support high densities of photosynthetic algae.

2) Contrast osmoregulation in freshwater vs. saltwater fish (bony fish, not sharks). What is the major osmoregulatory problem each type of fish faces, and what adaptations do they have to solve it?

Freshwater fish are hyperosmotic to the environment, so they need to conserve salt. Therefore they avoid drinking water, and use their kidneys to frequently excrete large volumes of dilute urine. They also use chloride cells in their gills to actively pump ions into their blood.

Saltwater bony fish are hypoosmotic, so they need to conserve water and excrete salt. They drink water constantly, and use their kidneys to (rarely) excrete small volumes of highly concentrated urine. They use chloride cells in their gills to actively pump ions into the environment.

Full credit requried mentioning both the water intake/urination pattern and ion pumping in both types of fish, plus accurately stating the osmoregulatory

problem. Just stating the problem but not providing any mechanisms was -3 points. Not stating the problem clearly was -2 points.

Many of you suggested that saltwater fish retain urea to become isoosmotic, but that is what sharks do, not bony fish. Also many of you confused urine (a general term for liquid excretory waste) with urea (a nitrogenous compound $CO(NH_2)_2$ that is a waste product in mammals but is stored in shark tissues).

Some of you also confused described an active transport process (saltwater fish pump ions out of their gills, against the concentration gradient) as a passive process (fish lose ions to the water). The fact that it is active transport and requires energy is important.

3) What is flocculation, and why does it tend to occur in estuaries? What consequences does it have for estuarine food webs?

Flocculation is the aggregation, clumping, and precipitation of dissolved or suspended particles in the water column. It frequently occurs in estuaries because when freshwater and saltwater meet, the pH and ionic concentrations of the freshwater change. Particles that had been suspended due to electrostatic interactions are neutralized and can clump together, and metal ions can precipitate.

The consequences for the food web are 1) increased turbidity limits primary productivity below the surface; 2) increased flux of organic matter to the benthos promotes sedimentation, inhibiting suspension feeders but favoring deposit-feeding detritivores.

4) Explain what critical tide levels are, and how they contribute to intertidal zonation. How will critical tide levels differ between coastlines that experience semidiurnal, mixed, and diurnal tides?

Critical tide levels are points in the intertidal at which small (cm) changes in tidal elevation lead to large changes in exposure/indundation time. This arises near the MHW and MLW points, where, for example, organisms separated by a few cm could go from experiencing no inundation (just above MHW) to experiencing two tides per day.

The number of critical tide levels will differ among tidal regimes. In semidiurnal and diurnal regimes, there will be essentially two critical tide levels, one at MHW and one at MLW (the difference being that the diurnal regime will have much longer immersions and exposures). In a semidiurnal tide there will be four critical levels, corresponding to MHHW, MHW, MLW, and MLLW, so there are more

opportunities for tidal inundation to produce unique and distinct patterns of inundation and exposure.

Many of you described critical tide levels as simply the extremes of the tidal range, but that is not quite complete as an answer. Others noted it was a place where small changes in elevation led to big changes in exposure, but did not explain that this was due to the location near MHW, MHHW, etc. Many responses didn't really explain what critical tide levels were, but did give a lengthy discourse on the differences in the various tidal regimes. All of these types of answers lost 2-3 points.

PART V Longer Answer – Answer ONLY ONE of the following two options. Answer all parts of the option you choose! (10 pts; be sure to indicate which question you are answering)

Option 1) Many fish species exhibit **diadromy** (catadromy and anadromy).

A) Explain what both catadromy and anadromy are, and give an example of a species that performs each.

Catadromous fish spend their adult life in freshwater, then migrate to sea to spawn; juveniles rear in the open ocean before returning to freshwater for adulthood (e.g., American eel). Anadramous fish do the opposite: ocean-dwelling adults return to freshwater to spawn; juveniles then migrate from freshwater to seawater (e.g., salmon).

Full credit required describing which life stage is in each habitat, simply stating "anadromy is migration from seawater to freshwater" was not sufficient (and not entirely accurate). Getting the definitions reversed was -2 points.

B) Explain the apparent adaptive advantages of these complex reproductive strategies.

Generally speaking the advantages are similar: juveniles are spawned in low-productivity environments with relatively few predators, but they move to riskier, higher-productivity environments when older and larger in order to maximize growth. Separating juvenile and adult habitats also reduces competition among those life stages.

C) Explain where in the world we are more likely to find catadromous species and anadromous species.

Generally speaking (again), anadromy is more common in places where the coastal ocean is much more productive than inland freshwater rivers, and catadromy is more common where freshwater systems are highly productive but the open ocean is relatively low-productivity. The former describes higher temperate and subpolar latitudes, and the latter describes tropical and subtropical latitudes. However, the first part of the explanation is necessary – just saying "high latitude" or "low latitude" does not explain the pattern.

Many of you said "estuaries" or "where rivers flow into the ocean" but, aside from being trivial answers, they are not really correct – these fish pass through estuaries, but spend most of their time either out in the open ocean or up in fully fresh rivers.

D) Name a physiological challenge a diadromous species faces when making its initial migration, and describe a specific adaptation it is likely to use to respond to that stressor. (Example: "evaporative cooling" is a specific adaptation to solve the physiological challenge of "overheating." "Regulating temperature" would not count as a *specific* adaptation).

The most obvious challenge is the change in osmoregulation during the transition from fresh to saltwater (or back). One example of an adaptation is the use of chloride cells to actively transport Cl^- (and thus Na^+) either in or out of the cell, depending on the transition.Chloride cells can be switched between these modalities (and new cells can be recruited from stem cells) using a hormonal signaling pathway that includes cortisol.

Full credit required describing a physiological problem (avoiding predators or finding a mate are not physiological problems) and an actual adaptation (just saying "they osmoregulate" is not describing an adaptation). Two common misconceptions were that these fish are osmoconformers (as we discussed, most fish osmoregulate; only invertebrates and sharks are osmoconformers, and usually only over particular salinity ranges) and that the change in appearance of male sockeye salmon is related to osmoregulation (it is due to sexual selection on males, as we discussed).

Option 2) Salt marshes and **rocky intertidal** communities both exhibit strong zonation.

A) Describe the patterns of zonation in these two communities. What are the major species (or types of space-occupying organisms) in each zone, moving from MLW to above MHW?

B) Compare and contrast the patterns of zonation in these two communities. What are the ecological or physical factors affecting species distributions at the upper and lower reaches of these habitats?

Zonation in the rocky intertidal is dominated by physical stresses (dessication) at the upper margin, and interspecific interactions (competition, predation) at the seaward edge. Thus the lower intertidal is very species-rich; dominant space competitors (e.g., macroalgae, mussels) exclude less-dominant competitors (e.g., barnacles) except where predators (e.g., sea stars) preferentially attack the dominants. Moving up the intertidal gradient, only species that can withstand dessication are able to survive, so species that were competitive subordinates in the lower intertidal (small barnacles) become dominant in the upper intertidal (where they are the only species remaining), and their upper range is limited by heat tolerance.

Zonation in the salt marsh is reversed in terms of important processes. In the extreme upper intertidal, certain terrestrial plants (e.g., Iva) are the strongest competitors and exclude marsh species (e.g., Juncus, Spartina). Moving lower in the intertidal, there is a tradeoff between competitive ability and salt tolerance, with better competitors giving way to more salt tolerant species (Juncus -> Spartina). The lower limit of the salt marsh is defined by tolerance of Spartina for inundation in saline water.

The most common mistakes here were A) not actually describing the zonation pattern as asked in the question, and B) describing only physical stressors causing zonation but not mentioning biotic factors such as competition and predation.

C) For **each** of the two habitats, describe one experiment we discussed in class (or in the text) that has been used to determine the type of process affecting zonation in the upper intertidal. By 'describe an experiment' I mean: explain the hypothesis, briefly describe the experimental design and how it relates to the hypothesis, and explain what results would support or reject the hypothesis, and what results were obtained.

There were lots of options here, mostly involving the use of cages and transplant experiments to determine if organisms from one zone could be outcompeted in a different zone, or whether they would succumb to physical stress.

For full credit the experiment had to be described in enough detail to understand what mechanism was being tested, and what results would lead to one to conclude. Simplying saying "transplant larvae on a settlement plate" was not a sufficient description of the experiment.

The most common mistakes here were A) describing an experiment that had nothing to do with zonation (e.g., testing for top-down effects on Littoraria) or B) describing an observational study that is not actually an experiment (e.g., "measure soil salinity at different locations").

PART VI: Bonus! (4 pts total)

___B____ 1) Which of the following is a common invasive crab on New England rocky shores?

a) *Callinectes sapidus* (blue crab)
b) *Carcinus maenas* (green crab)
c) *Callinectes similis* (dwarf crab)
d) *Cancer productus* (red rock crab)
e) All of the above

2) What is an amphidromic point?

This is a point in the ocean that does not experience any tidal fluctuations; the tides move around this point in a wave, with the amphidromic point acting as a stationary node.

3) What is thixotropy?

The property of non-Newtonian fluids that change viscosity when shear stress is applied.

4) What major genus of Caribbean coral recently changed names?

Montastrea → *Orbicella*

(actually only applies to some species in the genus; there are still some *Montastrea* species that kept their names).