

**I. Seawater Chemistry (About 20 points, 10 questions)**

Definition of salts and ions, why they are dominant dissolved solids in sea water (solubility)  
Average salinity of seawater, Big 6 most abundant salts in seawater  
Residence time & equilibrium for ions in seawater, relationship to solubility  
Major sources (3) & sinks (4) for salts in seawater  
Examples of ions with long & short residence times from among Big 6  
General distribution of O<sub>2</sub> & CO<sub>2</sub> with depth, Processes controlling N<sub>2</sub>, O<sub>2</sub> & CO<sub>2</sub> in surface & deep water  
Definition of pH and general values of acid, alkaline, & seawater  
2 key roles of CO<sub>2</sub> in seawater carbonate chemistry  
5 forms of carbon in seawater carbonate chemistry system (do not need to know exact formulas)  
Definition and significance of buffering  
Relationship of dissolved CO<sub>2</sub> to pH, response of pH to changes in dissolved CO<sub>2</sub>  
Effects of increased dissolved CO<sub>2</sub> on calcareous organisms  
Definition of conservative & nonconservative dissolved constituents of seawater, with examples  
Principle of Constant Proportions & its significance  
3 “macronutrients” for primary productivity

**II. Coral Reefs (About 20 points, 10 questions)**

Structural characteristics of Cnidaria & coral  
Growth patterns of corals to build reefs, Succession of fringing, barrier, atoll reefs  
Other corals on the reef, other reef-building organisms, Deep-sea corals  
Coral feeding mechanisms & prey, Coral symbiosis & its nutritional importance relative to feeding  
Environmental needs of coral: temperature, clarity, wave energy, herbivores  
5 benefits of coral reefs for humans; 2 benefits of coral reefs for fish  
Relationship between reef productivity & biodiversity  
Details of 7 categories of threats to coral reefs (Emphasis on bleaching & acidification)

**III. The Pelagic Environment & Organisms (About 20 points, 10 questions)**

Definitions & boundaries of pelagic subzones  
General formulas for photosynthesis & respiration, carbohydrates  
Identities of major categories of pelagic primary producers  
Growth properties of major categories of pelagic primary producers  
Strategies for phytoplankton to stay afloat near the surface  
Migratory strategies for mobile phytoplankton to obtain scarce nutrients  
Names for various trophic levels (secondary producers, primary consumers, etc.)  
Net vs. gross photosynthesis & productivity & explanation, Units of carbon for production & productivity  
Difference between productivity & various measures of standing stock, methods to measure biomass & productivity  
General comparison of marine & terrestrial production & biomass (per unit area & global) and explanations  
General relationship of photosynthesis to depth  
Trophic pyramid & general concept of trophic efficiency

**IV. Pelagic Primary Productivity (About 20 points, 10 questions)**

4 types of phytoplankton and size & growth characteristics of each  
General values & ranking of primary productivity (per unit area) in different pelagic environments  
Factors accounting for differences in light availability and nutrient supply of different pelagic environments  
Factors accounting for differences in primary productivity (per area) of 3 different pelagic environment examples  
Ranking of total global primary productivity of different pelagic environments & reasons

Reasons that surface nutrient supply can become limiting to primary productivity  
 Role of animal waste & decomposer regeneration in surface nutrient supply  
 Relationship between surface nutrient supply and upwelling, convection & vertical mixing  
 Seasonal pattern of primary productivity in temperate/subpolar ocean environment & processes that account for it  
 Dominant phytoplankton types in 3 different pelagic environments & processes that account for this dominance  
 Dominant phytoplankton types by season in temperate/subpolar ocean & processes that account for these shifts  
 Properties that make neritic zones productive

**V. Pelagic Food Chains (About 20 points, 10 questions)**

Ability to recognize & identify typical examples of phytoplankton & zooplankton from pictures  
 Ability to place typical examples of phytoplankton, zooplankton & nekton from pictures at the proper trophic level in the proper type of pelagic environment  
 Ranking of total global fish productivity of different pelagic environments  
 3 factors that determine fish production of trophic pyramid in different pelagic environments  
 Application of these 3 factors in 3 different pelagic environment examples  
 Number of trophic levels & factors that determine number of trophic levels in different pelagic environments  
 Values of efficiency & factors that determine efficiency of trophic pyramid in different pelagic environments  
 Estimate harvestable fish production at using trophic pyramid models in 3 different pelagic environment examples  
 Difference between food chain of Peru & other upwelling areas

**VI. Harmful algal Blooms (About 10 points, 5 questions)**

PSP, ASP: types of causative organisms (scientific name not necessary), names & effects of toxins, general area of occurrence, what is known about circumstances of blooms, effective & ineffective public health precautions  
 Net-pen salmon mortalities: types of causative organisms (scientific name not necessary), what is known about mechanisms, effects on salmon  
 Why “red tide” is a misnomer  
 Names & general features of NSP, brown tide, Pfiesteria, ciguatera  
 National & global increase in HABs & potential relationship to pollution

Acidity	Alkalinity	Ambush predators	Amphipods	Anchovy
Aphotic	Baleen whales	Bicarbonate	Biomass	Breeding bays
Calcium	Carbonate	Carbonic acid	Carnivore	Chaetognaths
Chloride	Chlorophyll	Chordates	Ciliates	Cnidoblasts
Cod	Compensation depth	Copepods	Crustaceans	Ctenophores
Cyanobacteria	Decomposers	Decomposers	Detritivore	Dinoflagellates
Disphotic	Dogfish	Domoic acid	Euphausiids	Euphotic
Filter feeders	Fixed nitrogen	Flying fish	Foraminifera	Gelatinous
Glucose	Hake	Herbivore	Herring	Invertebrates
Krill	Lanternfish	Larvaceans	Larvae	Lesions
Mackerel	Magnesium	Medusae	Microflagellates	Microzooplankton
Mixed layer	Mortality	Mutualism	Mysids	Nauplius
Nekton	Neritic	Neurotoxin	Nitrogen fixation	Notochord
Oceanic	Phosphorus	Photic	Photosynthesis	Plankton
Polarity	Pollock	Polyp	Population	Potassium
Predators	Protozoa	Pteropods	Pycnocline	Radiolaria
Respiration	Salmon	Salps	Sand lance	Sardine
Saxitoxin	Seals & sea lions	Silica/Silicon	Siphonophores	Sodium
Squid	Stability	Standing Stock	Stratification	Sulfate
Symbiosis	Thermocline	Tuna	Upwelling	Vertebrates
Zooxanthellae	Alternation of generations	Billfish (sailfish, swordfish, marlin)	Diatoms (centric/pennate)	Toothed whales, dolphins, porpoises