Chapter 3
Phytoplankton

Chapter Concepts Outline
Most primary production in the sea is accomplished by phytoplankton, unicellular, photosynthetic organisms. Hence, marine primary producers are fundamentally different from terrestrial producers.

3.1 PHYTOPLANKTON GROUPS
Most common phytoplankton, are from 3 divisions in two kingdoms,
- Monera
- Protista.

Cyanobacteria
- Cyanobacteria have been producing oxygen in the sea for more than three billion years. Today they are everywhere, from intertidal rocks and estuaries to coral reefs and the open sea. Species capable of nitrogen fixation commonly form symbiotic associations with a variety of marine organisms.

Chrysophyta
- Division Chrysophyta is represented in the sea by nanoplanktonic coccolithophores and silicoflagellates and diatoms that can be macroscopic. Diatoms, often the most important members of cold-water phytoplankton communities, occur in a large variety of shapes, sizes, and locations.

Dinophyta
- Dinophytes dominate warm-water phytoplankton communities and are unique in their abilities to create light via bioluminescence and powerful toxins that become deadly via the phenomenon of biological magnification.

Other Phytoplankton
- With improving technology, our understanding of and nano-, pico-, and ultraplanktonic species is increasing each year.
- These include additional classes of Chrysophyta and members of the division Chlorophyta

3.2 ADAPTATIONS FOR A PLANKTONIC EXISTENCE
Phytoplankton confront a persistent dilemma in that they must remain in the photic zone, yet nutrients occur in much greater concentrations near the seafloor. Most of their adaptations are responses to their need to linger near the surface while accumulating nutrients that are in extremely short supply.

Size
- An extremely small cell diameter provides most phytoplankton with a relatively high surface area-to-volume ratio. This attribute increases frictional resistance to sinking and
enables efficient uptake of very dilute nutrients.

Sinking
- Phytoplankton are slightly more dense than seawater and tend to sink.
- Phytoplankton exhibit many adaptations that slow their sinking rate.

Adjustments to Unfavorable Environmental Conditions
- Phytoplankton must adjust to limited sunlight in winter and nutrient supplies in summer.
- Some phytoplankton can move, switch to other energy sources, emit toxins, produce more chloroplasts or produce dormant stages.

3.3 PRIMARY PRODUCTION IN THE SEA
Measurement of Primary Production
- Estimation of gross and net primary production is necessary for understanding production potentials of and the quantity of organics available to marine communities. Such estimates have been made for nearly 100 years, starting with light-and-dark-bottle techniques and culminating with modern remote sensing via satellites.

Factors that Affect Primary Production
- Grazing. Small herbivorous grazers routinely occur at such high concentrations that phytoplankton communities may be destroyed over a period of just a few weeks.
- Light in water. Light is necessary for all photosynthetic organisms, yet it occurs at sufficient intensity only in the relatively shallow photic zone. Consequently, accessory photosynthetic pigments (such as fucoxanthin) are more important in marine producers than terrestrial plants.
- Nutrient distribution.
- Nutrient regeneration. Marine producers rely on a number of mechanisms of nutrient regeneration, such as turbulent mixing, convective mixing, and upwelling.