Plankton Races

SC Academic Standards: 3.L.5A; 4.L.5A; 4.L.5B; 5.L.4B; 6.L.4A; 6.L.4B; 6.L.5A; 7.L.3A; 7.EC.5A; 8.E.6B; H.B.2B; H.B.3; H.B.6

NGSS DCI: 3-LS4.B; 3-LS4.C; 4-LS1.A; 5-LS1.C; 5-LS2.A; 3-5-ETS1.A-C; MS-ETS1.A-C; MS-LS1.A; MS-LS1.C; MS-LS2.A; MS-LS4.B; HS-LS1.A; HS-LS2.A; HS-LS4.C; HS-ETS1.A-C

Science and Engineering Practices: S.1A.1; S.1A.2; S.1A.3; S.1A.6; S.1A.7; S.1A.8

Crosscutting Concepts: Patterns, Cause and Effect: Mechanism and Explanation; and Structure and Function.

Focus Question(s): What features of photosynthetic plankton allow them to remain in the photic zone (or to sink very slowly)? Why would phytoplankton want to remain in the photic zone?

Conceptual understanding: Structural adaptations within groups of plants and animals allow them to better survive and reproduce.

In all ecosystems, organisms and populations of organisms depend on their environmental interactions with other living things (biotic factors) and with physical (abiotic) factors (such as light, temperature, water, or soil quality). Disruptions to any component of an ecosystem can lead to shifts in its diversity and abundance of populations.

The Protist Kingdom is one of the most diverse groups and includes organisms that have characteristics similar to but are not classified as plants, animals, or fungi. These microorganisms live in moist environments and vary in how they obtain energy and move.

The Plant Kingdom consists of organisms that primarily make their own food (autotrophs) and are commonly classified based on internal structures that function in the transport of food and water. **Plants have structural and behavioral adaptations that increase the chances of reproduction and survival in changing environments.**

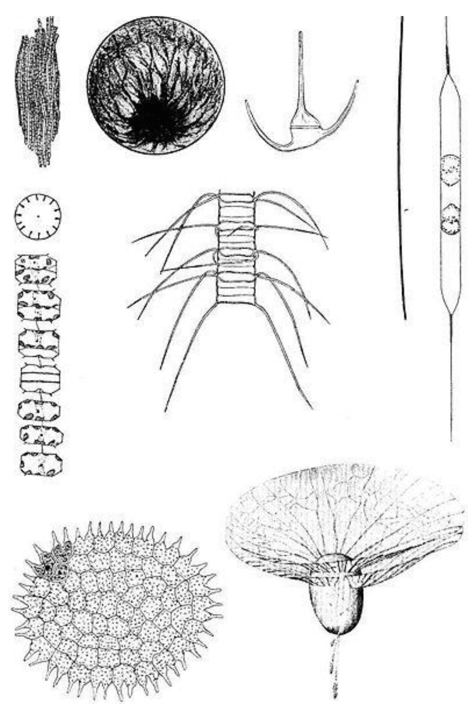
Adaptation by natural selection acting over generations is one important process by which species change in response to changes in environmental conditions. Biological evolution occurs primarily when natural selection acts on the genetic variation in a population and changes the distribution of traits in that population over multiple generations.

Inheritance is the key process causing similarities between parental organisms and their offspring. Organisms that reproduce sexually transfer genetic information (DNA) to their offspring. This transfer of genetic information through inheritance leads to greater similarity among individuals within a population than between populations.

Background: An estimated 90% of all photosynthesis and production of usable oxygen takes place in the oceans. Marine phytoplankton are the first link in the large marine food chain. Larger animals like fish and the blue whale then consume the zooplankton, which feeds on the phytoplankton. The food material from living and dying plankton may sink to the bottom and become food for organisms living on the bottom.

About 90% of the world's fisheries occur in rich coastal areas because of the high densities of plankton that grow in areas with many nutrients in the water. The high protein content of plankton is causing them to be considered as a potential food source for people. There is also discussion about using phytoplankton in space missions. The astronauts would give the plankton carbon dioxide and it would in turn give oxygen and a food source to the people.

The word plankton is from the Greek word for "wandering". They drift or wander the oceans at the mercy of the currents. They are generally unable to move against currents. This lack of mobility separates plankton from the nekton, which are organisms that can propel themselves through the water (such as fish). Some planktonic organisms can be quite large (like jellyfish); however, most are smaller than nekton, and small enough that they have to be viewed under a microscope. The plankton that photosynthesizes are called phytoplankton and are made up of organisms called algae. The plankton that eat other plankton are called zooplankton, and are made up of tiny animals and single-celled protozoans. Organisms that spend their whole lives drifting are called holoplankton; those spending only part of their lives as plankton are called meroplankton. Most meroplankton are the larvae of animals which spend their adult lives on the bottom or free swimming. (Note: not all plankton float – there are some benthic (bottom dwelling) plankton too).



Phytoplankton are a flora of freely floating, often minute organisms that drift with water currents. Like land vegetation, they produce much of our oxygen, are an important absorber of carbon dioxide (responsible for climate change), and convert minerals to a form that animals can use. Phytoplankton is the primary food source, directly or indirectly, of all sea organisms. Diatoms and dinoflagellates are among the most important members of the phytoplankton. Diatoms are housed in beautifully decorated glass skeletons shaped like petri dishes. Some diatom species form long chains, which help them float and avoid being eaten. Dinoflagellates share both animal and plant traits. Like plants, most photosynthesize, but some eat other organisms, and some switch back and forth between lifestyles. They can also swim using tiny whip-like flagella. Some dinoflagellates are bioluminescent and create light when disturbed by waves, boat wakes or predators. Other dinofalgellates produce toxins, which they release into the water. Large concentrations, or blooms, of these dinoflagellates are called "red tides" and can cause fish kills due to poisoning and oxygen depletion. During some months, mussels and other filter-feeding shellfish are unsafe to eat due to concentrated dinofalgellate toxins which cause Paralytic Shellfish Poisoning.

Most major animal groups have representatives in the zooplankton. Arthropods of the class Crustacea are the most numerous zooplankton. Some, like the copepods spend their entire lives as plankton (holoplankton). Some crustaceans, like crab larva, are temporary members of the plankton community, and settle to the bottom to live their adult lives. Shrimp-like krill are among the most well known plankton because they are the major food source for some of the great whales. Other common zooplankton groups include the adults and larvae of the phyla Cnidaria (jellyfish), Mollusca (snails, clams, etc.), Chaetognatha (arrow worms), Ctenophora (comb jellies), and Chordata (e.g., fish larvae, sea squirts, salps). With nowhere to hide in the open sea, many plankton species are transparent, and nearly invisible. In addition, many have long spines to help repel predators and to help with flotation. Though they don't need sunlight and aren't photosynthetic, they tend to stay near the surface to feed. Often they will be at the surface at night, to feed while darkness hides them from their predators, then they sink (often over 1,000 feet) to hide in the murky low-light levels of the deep during the day (this is called "vertical migration", and may allow zooplankton to continually enter "Fresh" areas so they don't deplete phytoplankton in one spot, and it may allow zooplankton to conserve energy in the darker, cooler, depths (like ectotherms)).

Plankton generally try to *avoid* sinking, yet they don't necessarily want to float either (easy prey for birds, plankton feders). Phytoplankton need sunlight for photosynthesis, so they must stay within the photic zone, usually the top 100 meters. Zooplankton depend on phytoplankton and other zooplankton for food, so they must avoid sinking as well (at least when feeding). Plankton avoid sinking by increasing their surface area and/or decreasing their density. Most plankton are quite small and so have a larger surface area to volume ratio than do larger organisms. Flattened bodies and appendages, spines, and other body projections also slow sinking by adding surface area without increasing density. Some diatoms resist sinking by forming chains. The use of low-density substances like oil or fat helps increase buoyancy and can serve as food reserves. In addition, water currents caused by convection and upwelling can stir the water and help keep plankton from sinking. Viscosity enters the picture as well: small animals experience too much friction relative to their muscle strength to go fast. To them, water feels like molasses would to a human swimmer (imagine a swimming pool full of molasses!). Although small organisms cannot swim very fast, neither can they sink very fast. Spines, flattened bodies, etc., have so much surface area for viscosity to work on, that such organisms hardly sink at all.

There are many wonderful shapes, colors, and sizes of marine phytoplankton and zooplankton. The biodiversity of plankton is quite high, but there is a strong connection between structure and function. Phytoplankton must remain in the photic (sunlit) zone in order to photosynthesize, grow, and reproduce, so if they sink too fast they will die. Many of the building blocks of phytoplankton are more dense than seawater (proteins, the nucleus, chloroplasts). In this activity, dense reproductive body parts are represented by metal washers. To keep plankton afloat, phytoplankton have developed elaborate systems to slow sinking rates or make the overall plankton of a similar density to seawater. However, if the plankton is too buoyant, it will rise to the surface of the ocean and become easy prey to birds or other surface feeders.

In this lab, learners are challenged to **design** a planktonic organism that will neither float like a cork nor sink like a stone. They are given pictures of planktonic organisms and simple materials. The best model of a planktonic organism will sink slowly or be neutrally buoyant. After designing with their teammates, learners test and race their plankton in a simulated ocean. The winner of the race is the plankton that *sinks* (it can't float) at the *slowest* rate.

Materials:
Stopwatch, Washers, or fishing split-shots, (to represent "heavy" cell / reproductive parts), and either 10x10 inch squares of tin foil or water proof modeling clay (not play-doh, pre-weighed to the same size, each about the size of a large marble).

You will also need several large containers of water (5 gallon bottled water containers with top cut off work well, as does a large aquarium, or large plastic snack containers. Ahead of time designate the "Photic Zone" on your racing container - mark a line on a 24 inch (60 cm) tall container down 10 inches (25 cm) to indicate photic zone cut-off). You may also want small plastic containers, like mayo jars, for practice. Or, for an **alternate** procedure, use 250 ml graduated cylinders with the modeling clay and corn syrup (instead of water).

Previous Knowledge: (math): Surface Area : Volume relationships- A small organism, like an amoeba, has a large surface area:volume ratio, and so it can accomplish all the exchange of materials (like oxygen) it needs by simple diffusion across its body surface. However, a large organism, like a mammal, has a much smaller surface area: volume ratio, so it cannot accomplish all the exchange it needs in this way (a large surface area:volume ratio is preferable for carrying out exchange of substances). Such large organisms need special respiratory organs such as lungs for taking in oxygen and removing carbon dioxide.

$$\text{Surface Area of a Cylinder} = 2\textit{pi}\ r^2 + 2\textit{pi}\ r\ h$$

$$\text{Surface Area of a Sphere} = 4\ \textit{pi}\ r^2$$

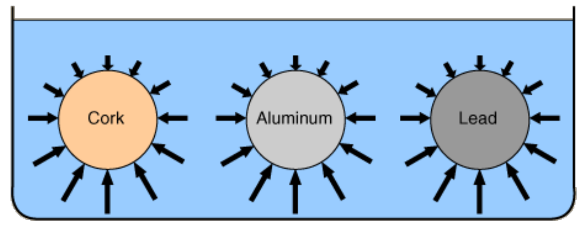
The requirements for materials depends on the volume of the organism, so the ability to meet the requirements depends on the surface area : volume ratio. As organisms get bigger their volume and surface area both get bigger, but volume increases much more than surface area. Think of it this way: a bacterium, with a length of 1 mm and a surface area (SA) of $6 \times 10^{-12}m^2$ has a volume (V) of $10^{-18}m^3$ will have a SA:V ratio of 6,000,000. A fly, with a length of 10 mm and a surface area of $6 \times 10^{-4}m^2$ has a volume of $10^{-6}m^3$ and a SA:V ratio of 600. But a dog, with a length of 1 m and a SA of 6 m^2 has a volume of $1m^3$ and a SA:V ratio of 6.

Previous knowledge: (physics): Reynold's number (R_e). Objects exist under very different conditions in the same seawater, depending on their size and velocity. If you are very small, you are living in a **viscous** medium, and the moment you stop working to move you will stop. If you are large and can generate a fairly high velocity you can propel yourself and you will have inertia and you will "coast" Some organisms can live under both conditions. For example a copepod feeding moves very slowly and lives at very low R_e, but a copepod swimming to escape from a predator generates thrust with its swimming appendages and operates under higher R_e, and has inertia.

$R_e > 1000$: inertial forces predominate (coast to stop)
$R_e < 1$: viscous forces predominate (sudden stop)

(* note: as this is not a biomechanics exercise, we are ignoring Reynold's number issues. However – with older students I do like to use corn syrup instead of water in a 250 ml graduated cylinder to show that to a planktonic organism, water is very viscous).

Previous Knowledge: (physics): Buoyancy. Buoyancy arises from the fact that fluid pressure increases with depth and from the fact that the increased pressure is exerted in all directions (Pascal's principle) so that there is an unbalanced upward force on the bottom of a submerged object. As an object is submerged in water, it moves, or **displaces**, water according to how much it weighs. Archimedes found that the water will push upward against the object with a force equal to the weight of water that is displaced (Archimedes' Principle)



How much water is displaced is determined by the **density** of the object. Density is the measure of how much mass is in an object, related to its volume. A bowling ball and a beach ball may have the same volume, but the bowling ball weighs much more, and is much denser, than the beach ball. Meanwhile, a block of solid steel and a steel ship may both be heavy, but the steel ship has a greater volume of steel (in addition to weightless air). It displaces enough water to match its own mass, so it floats. When that solid, heavy bowling ball is dropped in water, the water pushes up on it with a force equal to the weight of water it displaced. The ball weighs more than the amount of water it displaced and will sink. The beach ball, meanwhile, displaces very little water, and the air inside is much lighter than the weight of the water that was displaced. The **buoyant force** from below keeps the beach ball afloat. If you were to try to push the beach ball down into the water, the push back that you would feel is the buoyant force of the water at work. Objects that displace an amount of liquid equal to their weight will float because they receive that upward push from the water. Buoyancy is the upward force we need from the water to stay afloat, and it's measured by weight. Buoyant forces are why we feel so much lighter when we're in a swimming pool or bathtub. Our bodies are mostly water, so a person's density is fairly close to that of water. Because of this, an average person needs only about seven to 12 pounds of additional buoyancy to float.

Procedure:

1. Discuss / Review the benefits and hazards to phytoplankton of staying near the sunlit water surface.

2. Look at some photos of phytoplankton and watch a plankton video (from Monterey Bay Aquarium, http://youtu.be/d8pVPEC_aoM or NASA earth week video https://www.youtube.com/watch?v=H7sACT0Dx0Q). Brainstorm some adaptations used by phytoplankton to keep them near the water's surface.

3. Explain to the students that they are to use the materials provided to create a plankter that hangs just below the water's surface and sinks *slowly* to the bottom. Have the students decide on an amount of time the plankter is allowed to float at the surface before beginning to sink.

4. **The only rules**: The plankter must fit into a Styrofoam cup (or the mouth of the graduated cylinder if you are using this as your container), and the plankter must contain at least 3 “heavy” reproductive parts (washers or split shots if you use tin foil – or the plankter must use the entire ball of pre-sized waterproof clay (which itself is heavy enough)). And- if two foil plankters sink at the same rate, the one with the most heavy parts wins.

5. <u>**Procedure 1:**</u> Give students 3-4 10x10 square inch tin foil sheets plus 12 “heavy” elements (small washers, or split-shots from the fishing aisle). Have students work in teams to construct a phytoplankton that will sink as slowly as possible (allowing the pre-determined time interval – step 3).

    6. In groups, **Test** the phytoplankton in small clear plastic containers, and record the sinking time. You do <u>not</u> need to use the entire foil square.

    7. **Revise** the design as needed. When you have a good design, test it three times and enter your data as trial #1-3 on your data sheet.

    8. **Race!** Each group comes up to the front of the class and tries their design in a large tank. Time the plankton from the second it touches the water until the entire plankter is below the photic zone line. Any plankter that floats longer than the pre-determined “allowable” time is disqualified.

Hints: For younger students, I find that a tall plastic container (see-through) works well – like the containers “pub mix” comes in, or a tall jar for holding pasta. Fill with water and, for a 24 inch tall container draw a line 10 inches down from top – below the line is the aphotic zone, above is photic. For different sized containers adjust depth accordingly. Remember, if you need to take the plankter out, when you put your hand into the container, water will be displaced (I like to do this on a cookie sheet or cake pan to catch spillage).

9. <u>**Procedure 2:**</u> alternatively, use just water proof modeling clay pre-weighed to the same size (not play-doh!)). Each student needs 12 marble - sized lumps of clay.

    10. Use a 250 or 500 ml graduated cylinder filled to the 200 ml mark with either water or corn syrup (which more accurately depicts how viscous water is to a small planktonic organism)).

    11. First, turn 3 pieces of clay into spheres, and test the rate of sinking when dropped into the graduated cylinder. Drop one clay sphere into the syrup or water. Start the timer when the plankter passes the 180 ml mark, and stop timing when it passes the 80 ml mark.

12. Repeat with 3 different Plankton body shapes (3 copies of each), with the intent of finding the body design that will sink the slowest.

13. Record the time it too to sink 100 ml. Calculate rates as distance / time.

Hints: one, the corn syrup can be re-used. Pour it back into your container and save it. Two, as you drop the plankton into the graduated cylinder, the water / syrup level rises. BUT, if you keep starting your time at the 180 ml mark, and ending at the 80 ml mark, the increase doesn't matter –so you don't have to constantly pour out sticky syrup and re-fill. You have 3 plankton all of the same design, then 3 of a second design, you don't remove plankters in between.

Remember, the corn syrup mimics the environment a plankton feels with the low Reynold's number and viscous forces dominating. For very small organisms, the surrounding water molecules are proportionately very *large* and make movement through the water more difficult. **For small plankton, swimming through water is the equivalent of a human swimming in a sea of molasses.**

14. For either procedure, discuss adaptations and their results.

- What changes helped to slow down the rate of sinking?
- How is your plankter different than a faster plankter?
- What improvements can you make to your plankter
- Can you compare your plankter to a real phytoplankton? Which one?
- Can you see a correlation between surface area and sinking rate?
-

Procedure 1

Group Name	**Trial 1 (sec)**	**Trial 2 (sec)**	**Trial 3 (sec)**	**Avg. Time (sec)**	**Distance (cm)**	**Rate = Distance/Time (cm/sec)**

Table 1. Time (sec) it takes for plankton to sink to below photic zone. The winning plankton is the one that sinks at the *slowest* rate.

Average Time (sec) it would take to reach bottom of photic zone = _________ sec. (if photic zone ended at 100 m)

Procedure 2:

Trial	Shape				Rate = distance / avg time (ml/sec)
	1: sphere	2:	3:	4:	
1					
2					
3					
AVG					

Table 2. Time (sec) it takes for plankton to sink 100 ml. The winning plankton is the one that sinks at the *slowest* rate.

Data Analysis: After averaging your trials together, calculate rate of sinking by dividing the distance (down to the photic zone, with procedure 1, and down 100 ml for procedure 2) by average time (average of the 3 trials - time it takes for plankter to be completely below photic zone line). If you also calculate surface area, the plankter with the largest surface area *should* sink the slowest. Increasing surface area is an adaptation to help float. So, if you calculate surface area, put time in photic zone (sec) on the Y axis (here, time is the dependent variable!) and put surface area (mm) on the X axis.

To graphically display your data, graph sinking rates as a frequency histogram. Find your range of rates – divide into 4-5 "bands" – and see how many teams had a rate within each band.

To calculate how long it would take for your plankter to go beyond the photic zone, do this: Sinking time to 25 cm x 4 = sinking time per meter.
Sinking time per meter x 100 = time to go below photic zone (100m).

Extensions: You can have the students measure the length, width and height of their plankter to determine surface area (you may need to add the different surface faces together, including spines, flagella, etc). Now, compare surface area to rate of sinking. Or, redo the race after adding 2 cups of aquarium salt to the race water (remember, you are more buoyant in salt water, because salt water has a higher density!). Last, you could try adding several drops of liquid soap to the water – soap is a surfactant, and will help reduce surface tension.

Reflection Questions:

- **Why would a phytoplankton want to stay in the photic zone?** (to photosynthesize it needs to be in the sunlight – but too close to the surface it can dry out, or be damaged by UV. Also in well-lit waters there are the hazards of predation!)
- **How would a phytoplankton stay in the photic zone?** (adaptations like spines, forming chains, using oils all help a plankter to float).
- **What works best to help reduce sinking rates?** (Flattened appendages, small bodies, large surface area relative to volume, reduced density, oil or gas floats, chains, etc.)
- **Why does the slowest to sink win?** (if you sink too quickly you will be in the dark and unable to photosynthesize, and die!)
- **If we conducted this experiment with sea water, would you expect different results?** (yes and no - the same plankter would still win, but all the plankton would sink more slowly in salt water which is more dense than fresh).
- **Phytoplankton are different colors based upon the pigments used to capture solar energy necessary for photosynthesis. Zooplankton do *not* perform photosynthesis and so lack such pigments. What color do you think most zooplankton are in the surface waters of the ocean? What color do you think zooplankton are in the deep sea?** (Autotrophic plankton use photosynthesis (solar energy) to produce organic matter and are commonly referred to as *phytoplankton*. Because of the pigments needed for this process, phytoplankton tend to be colored in shades of green, brown, or red. Heterotrophic plankton must obtain nourishment by eating and are commonly referred to as *zooplankton*. Zooplankton, to hide from and avoid predators, will be see-through or light colored up on the surface, so fish down below looking up (into the brightness) won't see them - but zooplankton that live in the deep are darker, matching the darker water (This is like counter-shading of a fish – light belly, dark back).
- **How does this experiment relate to, say, S.C.U.B.A. divers? Or Submarines? (Engineering!)** SCUBA divers and submarines make use of neutral buoyancy - a condition in which a physical body's average density is equal to the density of the fluid in which it is immersed. The buoyancy offsets the force of gravity that would otherwise cause the object to sink (if the body's density is greater than the density of the fluid in which it is immersed) or rise (if it's less). An object that has neutral buoyancy will neither sink nor rise.

In scuba diving, the ability to maintain neutral buoyancy through controlled breathing accurate weighting and management of the buoyancy compensator is an important skill. A neutrally buoyant diver does not need to fin to maintain depth, saving energy, resulting in less exertion, and less air wasted (more down time)!

Buoyancy is important in a surprising number of fields. Designers and engineers must design boats, ships and seaplanes in a way that ensures that they remain afloat. In the case of submarines, experts developed ways to make them sink and bring them back to the surface. Many objects were developed with buoyancy in mind, such as life preservers and pontoons. Life preservers are filled with compressed air and help to lower a person's average density, assisting in floating and swimming.

Additionally, buoyancy is very important in a number of water related sports. Many swimmers know that there are easy ways to float at the surface, such as lying on one's back or holding a full breath. Buoyancy becomes noticeable when a swimmer tries to dive to the bottom of the pool, which can take effort. Scuba divers work with many buoyancy issues, as divers must know how to float, hover and sink in the water. In fact, scuba divers often wear lead weights to counteract the positive buoyancy of their bodies and gear.

Neutral buoyancy is used extensively in training astronauts in preparation for working in the microgravity environment of space.

The human brain exhibits neutral buoyancy as a result of its suspension in cerebrospinal fluid.

Extension: STEM Challenge : Can you engineer a submarine that – because it is neutrally buoyant - reduces energy use?

Models and Explanations: In this lab we explored buoyancy and sinking rates as it applies to ocean phytoplankton. **A student who demonstrates understanding** of these concepts can **explain** what adaptations can slow the rate of sinking in phytoplankton, and, further, why phytoplankton need to stay near the surface of the ocean. Students will explain that plants and animals have physical characteristics that allow them to receive information from the environment. Structural adaptations within groups of plants and animals allow them to better survive and reproduce. Any structure that allows phytoplankton to remain in the photic zone for as long as possible is an inherited, adaptive trait. **A proficient student will be able to explain** the relationship between surface area and sinking rate. **This student will be able to design** a model phytoplankton that will sink at a slow rate, and will be able to evaluate and revise the design as necessary.

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Pictures of Plankton:

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http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=7&ved=0CEkQFjAG&url=http%3A%2F%2Fwww.marine.usf.edu%2Fpjocean%2Fpackets%2Ff01%2Ff01u6p2.pdf&ei=zyAbVKH_Co6wyAS25YCgDQ&usg=AFQjCNFQIY8_kJNt-aupbz3M2vNbeM-Mdw&bvm=bv.75097201,d.aWw

Student Worksheet:

There are many wonderful shapes, colors, and sizes of marine phytoplankton and zooplankton. The biodiversity of plankton is quite high, but there is a strong connection between structure and function. Phytoplankton must remain in the photic zone in order to photosynthesize, grow, and reproduce, so if they sink too fast they will die. Many of the building blocks of phytoplankton are more dense than seawater (proteins, the nucleus, chloroplasts). Here, dense reproductive body parts are represented by metal washers. To keep plankton afloat, phytoplankton have developed elaborate systems to slow sinking rates or make the overall plankton of a similar density to seawater. However, if the plankton is too buoyant, it will rise to the surface of the ocean and become easy prey to birds or other surface feeders. In this way, structural adaptations within groups of plants and animals allow them to better survive and reproduce are called adaptive traits. Traits like body shape in plankton are inherited.

In this lab, learners are challenged to **design** a planktonic organism that will neither float like a cork nor sink like a stone. They are given pictures of planktonic organisms and simple materials. The best model of a planktonic organism will sink slowly or be neutrally buoyant. After designing with their teammates, learners test and race their plankton in a simulated ocean. The winner of the rave is the plankton that *sinks* (it can't float) at the *slowest* rate.

Observations:

Hypothesis:

Draw: My Team's Winning Design:

Procedure 1:

Group Name	Trial 1 (sec)	Trial 2 (sec)	Trial 3 (sec)	Avg. Time (sec)	Distance (cm)	Rate = Distance/Time (cm/sec)

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2					
3					
AVG					

Table 2. Time (sec) it takes for plankton to sink 100 ml. The winning plankton is the one that sinks at the *slowest* rate.

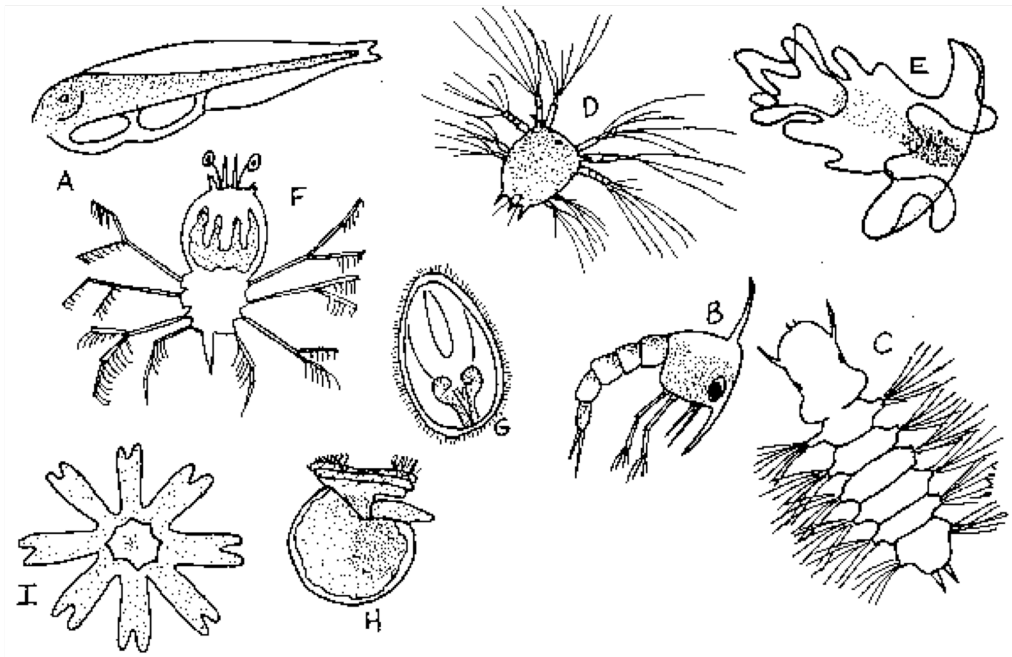
Conclusion:

- **Which plankton shape was the slowest?**
- **Why was that plankton the slowest?**
- **What works best to help reduce sinking rates**
- **Why does the slowest to sink win?**
- **If we conducted this experiment with sea water (salt at 35 ppt), would you expect different results?**

Meroplankton Match-Up

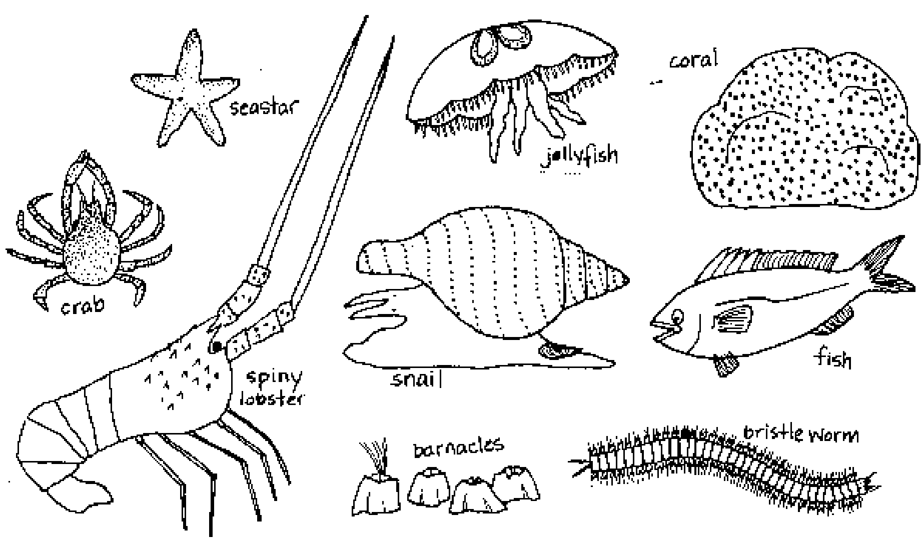
Using the figures below, match up the meroplankton to their adult counterparts. Label the adult organism with the appropriate letter of their larval form.

LARVAE:



A = yolk sac larvae; B = zoea; C = polychaete larvae; D = nauplius;
E = bipinnaria larvae; F = megalops; G = planula; H= veliger; I = ephyra larvae

ADULT:



A=

B=

C=

D=

E=

F=

G=

H=

I=

KEY:

A = yolk sac fish larvae;
B = crab zoea;
C = polychaete larvae;
D = barnacle nauplius;
E = bipinnaria starfish larvae;
F = megalops crab;
G = planula (cnidarian);
H= veliger snail;
I = ephyra jellyfish larvae

Answers to Meroplankton Match-Up

A - FISH
B - CRAB
C - BRISTLEWORM
D - BARNACLE
E - JELLYFISH
F - LOBSTER
G - CORAL
H - SNAIL
I - SEA STAR