Name ___________________

Date ___________________

Wash Up!

Whether it's a sign in the restroom at work or the nagging voice of parents, most of us are reminded several times each day to wash our hands. Though the benefits of hand-washing are obvious—the most important being protection from disease-causing bacteria and viruses—very few people understand the scientific principles that underlie the way hand-washing works. The chemistry can, indeed, be quite complex, but the principles behind this mundane task start with a premise that almost everyone understands: oil and water don't mix.

Most chemical compounds fall into one of two categories: Hydrophilic and hydrophobic. Hydrophilic, or water-loving, compounds can dissolve in water, while hydrophobic, or Water-fearing, compounds such as oils do not dissolve in water. Hydrophilic and hydrophobic substances cannot dissolve into one another, hence the saying, "oil and water don't mix." Human skin and hair secrete oils that trap dirt, bacteria, and other undesirable substances close to the body, where it can be accidentally inhaled or swallowed. Washing your skin and hair with ordinary water will not dissolve these oils, so whatever is trapped in them remains stuck in place.

Soap is special in that it is, strictly speaking, neither hydrophilic nor hydrophobic. Instead, it is an emulsifier; it can help hydrophilic and hydrophobic substances dissolve into one another. How does soap accomplish this task? The answer lies in soap's unique molecular structure. The soap molecule contains two parts: a carboxylate group and a long hydrocarbon chain. The carboxylate group is hydrophilic, or water-loving, and can interact with water through hydrogen bonding. The hydrocarbon chain, however, is hydrophobic, and can break up oil molecules, causing them to dissolve. So, when you wash your hands, the soap's hydrocarbon chains dissolve the oils that exist naturally on your skin and hair, freeing the dirt and germs that the oils have trapped. Then, the soap's hydrophilic carboxylate group allows the whole mess—water, the oils on your skin, and the germs the oils have trapped there—to wash safely down the drain.

This is the process by which traditional soap works, but anti-bacterial soap operates in a different way. Bacteria are living organisms, and anti-bacterial soaps contain a chemical additive—usually Triclosan—that disrupts the biological operations of bacteria they come into contact with, causing the bacteria to die. Health experts disagree, however, about the benefits of anti-bacterial soap. First of all, not all bacteria are virulent, and anti-bacterial soaps kill both good and bad bacteria. Humans need contact with certain good bacteria to survive and remain healthy. In addition, many diseases are caused not by bacteria, but by viruses that are not killed by anti-bacterial soaps. Finally, most anti-bacterial chemicals like Triclosan need up to two minutes of direct contact with bacteria in order to kill it. Most people do not leave the solution on their hands this long, in which case it will not have the desired effect.

While it is not necessary to know exactly how soaps work to appreciate their benefits, it can be fascinating to consider the complex chemical reactions that are taking place each time you wash your hands.