

NATURE NOTES

With Tamborine Mountain Natural History Association

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As the warmer weather approaches many people are looking forward to some form of water recreation – swimming, surfing, snorkelling, diving or just cooling off and having fun. Most people are so accustomed to being in the water that the process of swimming in the water is taken for granted, but the properties of water mean that moving in water is different from moving in air.

When you walk in water, you feel far more resistance than walking in air, this occurs for a number of reasons - water is about 750 times denser than air; water is 55 times more viscous than air; and water cannot be compressed, so when you are immersed in water, you displace a corresponding volume of water. Once you are out of your depth you will become conscious of another force - gravity pulls you downward as usual, but an upward force equal to the weight of water you displace, pushes you upward – this force is buoyancy, its formula is described as the Archimedes principle. Neutral buoyancy is reached when the downward force of gravity equals the upward force of buoyancy.

Swimming is the term used to define locomotion in the water, the physics of swimming is very complicated but the basic principle is that forward propulsion is created by action and reaction.

A wide variety of non-aquatic animals, including humans, can swim. Humans use a range of arm and leg swimming movements, but most of the propulsion comes from the drag force of the arms rather than the movement of the legs. This is the same pattern of propulsion for most non-aquatic animals, even powerful swimmers such as the polar bear.

Aquatic and semi aquatic animals have a wide variety of adaptations for swimming:

Fish mainly use the side to side movement of their tails to generate propulsive force, in some fish the whole body undulates and in others the body remains rigid while the tail moves. Fish that do not have a swim bladder eg sharks, must swim constantly above a critical speed to achieve neutral buoyancy. Fins are usually used for lift, steering and stability but there are some fish that swim by flapping their pectoral fins and others that swim by flapping their top and bottom fins.

Whales and dolphins are propelled by the up and down movement of their tail flukes. The power comes from the lift of the upstroke; the drag of the downstroke is less forceful. The flippers are used for steering and balance. The immense power of the propulsive force is reflected by fast swimming speeds of dolphins and whales (some species 56kmh) and the ability to breach and leap.

Squids, octopus, jellyfish, and some shellfish have the ability to swim by jet propulsion – they squirt a jet of water out of a muscular contracting cavity – speeds of up to 40kmh may be attained.

Birds have a variety of swimming adaptations – penguins are flightless but use their wings as if flying through water, some sea birds are able to use their wings to both fly in the air and swim in the water. Water birds such as ducks have webbed feet, which propel them through the water by the drag and lift of the legs power stroke.

Sea turtles, sea lions, seals, walruses are propelled by undulation of limbs, particularly forelimbs, all 4 limbs have become paddle like flippers to increase lift and drag and so provide more forward thrust.

Webbed feet are an adaptation of many aquatic animals – some animals are propelled by their hindlegs eg beavers, otters, frogs, and others by their forelegs eg platypus

Reptiles swim with side to side undulation of body and tail.

Aquatic insects use modified legs, water jets, tails, wings and plates to swim.

Microorganisms use whiplike flagella, cilia or undulating movement to provide propulsion.

As the dynamics of swimming are studied in more detail, scientists are realising just how complex this activity is, but for most of us swimming is more about fun than physics.

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