

## Butterfly Stroke

During this stroke, both arms recover over the water while the legs kick simultaneously upward and downward in a dolphin or fish-tail motion. Two leg kicks must be performed for each arm cycle, and the swimmer must constantly keep in mind that the rules require the arm movements to be simultaneous and symmetrical on both sides. The same applies to the leg movements (Counsilman, 1986, p. 134).

### 3.4.1. Body Position

Due to the wave-like undulation of the body in the water and the simultaneous forward movement of both arms, body position in butterfly is less stable than in other strokes. This also modifies the degree of inclination of the (imaginary) transverse axis of the body relative to the water surface. It is important that this inclination remains significant and that the legs do not emerge from the water during the dolphin movements (Lewin, 1981, p. 87).

During the propulsive actions of the arms, body position must not hinder forward motion. Conversely, during the undulatory phases, body obliquity is not a disadvantage. Indeed, the frontal surface area is evaluated relative to the direction of movement, and in this case, since the displacement is oblique, the body must follow this direction in order to reduce drag. The head should streamline as much as possible during propulsive actions and must also anticipate respiratory movements. It rises toward the end of the arm push and returns to position before the second part of the arm recovery (Chollet, 1997, p. 118).

### 3.4.2. Arm Movement

Arm movement in butterfly consists of three diagonal sweeps and a recovery. The sweeps include the outward sweep, which comprises water entry and the catch, the inward sweep, and the upward sweep.

#### 3.4.2.1. Outward Sweep, Water Entry, and Catch

The swimmer's hands should enter the water in front of the shoulders, aligned with or slightly outside them. The palms should be turned outward so that the hands enter the water edge-first. After entry, the hands sweep outward and downward until they reach shoulder level laterally, with the palms facing backward; this is where the catch occurs and where the arms begin to produce propulsion.

The hands may be slightly turned outward or downward at the start of this sweep. However, regardless of their initial orientation, the palms must be turned outward during the outward sweep until they are oriented backward and outward at the moment of the catch. Hand speed decreases and is almost zero at the moment of the catch.

This outward sweep is not propulsive. It should be a smooth, stretching movement whose purpose is to position the hands correctly for the subsequent inward sweep, which is propulsive.

Swimmers should gradually flex their arms as they approach the catch position to facilitate backward orientation. Any attempt to apply propulsive force before the hands and arms are oriented backward

and aligned in this manner will only result in a loss of speed by displacing water outward or downward (Maglischo, 2003, pp. 155–157).

#### **3.4.2.2. Inward Sweep**

The inward sweep is the first of the two propulsive sweeps in butterfly. The arms sweep downward, inward, and upward in a semi-circular motion, while the elbows continue to flex after the catch. The inward sweep ends when the two arms nearly touch beneath the swimmer's body. At this point, the arms are flexed at approximately 90 degrees.

The hands, which were oriented outward and backward at the catch, are progressively turned inward during this phase, finishing oriented inward and upward when they meet beneath the swimmer. Hand speed increases moderately throughout this movement (Counsilman, 1986, p. 157).

Throughout the propulsive phase, the pectoralis major and latissimus dorsi are the primary driving muscles, while the wrist flexors maintain the wrist in a neutral to slightly flexed position. The biceps brachii and brachialis are activated to move the elbow from full extension at the initiation of the catch to a flexed position of about 40 degrees during the intermediate part of the pull (McLeod, 2012, p. 4).

#### **3.4.2.3. Upward Sweep**

The upward sweep begins when the hands come together at the end of the previous sweep. They describe a circular path outward and backward and then sweep upward toward the water surface. The hands quickly rotate outward so that they are oriented outward and backward during this upward sweep.

Hand speed decreases during the transition between the inward and upward sweeps, then accelerates until pressure is released at the water surface. This release occurs around thigh level, at which point recovery begins. The swimmer's arms extend slightly during the upward sweep but remain somewhat flexed until the beginning of the release phase (Costill et al., 1994, p. 81).

Unlike freestyle, butterfly swimmers forcefully extend their elbows during the final part of the pull, thus engaging the triceps brachii to a much greater extent. As in freestyle, the rotator cuff and deltoid muscles act during the recovery phase, but the mechanism differs slightly. In butterfly, there is no body roll to assist recovery as in freestyle; instead, trunk undulation lifts the upper body out of the water and contributes to the recovery process.

Once again, the scapular stabilizer muscles are extremely important, as they provide a solid anchoring point for the propulsive forces generated by the arms and assist in repositioning them during recovery (McLeod, 2012, p. 4).

#### **3.4.2.4. Release and Recovery**

At the end of the arm push, the hands are located slightly beneath or just outside the thighs. The whipping action of the hands has no propulsive function; it reflects a change in hand trajectory and marks the beginning of recovery. Arm exit occurs at thigh level.

Simultaneous aerial recovery is only possible with full extension of the upper limbs, and relaxation is essential. For effective relaxation, only the muscles responsible for projecting the arms forward should be contracted. When this occurs, the palms face upward. This pronated position of the laterally extended arms skimming the water tends to be maintained throughout the recovery path. However, due to the requirement for relaxation, once the arms pass beyond shoulder alignment, the hands tend to rotate so that the palms face downward.

Depending on the degree of laxity of the swimmer's shoulder joint, the range of motion achieved as the arms pass overhead may vary (Catteau & Garoff, 1986, p. 186).

Although there is no body roll in butterfly as in freestyle, trunk stabilizer muscles are crucial for linking upper and lower limb movements and play an essential role in the undulatory motion that allows the swimmer to lift the upper trunk and arms out of the water during recovery. This movement is produced by the contraction of the paraspinal muscles, which run in groups from the lower back to the base of the skull. This contraction arches the back while the arms are in the recovery phase. Abdominal muscle contraction follows rapidly, preparing the upper body to re-enter the water after the hands and initiate the next propulsive phase (McLeod, 2012, p. 4).

The arms, which were slowly extended during the upward sweep, are rapidly extended after release so that they leave the water in a circular motion directed upward, outward, and forward. They then travel over the water until the next entry. The arms may be fully extended or slightly flexed during the first half of recovery. It is recommended that swimmers slightly flex their arms during the second half of recovery to facilitate the transition between water entry and the outward sweep.

During the final phase of recovery, the arms are oriented more inward, but their direction must change outward after water entry. This change is facilitated if the arms are slightly flexed before entering the water, as they can then be extended after entry, causing the hands to move outward even while the arms are still moving inward.

The hands should remain on the sides during recovery, oriented inward during the first half and outward during the second. Recovery should be fast but not abrupt. Swimmers must allow sufficient time to position their legs for the downward phase of the first kick before the arms enter the water. The arms should remain as relaxed as possible so that the muscles can recover during this phase. Swimmers should allow the momentum from the upward sweep to carry their arms during the first half of recovery and use only minimal energy during the second half to redirect the arms forward and re-enter the water.

Although recovery is performed relatively low and laterally, the arms must rise sufficiently to avoid contacting the water and creating wave drag. Swimmers must lift their shoulders well out of the water to create adequate clearance for the arms during aerial recovery (Costill et al., 1994, pp. 81–83).

### **3.4.3. Dolphin Kick**

According to the latest swimming regulations, all upward and downward movements of the feet must be simultaneous. The legs or feet do not have to be at the same level, but they must not alternate. A breaststroke kick is not permitted (World Aquatics Rules, 2023-2025).

The dolphin kick describes the leg movement in butterfly because the legs move together like a dolphin's tail, whose horizontal fin produces propulsion through vertical movements. The upward and downward pivoting of the hips and nearly closed legs produces continuous propulsion in humans in a similar manner. The impulse for the dolphin movement originates in the thoracic and lumbar vertebrae and is transmitted through the pelvis, thighs, ankles, feet, and finally the toes. Because propulsion involves both hip and leg movements, it is not appropriate to refer solely to leg movements (Lewin, 1981, pp. 87–88).

The dolphin kick used at the start of the race and after each tumble turn engages a larger muscle mass than the smaller, more isolated leg kicks associated with arm movements. In addition to hip and knee motion, the dolphin kick incorporates trunk undulation by engaging trunk stabilizers and paraspinal muscles (McLeod, 2012, p. 4).

### **3.4.3.1. Upward Kick**

Like the flutter kick in freestyle, the butterfly kick is a whipping movement in which one kick begins as the other is nearly completed. It begins with the legs almost extended during the downward phase of the previous kick. The downward kick produces a rebound effect that drives the swimmer's thighs upward. After completing the downward kick, the legs continue to glide upward, extending until they reach hip level. The next downward kick begins at this point.

The action of lifting the legs is performed by the hip extensors, primarily the gluteus maximus muscles. Water pressure above the legs maintains them in extension during the upward kick and also pushes the feet into a natural position midway between flexion and extension. Swimmers should not bend their knees during this upward kick (Maglischo, 2003, p. 161).

Posterior muscles, particularly the gluteus maximus and hamstrings, ensure elevation of the lower limbs. As the water load above the legs decreases, hamstring activity produces a slight, involuntary knee flexion. The feet, kept in plantar flexion from the start of this phase, reach or exceed the surface at the highest point of the kick. This elevation of the legs results in a slight sinking of the hips, with the pelvis serving as a pivot point (Catteau & Garoff, 1986, p. 192).

### **3.4.3.2. Downward Kick**

The downward phase of the first kick, which is the largest of each cycle, is a whipping action that begins with hip flexion, continues with knee extension, and ends with ankle flexion. This kick begins as the swimmer's feet pass above body level. At this stage, the swimmer presses downward with the thighs. Water pressure, now acting from below upward, causes the legs to flex and the feet to rise into a position of plantar flexion and inversion. Shortly after the hips begin to descend, the swimmer forcefully extends the legs to complete the downward kick (Costill et al., 1994, p. 84).

The release phase of the kick is driven by the gluteal muscle group. Simultaneous contraction of the hamstrings contributes to hip extension. The foot is maintained in plantar flexion through the combined effect of water resistance and activation of the gastrocnemius and soleus muscles (McLeod, 2012, p. 4).

#### **3.4.4. Arm–Leg Coordination**

Over a complete arm cycle, two undulations occur, each consisting of an upward and a downward phase. Optimal coordination precisely links a leg undulation phase with a key arm phase.

The downward phase of the first kick occurs when the arms enter the water after aerial recovery. The downward phase of the second kick occurs during the second part of the underwater propulsive arm movement, namely during the push. During this latter phase, the hands tend to push the hips downward. The second kick is therefore executed so that its downward phase prevents the hips from being pulled downward.

The second kick of the cycle appears slightly more pronounced than the first, especially when the butterfly swimmer is moving at maximum speed. However, at slower speeds, the first kick tends to be more pronounced than the second (Counsilman, 1986, p. 143).

#### **3.4.5. Breathing**

Due to the symmetry and simultaneity of motor actions in butterfly, breathing logic in this stroke is also symmetrical. Because the head is submerged during swimming balance, a voluntary and well-coordinated movement is required to bring the head into an optimal breathing position. As in other strokes, there should be as little conflict as possible between fixing the rib cage to optimize arm propulsion and allowing chest mobility for inspiration.

The most advantageous spatial position for head elevation is linked to the arm push and the second leg undulation. Taking these two factors into account, the swimmer must anticipate head positioning by gradually lifting it from the end of the pull. The head is fully raised, with the chin brought forward during the arm push and the downward phase of the leg undulation. This positioning allows inspiration to occur. Expiration, particularly when breathing every arm cycle, must be coordinated with inspiration to avoid respiratory pauses (Chollet, 1997, pp. 119–120).

Immediately after inhalation, the head lowers and quickly re-enters the water. When expiration does not begin immediately, it is usually for mechanical rather than physiological reasons. The simultaneous movement, which requires more power than alternating movements, demands a solid anchoring point on the rib cage for the arm muscles. A brief inspiratory apnea provides this support and occurs at the beginning of the pull (Catteau & Garoff, 1986, p. 194).

In butterfly, breathing every two cycles is the most commonly used pattern, although swimmers often switch to breathing every cycle at the end of 200 m races. Underwater observation of expiration reveals that it is rarely continuous and is often short and explosive following apnea during pulling phases, particularly in simultaneous strokes (Pelayo & Wojciechowski, 1991, p. 30).

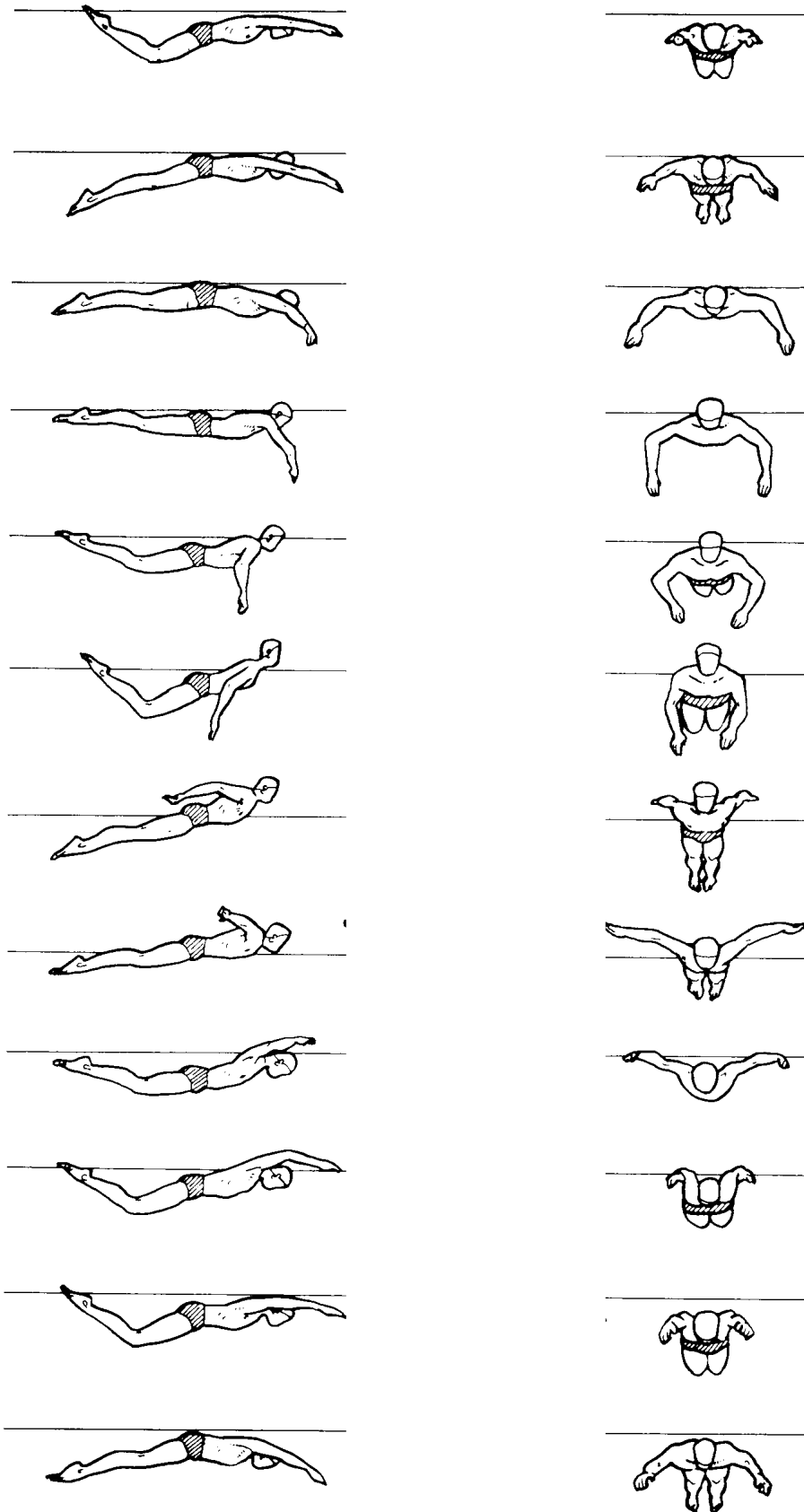


Figure. 4: Illustration of the Butterfly Stroke Technique