Most of us associate increases in training load with increases in fitness level. What we often overlook is the fact that the *real* gains in exercise capacity occur when the body and muscles are at rest. While practice is where we see *times* improving, the *underlying* adaptations to this training actually occur while the body recovers from this workload. So, while workout is the all-important *stimulus* that *initiates* the adaptation process, the majority of the body's "metabolic rebuilding" occurs while the body is at rest (i.e. during recovery).

Cool Down – Eat – Stretch – Massage – Sleep

These are the five key components to an optimal recovery that all swimmers should understand, believe in, and most importantly, *practice on a regular basis*. Here's why:

Cool Down and Recovery

Swimming at high intensities, such as during racing and tough sets, can cause metabolites like inorganic phosphate, ADP, hydrogen ions, and of course, *lactate*, to accumulate in the muscles. A build-up of these metabolites is associated with conditions that can compromise the next swimming performance.

Cool down (active recovery) facilitates the removal/ utilization of lactate after a race or tough set. The *intensity* of the cool down influences how quickly this removal/utilization of lactate occurs. Too high an intensity may produce additional lactate, while too low an intensity may not create enough circulation to remove/utilize the lactate any faster than standing around would (passive recovery).

Because sprinters tend to have and engage more fast-twitch muscle fibers than distance swimmers, they tend to produce larger amounts of lactate than distance swimmers. This also means that it tends to take longer for sprinters to remove/utilize accumulated lactate after races and other tough swims.

Therefore, the recommended intensity and duration of a swimmer's cool down depends on the individual's distance orientation and event:

Distance Orientation	***Duration of Cool Down***	***Intensity (Heart Rate)***
Sprinter (50-100 m/y)	25 min	Easy (120-130 bpm)
Middle Distance (200-500 m/y)	20 min	Easy-Moderate (130-140 bpm)
Distance (+500 m/y)	10-15 min	Moderate (140-150 bpm)

At meets where a warm down pool is not available, swimmers should complete their active recovery on land. This should include active stretching, light jogging, arm rotations and/or other land-based exercises that engage the same muscle groups used during the swim. Even on land, this type of activity increases the blood circulation and removes/utilizes metabolites faster than passive recovery alone.

Nutrition and Recovery

The primary fuel source for most swimmers during training is carbohydrate. During high intensity swimming, such as racing and completing tough sets, this carbohydrate comes from circulating blood sugar and glycogen, the storage form of carbohydrate. Over time, as glycogen is used, it must be replaced to avoid depletion. Should glycogen stores become low or depleted, circulating blood sugar shares the burden of supporting the demands of tough workouts and races with the body's last resort high-intensity fuel source, protein. Since this protein usually comes in the form of muscle protein, it is easy to see how long-term failure to replenish glycogen can lead to tissue breakdown. Combined with the tissue breakdown that is a normal result of hard exercise (and an important part of the adaptation stimulus during training), it is also easy to see why poor nutritional recovery usually rears its ugly face in two forms:

1. *Daily Training Indicators (chronic/long-term)*
   - complaints of "lead legs" and/or "can't keep up"
   - elevated resting heart rate
   - elevated heart rate on typical sets, and/or
2. *Meet indicators (acute/ immediate; usually on the back end of a meet)*
   - lower post-race peak lactate
   - diminished lactate recovery
   - feelings of fatigue
   - elevated resting heart rate
   - longer post-race heart rate recovery

Effective nutritional recovery maintains energy and limits tissue breakdown, especially during periods of high volume/high intensity training, and both carbohydrate and protein are essential to the plan. One of the key factors to keep in mind is that the "*window of opportunity*" for maximizing glycogen repletion starts to close as soon as exercise stops and lasts for about two hours. Therefore, the most effective ways to make the most of your recovery time and maximize the training adaptation are:

- Start the replenishment process *during* practice if workout is longer than an hour.
- Eat a substantial carbohydrate snack with some protein *immediately* after practice or within 20-30 min of finishing a workout.
- During *hard* training, add another post-workout snack 45 minutes to 1 hour later.
- Eat a main meal within 2 hours of finishing workout.
- During meets, eat a high-carb/moderate-protein snack *immediately* after your prelims race and *immediately* after your finals race, then again after cooling down.

- Substantial means 1.2-1.5 g of carbohydrate and .25-.4 g or protein per kg of body weight (*kg=lbs/2.2)
- Include *all* sources of carbohydrate, such as colorful fruits and juices, milks, yogurts, breads, cereals, etc.
- Include various sources of protein, such as meat, peanut butter, milks, yogurt, cereals, legumes, etc.
- Include liquids to replenish lost fluids.

During its time off, the body will adapt, but only if provided with the *right fuels at the right times***.** For many swimmers, ensuring good nutrition is like a *full-time eating job*! Not only is the goal to replenish glycogen, but also to ensure a high level of circulating protein, vitamins and minerals to combat tissue breakdown during subsequent swims and recovery periods and maintain hydration to optimize metabolic efficiency (a fancy way of saying that water allows the body to access the nutrients it needs when it needs them).

Stretching and Recovery

Stretching is a key component of the daily training plan for athletes. It plays an important role in the recovery process and in preparing for the next training session. Stretching increases blood flow to muscles, stimulates the passage of amino acids (building blocks of protein) into muscles, accelerates protein synthesis in cells, and inhibits protein breakdown. These processes help the muscle repair itself and improve the body's ability to recover in time for subsequent practices or competitions. Stretching as part of recovery can also reduce the chance of injury and enhance stroke technique during subsequent swims. Its effects on increasing flexibility and range of motion allow the arms and legs to move freely and unencumbered.

A few important directions for stretching:

- Stretch when muscles are warmed-up.
- Stretch major muscle groups (lower leg, upper leg, back, shoulders, neck).
- Hold each stretch for 20-30 seconds.
- Do not bounce.
- Do not stretch to the point of feeling pain. If you stretch and feel pain, you may be at risk of tearing a muscle.
- Do not hold your breath. Breathe freely and stay relaxed.

Keep in mind that not all athletes are built the same. A stretching routine that works for one person may not work equally as well on another person. A stretching program should be designed for the individual, taking into consideration individual needs and body type.

Massage and Recovery

Many swimmers face chronic muscle soreness, fatigue and tightness around peak training times and during multiple-day swim meets. Sports massage, which involves the rhythmic compression of muscle tissue, stimulates blood circulation during recovery. Similar to active recovery, the blood circulation can help cleanse the tissue of metabolic wastes and reduce the delayed onset of muscle soreness.

Massage during recovery can alleviate muscle tightness and induce mental relaxation. This can improve power output efforts and/or subsequent swimming performances that may otherwise be compromised by psychological tension or a muscle's inability to fully contract or relax. By alleviating muscle discomfort and spasm, massage during recovery may also improve training and racing performances that have been compromised by strength, endurance, flexibility and/or technique limitations associated with pain.

The appropriate use of massage, both post-race and post-workout, can facilitate the overall recovery process and contribute to the prevention and management of overuse injuries.

Sleep and Recovery

As mentioned previously, the majority of the body's muscle rebuilding occurs while the body is at rest. Therefore, in order to benefit the most from the work done during practice and to perform optimally, it is important for athletes to get sufficient sleep during their time away from the pool.

Getting too little sleep can hinder recovery from exercise by impairing glucose metabolism, increasing cortisol levels (causing decreased tissue repair and growth), and compromising immune function. Not only is protein breakdown reduced during sleep, growth hormone is released during this time. Sleep also helps maintain optimal emotional and social function during the day.

Due to individual differences in recovery time, there is no set duration of sleep that every athlete should get. An important point to keep in mind when it comes to sleep is that every athlete has a different optimal amount of sleep (7 hours of sleep may be optimal for some, while 9 hours is optimal for others).

It is recommended that athletes keep a sleep log that tracks the number of hours of sleep per night. This should be correlated to how they feel during the day and their ability to recover after practice. Over time they will be able to determine their individual optimal amount of sleep based on parameters/correlations from their daily sleep log.

Cool Down – Eat – Stretch – Massage – Sleep

Remember: Whether it's daily training or the biggest meet of the season, what you do with your recovery time can and *will* affect your next swimming performance. Incorporate recovery into your training plan. Understand it. Believe in it. DO IT! Train smart…Swim Fast!

For more information on swimming physiology, nutrition, and sports medicine, visit www.usaswimming.org