Fast Twitch/Slow Twitch
Muscle Fibers

As a swimming coach with a sports science background, I have always found it intriguing how much our coaching profession actually knows about the physiology of our sport, but simply does not articulate it in the typical scientific jargon. With this article, I hope to shed some light on the scientific side of fast and slow twitch muscle fibers, and how you may actually be applying this information in your program right now.

To begin, I would like to provide some baseline definitions of what fast twitch and slow twitch muscle fibers actually mean.

The classification of muscle fibers can be confusing—and for good reason. The terminology used in fiber typing is determined by the method from which it is measured.

For example, you may see a slow twitch fiber called Type I (histochemical measurement), slow oxidative (SO, biochemical measurement) or even myosin heavy chain I (MHC I, protein isoform). All three of these classifications are regularly used and, for the most part, refer to the same muscle fiber type.

Further clouding of the terminology occurs when scientific papers refer to the study and identification of new isoforms named muscle fiber types X, D or C.

FIBER-TYPE CLASSIFICATIONS

For clarification purposes of this article, I will refer to the fiber typing as measured by biochemical assessment.

This classification is slow oxidative (SO), fast oxidative glycolytic (FOG), and fast glycolytic (FG). The biochemical classification correlates well with the histochemical classification with which some readers may be more familiar. That is Type I, Type IIA, and Type IIB, respectively.

Slow oxidative fibers are characterized by their high concentrations of mitochondria (the muscle cells aerobic ATP generator) and dense capillarization indicative of its aerobic energy production capabilities. In addition, they have slower contraction times and a high resistance to fatigue.

The FOG fiber combines a fast contraction speed with a moderately well-developed oxidative capacity. It remains somewhat fatigue-resistant while providing force through anaerobic energy processes. It is truly a fiber that can adapt to the demands that a consistent training stimulus would apply. However, if a FOG fiber is sedentary in nature, it will develop the oxidative characteristics of a SO fiber.

The FG fiber is a fast-contracting fiber with a highly-developed glycolytic capacity and a small mitochondrial concentration. It is known as a fast fatigable fiber and the dominant force producer during anaerobic work.

A typical sedentary person exhibits a near 50:50 ratio between ST and FT fibers, with no discernable differences between females and males. Elite-level aerobic athletes have been known to have values as high as 75 percent ST, while elite sprinters have been observed with as much as 70 percent FT.

Although fiber composition is influenced primarily through an athlete's genetic code, there can be some shifting in fiber type through training. Muscle fibers are 'plastic' in nature, meaning that they are flexible in adapting to the demands put upon them.

What is commonly accepted now—but by all means is still open for research and discussion—is the next-door neighbor theory, i.e., that fiber type may change from SO --> FOG --> FG, but rarely, if at all, will a fiber type change from a SO to a FG or vice versa. It is more along the line that a fiber type will begin to take on the properties of the next similar fiber as dictated by the training stimulus it receives.

Therefore, a specific muscle group that has been trained exclusively in an aerobic nature may have some shifting of fiber types from FOG to SO properties. Conversely, high levels of anaerobic training may result in fiber shifts of a fast nature.

FIBER-TYPE ADAPTATIONS

At this point, I refer the reader back to the first article I wrote in the April issue of Swimming World Magazine on balancing aerobic with anaerobic training (see pages 40-41). If one type of training is overly dominant, then fiber-type adaptations may occur that are not of a desired nature.

For example, a 200 freestyle swim requires approximately 50 percent of its energy delivery from aerobic sources. If a swimmer is trained too long in an anaerobic nature without maintaining his aerobic base, he may have trained himself into a vulnerable position with regard to fiber types and energy delivery.

Another way that we can apply the understanding of fiber-type composition to swimming is to look at what — continued on 36
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occurs with energy production when swimmers take their initial 100 pace for a 400/500 race out too fast.

Initiating too fast of a tempo early in the race results in too much stimulation of the FG fibers. A pace that is too fast will challenge the limitations of fatigue associated with the FG fibers—primarily, too much acidity coupled with a significant reduction in glycogen within the fiber. The result is that swimmers will ultimately need to slow their tempo in an effort to bring in more SO fibers to generate the necessary energy. The slower tempo with reduced force production from the SO fibers equals a poor performance.

When swimmers are trained appropriately and take the correct tempo out, force production and energy delivery from the three types of muscle fibers are in balance to meet the needs of that specific race. Often times, the great swims are finished off with a well-paced “sprint” to the finish that is the result of maximizing all three fiber types’ energy potential.

Another example often seen is the scenario in which swimmers are trained correctly and ready to race, but fail to push themselves early enough in the final stages of a race. Here, we have swimmers who finish their race, leaving some “untapped” fibers for another day.

RECRUITMENT PATTERN OF MUSCLE FIBERS

The firing or recruitment pattern of muscle fibers is driven by the need for force output. It has been well established that SO fibers require a lower threshold for firing and are subsequently the first fibers called upon for contraction. As the desired force output is increased, the threshold required for contraction is met and FOG fibers are recruited.

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Finally, as a swimmer moves toward all-out maximal force generation, the FG fibers are recruited. This recruitment pattern of fiber types can be correlated with swim training intensity.

It is believed that training at an intensity corresponding to a heart rate (HR) of < 130 beats per minute (bpm) will result in the stimulation of primarily SO fibers. The SO fibers will continue to contribute up until a HR of approximately 185 bpm. At heart rates above 130 bpm, you begin to recruit FOG fibers up and through maximum HR. The FG fibers will likely begin to be recruited at a HR in the 165 bpm range and continue to contribute to the supply of force throughout maximum effort.

It should be noted that HR measurements are subject to tremendous individual differences. As coaches, we have all had swimmers for whom HR measurements were void of value when comparing them to other swimmers or charted recommendations. In addition, the HR ranges provided here are “grey” areas at best. They are subject to the day-to-day variations that affect HR. I caution you to think of them as transitional areas.

It is a common misconception to think that FOG and FG fibers are strictly anaerobic in nature. Quite the contrary—both the FOG and the FG muscle fibers contain a significant amount of aerobic potential. In addition, a fatigued muscle will call upon any fiber that it can to generate the force required. Therefore, the complete shutdown of any one of the three fiber types seldom if ever occurs.

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Improving Performance in Swimming

LEARNING STRATEGIES FOR BASIC TECHNOLOGY

BY ROD HAVRILUK

Improving performance in swimming by changing technique is a long and difficult process. Although coaches are often limited to basic technology (such as naked eye observation and verbal communication), the effectiveness greatly improves when strategies for language, demonstration, sensory input, instruction, feedback, practice, drills, exercises, interaction and systematization are employed:

- Wording specific cues to simplify communication
- Demonstrating the orientation of body parts
- Taking full advantage of visual and kinesthetic cues
- Progressing from proximal to distal body parts
- Providing feedback about compliance with cues
- Practicing short swims at a slow speed with limited breathing and constant focus
- Including drills and exercises to isolate focus on select cues
- Increasing the frequency of coach-swimmer interactions
- Implementing a team-wide system to ensure consistency in technique instruction

Strategies for improving technique not only expedite learning, but also improve communication between coach and swimmer. If a coach is limited to basic technology, applying a variety of learning strategies make the process far more effective.

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