

MAKING THE MOST OF MUSCLE

There's more to muscle than fast-twitch and slow-twitch

By Dario Fredrick

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Most cyclists will tell you they've heard of slow- and fast-twitch muscle fibers, and some may take the labels somewhat literally, thinking of a pure sprinter as fast-twitch and an ultra-endurance cyclist as slow-twitch. To some degree this is true, but it's also an oversimplification.

Understanding the differences among muscle-fiber types can give us some insight as to why two talented riders of similar body weight, like Jan Ullrich and Alessandro Petacchi, can have such different natural abilities. It can also show how adopting a higher pedaling cadence can improve performance for some cyclists. Cycling intensities are not only a function of the ratio of aerobic and anaerobic energy delivery, but of specific muscle-fiber-type recruitment as well.

MUSCLE FIBER TYPES

Within the slow- and fast-twitch categories, scientists have identified three main fiber types in human muscle: Type I, Type IIa and Type IIb. Type I is slow-twitch fiber, while fast-twitch fiber is subdivided into Type IIa and Type IIb (Table 1).

- **Type I** — Type I fibers are called slow-twitch because their V_{max} (maximal shortening velocity or speed of contraction) is slower than fast-twitch fibers. Also referred to as “slow-oxidative” fibers, Type I fibers are energized aerobically. Aerobic metabolism is a much more efficient energy pathway than non-aerobic metabolism, providing nearly 20 times the energy per unit of fuel as well as conversion of multiple fuel types to energy (glucose, fats, and lactate). As a result, Type I fibers are more efficient than Type IIa and IIb, and while Type Is do not produce forces as great nor as quickly as fast-twitch, they are very fatigue-resistant.

- Type IIb — Fast-twitch muscle fibers have the highest Vmax and produce the greatest force, but also experience the highest rate of fatigue. Type IIb fibers are called “fast-glycolytic” because they rely on glycolysis (anaerobic metabolism) for energy. Despite their high anaerobic capacity, the Type IIb reliance on stored carbohydrate in the form of glycogen burns through these fast fuel stores quickly. Glycogen stores are limited and it cannot be replenished during exercise, thus its depletion results in fatigue and ultimately a “bonked” state.

- Type IIa — The Type IIa fibers are the intermediate fast-twitch fibers. These “fast-oxidative glycolytic” fibers can be thought of as a cross between Type I and Type IIb fibers as they have the capacity to be energized via both aerobic and anaerobic metabolism. Type IIa fibers produce more force and have a higher Vmax than Type I, but less than Type IIb fibers. They have a low to moderate rate of fatigue depending on the energy pathway and fuels used. Perhaps most important to endurance cyclists, Type IIa fibers can be trained to utilize a greater ratio of aerobic to anaerobic metabolism thus increasing efficiency and reducing rate of fatigue.

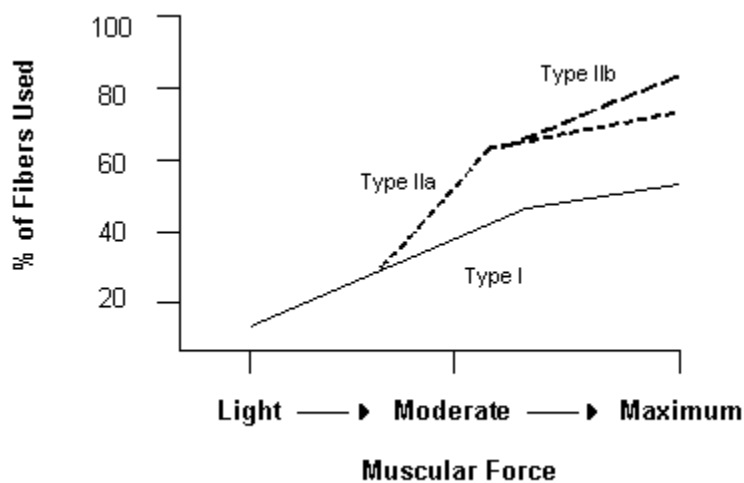
Table 1 - General characteristics of muscle fiber types

	Slow-twitch fibers	Fast-twitch fibers	
Characteristic	Type I	Type IIa	Type IIb
Main energy pathway	Aerobic	Aerobic or Anaerobic	Anaerobic
Maximal force	Moderate	High	Highest
Efficiency	Highest	Moderate	Low
Fatigue resistance	High	Moderate	Low
Primary fuels used	Glucose, fats, lactate	Glucose, lactate, glycogen	Glycogen

FIBER RECRUITMENT

As force increases from light to maximum (see Figure 1) the recruitment of fiber types expands from Type I to include Type IIa, then Type IIb fibers in that order. Aerobically energized Type I fibers contribute significantly to all power outputs, even in an all-out sprint. Thus, there is a large aerobic component to all cycling workloads even beyond one's "threshold."

Figure 1 – Fiber recruitment by muscular force



OPTIMIZING TRAINING WITH FIBER TYPES

With a greater understanding of fiber types we can see the importance of maximizing aerobic capacity for endurance-cycling performance. Endurance training of approximately 70-85 percent of maximal steady state (MSS) heart rate (MSS = 30-minute performance threshold) can improve the aerobic output of Type I fibers, while training at 85-93 percent of MSS can improve the aerobic output and ratio of aerobic/anaerobic metabolism of Type IIa fibers. At 90-93 percent of MSS, not only do the Type IIa fibers increase their aerobic qualities, some Type IIb fibers convert to Type IIa. However, if intensity is always kept below 85 percent of MSS, Type IIa fibers can convert to Type I supporting the importance of progressive variation in training intensity.

Pedaling cadence and force also affect proportions of muscle-fiber type recruitment. A relatively low cadence for a given workload shifts fiber type recruitment further to the right in Figure 1, whereas moderate to higher cadence reduces reliance on higher force fibers, thus improving fuel efficiency and reducing fatigue.

FLEX YOUR TYPE

While we may each have a genetic predisposition to either slow- or fast-twitch muscle fiber development, we can all train in a specific manner to affect fiber type recruitment and adaptation, and thus maximize a particular aspect of cycling performance. Pedaling force, cadence, and intensity all play a role in how the body adapts and performs. An optimal progression of intensity will not only flex your muscles when pedaling, it will flex the right type.

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