2.3
Strength & Conditioning Routine

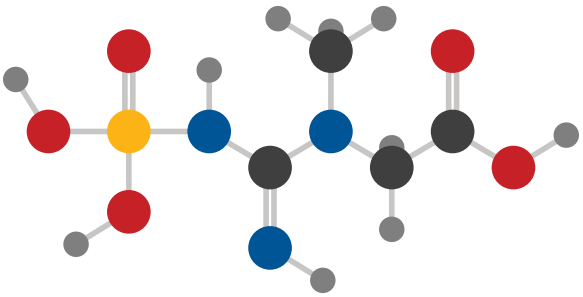
MOVEMENT PREP

As noted in the Pre-Throwing Warm-Up chapter, turning on the muscles responsible for joint stabilization and protection sets up athletes for a safer, more efficient workout. Since the last iteration of *Hacking the Kinetic Chain*, we've added dynamic warm-up exercises to the website to appropriately prepare athletes for throwing and lifting sessions. Since we don't outline each exercise individually in this chapter, make sure to check out the movement-prep videos on the website before incorporating the exercises into your athletes' routines.

Research shows that transfer of training is more effective when corrective exercises, CNS, power, agility, and other modalities are frontloaded ahead of weight training and throwing, instead of performing those exercises afterwards. Exercises such as throwing, sprints, med-ball throws, etc. tap heavily into the creatine phosphate and glycogen energy systems—the primary energy systems used for explosive movements.

While lifting tons of weight is fun and a valid means to gauge how much force an athlete's body can produce, the end goal is to allow increased strength from weight lifting to improve body control and movement quality. This in combination with skill-specific training (throwing, in this case) should allow athletes to function at higher levels during competition. Lifting heavily before performing explosive movements can deplete the body's creatine phosphate and glycogen pools, creating a less-than-desired training effect when performing force-application-specific exercises for training purposes. This can also increase the risk of injury due to muscle fatigue after moving significant amounts of weight.

Our movement prep days are split into A, B, and C days to give athletes a variety of different CNS, power, and agility exercises to perform. When using movement prep for throwing, these days are alternated. For example, if an athlete throws 6 times in a week (including recovery training days), then each type of movement-prep day will be performed twice during the week on the throwing side (A, B, C, A, B, C). Assuming the athlete has a small break in between throwing and lifting, the athlete will then perform movement prep again before lifting. The athlete will also alternate each type of movement-prep day on the lifting side of things (A, B, C). If you do the math, athletes will typically lift 3 days per week (2 during the season) and throw 6 days per week. That means there will be days where athletes perform different movement-prep protocols for throwing and lifting. For example, it's possible for an athlete to perform movement-prep C for throwing and movement-prep B for lifting on the same day. The athlete should do soft-tissue work before throwing but does not need to do soft-tissue work again before lifting.



Creatine Phosphate

1

CORE-MOVEMENT LIFTS

Loading the spine or arms with hundreds of pounds of iron is generally only a good idea if an athlete knows what he's doing with it, so mastering the technique of the lifts is vital. Conventional methods for doing form checks and mastering mechanical movements of compound lifts involve using very light weights or looking in a mirror during the movement. Unfortunately, there are some issues with these methods.

Attempting to replicate perfect mechanics by using light weights in the hope of transferring them over during near-maximal attempts is well-intentioned, but misguided. Problems mostly occur when weight increases—not with lighter weights. This means that a lot of technique mapping with lighter weights will not carry over to heavier loads. Additionally, increased weight on the bar often causes a different range of motion. This is especially true during the front squat where increased compressive loading allows for a deeper squat position in many athletes and a different speed at which this position is attained. While it is not a bad idea to check technique using bodyweight movements or lightly loaded drills, technique must especially be paid attention to as effort reaches 75-80%, as this is where athletes will gain the most proprioceptive benefit.

Looking in the mirror while doing the movements could be considered a reasonable idea, but it's naïve. Paying attention to a moving object in space while straining against near-limit weights can easily cause athletes to lose concentration and potentially put themselves at risk. Therefore, almost no elite powerlifting gyms in the world have mirrors, and as such our facility does not have mirrors either. It is highly advised for all athletes to pick a stationary focus point and to lock in on that spot throughout the lift. A single, stable point of focus to count is important, considering balance is a highly underrated yet very important part of moving big weights around. For example, try standing on one leg with your arms away from your body and roll your eyes around. Next, try standing on one leg with your arms away from your body while staring at a single point on a wall. See the difference? This is the type of focus required when an athlete has 315 lb. of iron across the shelf of his clavicle!

We highly suggest video review of each athlete's lifting mechanics, especially if it can be done shortly after completing the lift. This can create adequate visual feedback for athletes by allowing them to see themselves move the weight, which helps them correlate a feeling with a movement. From there, athletes can self-organize their lifting patterns, much like they do in throwing. Corrective exercises become easier to prescribe as well when visual and kinesthetic feedback exist to diagnose the issue.

Our strength programs are designed with core-movement lifts as the epicenter of the programs. This means that selecting high-quality, multi-joint exercises that have the highest carryover to general athleticism and sport-specific training is important because the human body has evolved over time to work as a group of coordinated levers and pulleys—not single-joint exercises that bear no similarities to human movement outside of the weight room. The core movements in *Hacking the Kinetic Chain — Advanced Pitching* are the **front squat, deadlift, dumbbell bench press,** and **pull-up**. These exercises were selected for their ability to cover the entirety of the athletic chain in an efficient manner while still being relatively simple to learn.

Front Squat

The front squat was chosen over the back squat for multiple reasons: it is easier to teach, carries lower risk of injury, pairs well with the deadlift with less overlap, and trains the stabilizers of the upper torso in a unique way. While more weight can be moved in the back squat due to mechanical and kinesiological advantage, raw numbers are not what we are targeting.

Front squats are quad-dominant exercises, meaning that the quadriceps are the prime movers for this lift. The quads extend the knee and flex the hip, which are vital movements in both creating and accepting ground-reaction forces during the pitching delivery. The glutes work synergistically to support the front squat and have high activity when the thighs break a plane parallel to the ground. The soleus and gastrocnemius (calf muscles) work to anchor the feet to the floor and provide stability, while the hamstrings pitch in as well.

The muscles that control the spine work isometrically to keep the back in a neutrally curved posture. The serratus anterior has high activity in this lift as the barbell is carried out front with the scapula protracted, making this a great tertiary activator of a major muscle group related to throwing a baseball. The obliques and rectus abdominis in the core work antagonistically to stabilize the torso, which provides a unique stimulus that cannot be attained through rotational power throws.

While the front squat is easier to teach than the back squat and arguably has better carryover in baseball, there are still a lot of areas where this lift can go wrong. Common mistakes in the front squat include:

- *Dumping the elbows when beginning the upwards initiation*
- *Rounding of the lower back due to insufficient lumbar control*
- *Cheating the depth and not squatting below parallel*

Baseball pitchers live with a forward-head posture and slumped shoulder. As a result, it becomes difficult to even remember what normal spinal posture feels like. This problem is compounded if one is to sit in a chair for most of the day, which is the case for all high school and college student-athletes, or any pitcher that rides the bench. For this reason, it's better to err on the side of lumbar hyperextension, as athletes may feel like they are overextending at the lumbar spine (lower back), but they actually have normal posture.

Squats that do not go below parallel do not count—and are actually dangerous for your knees. The myth that full-depth squats put the knees at increased risk for injury is not only perpetuated around the world but also is often used as a justification for squatting huge numbers in high-school football programs. Unfortunately, these reps are incomplete and do not build full body strength. Peak anterior cruciate ligament (ACL) force is at around 15 to 30 degrees of knee flexion, so rebounding out of a "quarter squat" position is actually very stressful on the knees' connective tissue. Creating more than 60 degrees of knee flexion reduces stress on the ACL and also allows the hamstrings to work as decelerators, reducing stress on the anterior knee and patellar tendon.

Since an entire book could be written about the biomechanics of the knee and hips, for more information on this we highly recommend Mark Rippetoe's *Practical Programming for Strength Training* and *Starting Strength: Basic Barbell Training* if you are so inclined.

Now, let's examine the steps to correctly perform the front squat:

1 STEP ONE

Help the athlete set the bar at correct height; this exercise is almost always done incorrectly with the bar's being set too high. If the athlete has to go on the toes to unrack the bar, the pins are too high on the squat rack. The bar should come to just above the solar plexus (mid chest) and the athlete should have to slightly bend the knees to get the bar into the correct position.

2 STEP TWO

Have the athlete jam the bar into the throat. This sounds crazy, but the correct bar position is very close to the neck. The further away the bar is carried away from the body, the bigger the level angle and the more likely it becomes that the bar will be dumped out in front or the mid-back will enter flexion; neither case is positive.

3 STEP THREE

Instruct the athlete to grip the bar. The preferred grip is clean with the index fingers hooked under the bar, elbows at shoulder height in front of the body. If the athlete lacks flexibility or the position is bothersome due to pre-existing elbow issues, the **strap-assisted grip** is the next best idea, though this requires some powerlifting straps or a light-arm sleeve that allows for the hands to operate above the bar in a reverse neutral grip. If that is not an option, then the **cross-hands grip** also works. However, dumping the bar if the athlete fails the lift can be tricky with this grip, so we only advise using this grip if straps are not available and if flexibility isn't good enough to use the clean grip. Additionally, powerlifting straps cost a few extra dollars online and are well worth it since they will allow athletes to deadlift and do pulling exercises even if they suffer a moderate laceration injury to their hand(s).

STEP FOUR

Have the athlete unrack the bar. The athlete should straighten the knees and extend at the hips, lifting the bar away from the pins with sufficient clearance. Take just two steps back, one with each foot to create sufficient distance away from the rack. If an athlete is squatting inside a cage, he should figure out the distance he can move back without hitting the rear uprights. It's important to get very good at this walkout procedure because taking extra steps and fumbling around as the weights get heavier is a waste of energy. The feet should be shoulder-width apart (or slightly narrower) and the toes should be pointed out slightly. This stance is not like the back squat, where the feet are wider and the toes are pointed out even further.

5 STEP FIVE

Have the athlete squat the bar. One cue for athletes is to think about dropping their torso between the legs. The negative movement is started by unlocking the knees and controlling the position of the hips so the torso falls straight downwards into the bottom position. Make sure the athlete keeps the back "flat" and elbows mostly up. Athletes should keep their vision locked downwards at roughly a 45-degree angle, looking at something on the floor. If necessary, set a towel, phone, or another object in this place for them to stare at. Don't look at gym windows or mirrors to check depth.

6 STEP SIX

Have the athlete return to standing position. Once the athlete has reached the bottom position below parallel (it doesn't count unless parallel is broken by a few inches), initiate the upwards movement by driving the elbow upwards and pressing the heels into the ground. The goal should be to put force deep into the ground while pushing the chest out and elbow up. As force is being applied into the ground, it's important to note that the athlete should be holding the breath; the **Valsalva maneuver** helps brace the core and protect the lumbar spine. The folk wisdom of "breathe in on the way down, breathe out on the way up" should not be used.

Deadlift

The deadlift was chosen as a core-movement exercise due to its ability to massively stimulate the posterior chain, primarily the glutes and hamstrings. It also works the upper back isometrically as the body supports maximal weights being pulled from the floor, making this a well-rounded exercise.

Two variations of this lift are acceptable: the **straight-bar deadlift** and the **trap-bar deadlift**. In both cases, the programming of sets, reps, and weight remains the same in *Hacking the Kinetic Chain — Advanced Pitching*, so they can be substituted for one another if necessary. However, switching between the two is not advised due to the familiarity of the lift and slight differences in mechanical patterns—skill and ability does not transfer in a 1:1 ratio between each lift. Pick one and stick with it.

Hip extension and glute anchoring are two huge components of the deadlift, and these movements are responsible for serious force production in the pitching delivery. While deadlifts may be the single-best strength exercise that can be performed for maximum carryover both to swinging a bat and throwing a ball, they are also one of the most dangerous lifts in the weight room. While the motion is rather simple to explain (pick a heavy weight up off the floor and then set it back down), the mechanics of the lift can sometimes lead to injury if particular care is not taken at critical points during the range of motion.

Imagine that the scapulae hang over the bar and you start with a neutral or slightly extended lumbar spine (remember, slight overextension is better than any amount of flexion). From this position, the bar should be pulled up the body is as close to a straight line as possible, yet the body is doing anything but that. Your back is straightening while your knees are locking out—it's no wonder there are serious areas where the lift can go wrong. Getting the deadlift technique correct is perhaps the most important factor in this chapter, so be sure to allow athletes to take their time when progressing this lift.

1 STEP ONE

To create the starting position, have the athlete approach and grip the bar. Both hands can either be pronated or in a mixed grip with the non-throwing hand supinated (this will eventually be necessary when deadlifting very heavy loads). The grip should be just outside knee width and the bar will be in contact with the shins. Another way for the athlete to picture this is if they look down at the feet, the bar should cut them in half. The bar should not be further away from the body than this. The athlete's vision should be focused downwards at a few feet in front of the body, not forwards or upwards towards the ceiling. The back should be flat and slightly extended at the lumbar spine while the scapulae hang over the bar. The shoulders should be above the hips, and the hips should be above the knees.

2 **STEP TWO**

Instruct the athlete to initiate the pull off the floor by pushing the heels and midfoot into the ground, propelling the bar upwards. Ensure the athlete keeps the bar very close to the shins, which likely means the bar will maintain contact with them throughout the pull. The athlete's knees unlock, hips extend, and back straightens as the weight comes up in a nearly straight path.

3 **STEP THREE**

The bar reaches the end range of motion and the athlete's knees, hips, and back are all locked out.

4 **STEP FOUR**

Have the athlete lower the bar by sticking the butt backwards before unlocking the knees. If the knees unlock first, which is something every new lifter tries, the bar will have to curve over the knees to avoid banging into the tops of them. This is fine at 100 lb. but will be a problem with much heavier loads. It's ideal to make sure the athlete nails down the correct lowering technique before dealing with heavier loads. Once the lowering of the weight is underway, have the athlete set the bar down, keeping hands on the bar, count for 1 second, and then begin the next rep. A deadlift is not bounced off the floor—if this was the case, it wouldn't be called a "dead" lift.

The steps for completing a deadlift with a trap bar is a bit simpler than a straight bar. The athlete should stand in the middle of the bar while it is on the ground and squat down with the back flat or slightly overextended at the lumbar area (lower back). Once he grabs the neutral handles, the athlete should put force into the ground through the heels, unlocking the knees and standing up straight into the lockout position. It's important to note to not "jerk" the elbows in an attempt to assist the lift. To lower the bar, the athlete should stick the butt out and unlock the knees slightly later to safely return the bar to the floor.

Dumbbell Bench Press

While we use different variations of the barbell bench press in our facility with athletes training under the supervision of our strength coaches, we prefer the dumbbell (DB) bench press for the purposes of strength programming for *Hacking the Kinetic Chain — Advanced Pitching*. The independence of the arms in the DB bench movement allows for greater scapular control and allows for unique variations like neutral-grip pressing that are not easily replicated with a barbell, unless your weight room has a neutral-grip barbell. Since throwing a baseball is asymmetrical, locking both arms in a singular plane of motion with the same grip on the barbell is not always the best decision. However, using dumbbells has tradeoffs. Progressively loading dumbbells can be tough without a full rack of dumbbells or specialized equipment, like Powerblocks, and increments are usually larger, making jumps between workouts rather big. Investing in some magnetic weights to attach to the dumbbells might be necessary if progress becomes difficult.

The pectoralis major and triceps are the prime movers in the DB bench press, and both are used in the pitching delivery. The pectoralis major flexes, adducts, and internally rotates the shoulder while the triceps extend the elbow. Those movements are the core of what people consider "throwing a baseball" looks like. The muscles of the back and upper torso are also used isometrically to provide support at the scapula to protect and retract throughout the movement, whereas the biceps anchor the elbow and work eccentrically.

The DB bench press is the primary upper-body push lift. While it seems like an easy movement, there are a few common mistakes to watch out for:

- *Flaring the elbows to the side*
- *Cutting off range of motion in the "bottom" position*
- *Not pronating/supinating through the range of motion*

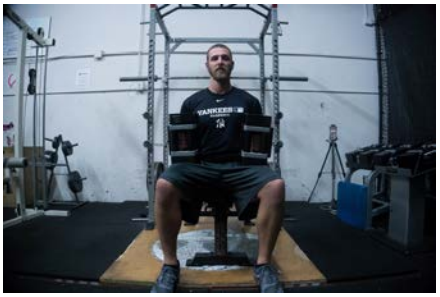
Lifters often cheat the range of motion since unlike a barbell, there's no definitive "bottom" in the DB bench press range of motion. The "bottom" with a barbell is simply touching the bar to the chest, but it's a little less clear what full range of motion feels like with a dumbbell. Additionally, most benchers in general flare their elbows very far away from their body, stressing their anterior capsules and lacking tricep activity to finish the lift. This is not only inefficient but also unnecessarily dangerous. Here are the steps to take in order to correctly perform this exercise:

1 STEP ONE

Have the athlete grab the dumbbells while standing. There are two ways to get the dumbbells into the upright position:

1. *Pull them away from the rack and keep the elbows locked, then lie down with the elbows locked*
2. *Sit down and kick them up with the knees while lying down*

The first method is definitely better as the athlete begins to handle heavier weights, but it's also trickier to time up. To summarize, the method used is really the athlete's personal preference.



2 **STEP TWO**

While lying down, ensure the athlete's feet are in a wide stance and firmly planted onto the floor. The athlete's idea should be to "screw the feet into the floor" and spread the knees by squeezing the glute muscles. From the upright position, tuck the elbows at roughly a 45-degree angle to the body as the dumbbells are lowered to the chest. The athlete will slightly supinate the grip to do this, which turns on the lats and puts the body in a strong position to push the dumbbells away from them. "Winging" the arms away from the body only causes the tendency to dump the weight, potentially even tearing the pec muscles. During this lift, instruct the athlete to focus on a single point on the ceiling and make sure the feet stay in contact with the ground throughout the lift. The athlete should not look at the dumbbells when benching because this disrupts balance and sense of motion.

3 **STEP THREE**

Using a slight rebound, have the athlete push the dumbbells away and straight up while either slightly pronating the grip or maintaining supination and locking the elbows out. It's not a full rep if the lift is not finished, so don't allow athletes to cheat the range of motion.

Pull-ups

We chose the pull-up as the primary bodyweight core-movement exercise due to the fact that it stimulates large groups of muscles responsible for velocity production. This exercise uses the latissimus dorsi (lats) as the primary mover, which adduct, extend, and internally rotate the shoulder. The lats also play a very large role in decelerating the pitching arm at the moment the ball separates from the throwing hand. The teres major, posterior deltoid, infraspinatus, teres minor, pec minor, and many other groups are used in synergy to complete the lift while the long head of the triceps dynamically stabilizes the arm throughout the range of motion of the pull-up, making this one of the best bang-for-your-buck lifts that athletes can perform.

Ideally you and your athletes will have access to a neutral-grip pull-up bar, as this is the best variation for baseball pitchers. However, this is not very common and therefore standard pronated-grip pull-ups are fine. Note that we avoid palms-in chin-ups in *Hacking the Kinetic Chain — Advanced Pitching* due to high-intensity loads on the biceps and comparatively lower activity in the lower trapezius. High-direct activity in the biceps is a movement we like to avoid, whereas increasing activity in the lower traps is ideal due to the role it plays in keeping the shoulders strong and healthy. Below are the steps to properly performing this exercise:

1 **STEP ONE**

Have the athlete start with the bar out in the last knuckles, not deep in the palm. If the athlete uses the standard pronated grip, the hands should be just outside of shoulder width. Neutral-grip will have the hands a little bit inside the width of the shoulders. Elbows should be nearly locked out with just a slight bit of bend and the feet should not be in contact with the ground.

2 **STEP TWO**

Right before the initial pull, instruct the athlete to brace the abs. Next, the athlete should pull up with zero assistance from the lower body—do not "kip" the movement by swaying the legs or torso side to side. Kipping pull-ups, while common in CrossFit, are actually rather advanced exercises that place huge dynamic stress on the shoulders that we want to avoid. While the athlete doesn't have to touch the chest to the bar, the chin must clear the height of the pull-up bar for the rep to count. Once the athlete has made it to the top, have them lower down to the bottom position, stopping just short of full elbow extension. The next rep should begin with a very slight assistance from the stretch rebound position. Do not cut the range of motion off just to get a higher rep total; we aim for quality reps, not an arbitrary quantity of reps.

ACCESSORY LIFTS

The core-movement lifts selected for *Hacking the Kinetic Chain — Advanced Pitching* were chosen specifically for their ability to stimulate large groups of muscles by working over a large range of motion and coordinating the movement of multiple joint together. As such, we don't place a large focus on accessory or assistance exercises in the book. An exhaustive list of all accessory and assistance exercises that we use with pictures and details could be several books on their own. As such, we recommend going to the website to find the accessory lift videos for details on how to perform the individual exercises correctly.

It should be made clear that accessory exercises are indeed just that—*accessories* to the core-movement lifts, not replacements. The athletes you see doing hypersets of bicep curls with tricep skullcrushers never get any bigger in the gym and never seem to get any stronger, and there's a good reason for

that: they're likely skipping out on the major movements. Accessory exercises should not be overly taxing; rather they should as corrective movements that help retrain specific motor patterns or bring up weak links in a lift. Picking a handful of exercises and cycling them in and out of a strength program on a regular basis can ensure that weak links are systematically eliminated.

Again, we want to include accessory exercises that make positive contributions towards an athlete's goal to throw harder. Here's a short list of types of accessory exercises to stay away from and the reasons why:

- *Heavy Overhead Pressing: conflicting movement patterns*
- *Upright Rows: closing subacromial space in the shoulder—"impingement"*
- *Lateral Raises: high activity in middle deltoids*
- *Weighted Sit-ups: lower-back flexion*

3

ENDURANCE TRAINING:
Building the Right Motor

Endurance and stamina are very important for an elite pitcher, whether a starter that pitches every five days or a reliever that needs to be ready on back-to-back days with long stretches of downtime. The ability to recover is closely linked to how strong an endurance engine has been built. Unfortunately, the concepts of building a pitching-specific endurance motor are not easily boiled down to a single method of training. The coach that forces an athlete to run poles after pitching and go on long runs to build stamina is certainly wrong, but so is the trainer that has athletes only perform all-out sprints and high-intensity work.

What's lost in the discussion of endurance training is the fact that throwing baseballs is a form of endurance training in and of itself. By long tossing, throwing bullpens, doing weighted-ball work, or even pitching in games, the various energy systems are all working and adaptations are occurring despite the fact that athletes are performing a sport-specific activity that they may have a high individual tolerance for. This training often goes unnoticed in the grand scheme of programming for workouts, which can result in serious overtraining and maladaptation for pitchers, causing regression and possible exposure to injury.

There are three major energy pathways in the human body:

- *Neuromuscular*
- *Anaerobic*
- *Aerobic*

While neuromuscular is generally left out of most analyses since it's not strictly an energy system, it should be covered since it is highly relevant to throwing baseballs at high velocities. It is often assumed by even very advanced baseball trainers that anaerobic thresholds are equivalent to neuromuscular ones; this belief ignores the relationship between the central nervous system and the motor neurons responsible for movement.

Within those groups, the systems function differently for athletics. The ability to produce power is not the same as the ability to build capacity, even if there is a strong overlap between the two skills. Anaerobic and aerobic energy systems are best stimulated in different ways depending on the desired results, whereas neuromuscular adaptations can only be driven through one type of training.

Coaches who have their athletes primarily run long distances focus too much on developing aerobic capacity, and coaches who have athletes do strictly sprint-based interval work focus too much on developing anaerobic power and capacity. Let's break down the exact demands a baseball pitcher places on the energy systems of body:

- *Throwing a single pitch at high velocities primarily depends on neuromuscular and anaerobic power.*
- *The ability to repeat this effort throughout an inning of work with limited rest primarily depends on anaerobic capacity as well as aerobic power.*
- *Continuing to do this over a full nine-inning game with extended rest intervals between innings is a blend of anaerobic and aerobic capacity.*

Some may wonder how throwing a baseball at high velocities relates to running long distances. The simple answer is that it doesn't, and many training programs simply leave it at that. The more complex, and correct, answer is that the body isn't a highly specific machine that only works in one direction. There's a lot going on under the hood.

Increasing Thresholds: Building Mitochondria

When the body is at rest or under normal stress, it uses adenosine triphosphate (ATP) for energy. There's no problem with this because ATP is being reliably cycled for fuel, and there's no lack of stored ATP in the pool. But when an athlete starts exercising, ATP reserves become depleted and adenosine diphosphate (ADP) increases—the loss of a phosphate group produces energy for the muscles. ADP is rapidly recycled into ATP by a phosphate ion from creatine phosphate (CP), and so the muscles can continue to work.

ADP is eventually metabolized to adenosine monophosphate (AMP), and this entire chain of ATP to ADP to AMP activates something called adenosine monophosphate kinase (AMPk). AMPk activation is a large factor when it comes to creating more mitochondria, which are the "powerhouses" of cells.

Mitochondria process oxygen and aid in converting fatty acids into energy, but mitochondria also help to clear the blood of waste products and acid. This is not the same as lactic acid or lactate, which can actually be converted into energy—despite the idea that "flushing" the body of lactic acid is what hap-

pens after a post-throwing long-distance run. However, what is actually in the bloodstream after a period of training or competition is acidosis, and while the mechanism of action is not understood, mitochondria definitely do help buffer this fatigue-inducing process, making it an important aspect to improve. **Anaerobic training is the primary way to stimulate this engine over a short period of time.**

Interval-based training is a very popular and efficient way to recreate the fatigue-clear-fatigue cycle. A study by Dr. Izumi Tabata showed that interval-based training was better than aerobic-style training at developing VO2 max (aerobic power/capacity), which was highly counterintuitive. This finding took the fitness world by storm, and trainers around the world prescribe "tabata" protocols that alternate high-intensity work with rest periods in order to whip their clients into shape and improve their endurance capacities. High-intensity interval training (HIIT) became and remains popular today, and it is definitely an improvement over the long slow-distance (LSD) training that dominated the marketplace before it.

However, like most things in sports science and physiology, the body isn't that easy to hack. For your average sedentary person, HIIT is a great workout program to do twice per week to feel better. For athletes trying to compete at the highest levels, **HIIT alone can't be the answer.** For starters, interval-based training shows very rapid diminishing returns—after just a few weeks to a few months, adaptations crawl to a slow even though you're busting your butt in the gym. Mitochondria are not being sufficiently stimulated, and fatigue continues to set in at predictable levels. Secondly, high-intensity interval training is extremely difficult. HIIT-style workouts on a regular basis will lead to burnout and potential injury in even the most dedicated trainees. To break through this plateau without risking maladaptation, intelligent use of aerobic-style training is required.

Since interval-style training is both very taxing and leads to quick plateaus, we need to cycle in hard aerobic training to nudge the energy system to develop as a whole. By performing longer intervals with similar rest patterns as high-intensity interval training, both energy systems can be trained while focusing on aerobic power. The idea that training "slow" causes slow-twitch (type I) fibers to dominate the skeletal-muscle system has little to no basis in research or experimentation; besides, less than 10% of the training program is actually spent on "slow" cardio work—and that's only when the program focuses on aerobic development, which is usually less than half of an intelligently designed program.

Simply put, a blended approach to endurance training leads to increased pitching performance, increased ability to train for longer periods of time, a shorter recovery period as waste products more efficiently move throughout the system, and higher compliance due to variation in programming and lack of burnout. Let's break down the various types of training:

NEUROMUSCULAR POWER—MAXIMUM INTENT

Neuromuscular power is developed by the absolute effort an athlete can give to a particular type of exercise. A person should not be able to talk, control breathing, or even think about anything while performing this exercise at an absolute maximum level of effort. The work interval is about 10 seconds long while the rest interval is indefinite; the athlete should be fully recovered before attempting another rep, which usually means 2-5 minutes depending on ability level. Movements that fit the bill are concentric-heavy with very few eccentric "rest" periods—and the single best method for this is **sprinting.**

All-out sprints at the athletes' highest level of effort, as if they were running away from a feral animal, are great. Ten seconds of maximum-intensity sprinting followed up by three minutes of rest while lying down on the ground seriously stimulates neuromuscular power thresholds and not much else. If you have the equipment available, having athletes push or pull a loaded weight sled is also outstanding, and also a quick way to test what they ate for lunch if they don't take rest intervals seriously.

A sample neuromuscular power scheme involves 10 seconds of exercise at maximum intensity effort with 2-5 minutes of complete rest. Repeat four times (five bouts total).

ANAEROBIC POWER/CAPACITY— HIGH AND MIXED INTENT

Anaerobic power and capacity are strongly linked, so we discuss them in the same category. While doing anaerobic training, athletes should not be able to talk but should be able to control breath and thought. This is different from neuromuscular-power training where everything not related to the exercise gets shut down due to the intensity of the movement. The work intervals for anaerobic training are 15-45 seconds long with an equivalent rest period; the athlete should be challenged but not fully recovered when beginning the next rep. Eccentric patterns are acceptable when selecting exercises for this modality, since intra-rep rest doesn't affect the goal of the program, which is to train through a slightly fatigued state.

There are a wide number of exercises that work well for this modality:

- *Deadlifts (submaximal weight)*
- *Front Squats (submaximal weight)*
- *Kettlebell Swings*
- *Pull-ups*
- *Rowing Ergometer/Concept2 Rower*
- *Thrusters*
- *Weight-Sled Push/Pull*

Cycling in various exercises is probably the best approach, as it keeps the endurance training fresh, interesting, and also helps to balance out the athlete's actual training in other areas. By doing deadlifts at near-maximum intensity for many reps in a defined time period, athletes may discover how to better swing the kettlebell more efficiently, transferring beneficial movement patterns back into their strength program.

A sample anaerobic power/capacity scheme could include 30 seconds of high effort Concept2 rowing work followed by 30 seconds of complete rest. Repeat cycle seven times (8 minutes total).

AEROBIC POWER/CAPACITY— SUPRAMAXIMAL STEADY STATE

Like anaerobic power and capacity, aerobic power and capacity are closely linked, so we lump them into the same category—though *Hacking the Kinetic Chain — Advanced Pitching* trends significantly more towards aerobic power. During aerobic training, athletes should be able to hold a terse conversation, control the breath, and think about simple things over the duration of the exercise. The work intervals are anywhere from 8-20 minutes in length with a rest period half of the work period.

Whole-body stimulation is ideal for aerobic power training, but may be difficult without specific equipment. The single best piece of equipment is a rowing ergometer, usually a Concept2 Rower, to get the widest cross-section of muscle contribution. If a Concept2 is unavailable, a bicycle (stationary or conventional) works rather well, especially if it is a

training bike with moving arms like an AirDyne.

Since time is usually a factor, recommending 20-minute work intervals with 10-minute rest periods over 4 sets is tough to adhere to, as two hours on a bike will certainly drive most baseball players crazy. Fortunately, since we generally want the lower-end rep range to produce the results we want, it doesn't end up taking too much time. Remember that these reps should not be easy; it should not be terribly comfortable for the 8 minutes the athlete is pumping the bike's pedals.

A sample aerobic power/capacity scheme could include 8 minutes on a stationary bike at above steady-state effort followed by 4 minutes of active rest while the athlete performs light mobility drills during this period of time. Repeat 2 times (36 minutes total).