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Anatomy Gets Real
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FLS FITNESS LEARNING SYSTEMS

For fitness professionals, anatomy is the never-ending learning challenge. It is difficult to understand when you begin your fitness professional journey, and the need to learn more continues throughout your career. It's like slowly climbing a never-ending ladder. Rung by rung you make progress, but never reach the top because there is always more to achieve in the learning process.

Referred to as "Applied Anatomy" or "Structural Kinesiology" or "Fundamental Movement", this topic is about muscles and joints, and how the body moves. It is also about the complexity of movement that is created when you add external forces, such as tubing, weights, or the water.

Joints, Movement Terms, Planes of Motion & Axes of Rotation
Every review of muscles, joints and movements begin with the planes of movement, axes of rotation and basic joint structure. It is important to understand how joints work and in which direction they allow movement. In addition, you need to regularly review the movement terms and be able to apply them in combination with the joints and movement planes. If there are terms in these tables with which you are not completely familiar, pull out your anatomy book, or look them up online, to move up another rung on the ladder.

Diarthrosis Joints - Freely Moveable Joints			
Name of Joint	**Description**	**Examples**	**Primary Movements**
Gliding or Arthroidial	Bones are usually flat. Simplest type of movement at a joint.	Between carpals and tarsals, ribs glide on vertebrae, clavicle glides on the sternum and scapula.	Side-to-side and back-and-forth movements.
Hinge Joint or Ginglymus	Convex surface of one bone fits into concave surface of other.	Knee, elbow, ankle, interphalangeal joints.	Typically in one plane; flexion and extension.
Pivot or Trochoid	Rounded or pointed surface of one bone articulates within a ring surface of another.	Between the atlas and axis (neck), and the ulna and radius (forearm).	Rotation; one plane.
Condyloid or Ellipsoidal	Oval shape of one bone fits into an elliptical cavity of another.	At the wrist between the radius and carpals.	Side-to-side and back-and-forth movements in two planes. Can combine into circumduction, which is multiplanar.
Saddle or Sellaris	One bone is saddle shaped and the other is shaped like the legs of a rider sitting in the saddle.	Joint in the thumb by the wrist. It is a modified condyloid joint. Allows opposition of the thumb.	Side-to-side and back-and-forth movements; slightly freer than a condyloid joint.
Ball and Socket or Spheriod	Ball-like surface of one bone to a cup-like depression of the other.	Shoulder and Hip	Permit movement in all three planes. Flexion, extension, abduction, adduction, rotation, and circumduction.

Following is a basic review table (not comprehensive) to help you combine and review these three movement concepts.

PLANE	AXIS	MOVEMENTS	JOINTS
Frontal - Runs side to side dividing the body into front and back halves	Sagittal - Runs front to back intersecting the frontal plane at a right angle	Abduction & Adduction	Hip, Shoulder, Scapulothoracic, Wrist, Fingers and Thumb, Pelvis, Knee, Atlanto-occipital (neck), Spine
Sagittal - Runs front to back dividing the body into right and left halves	Frontal - Runs side to side intersecting the sagittal plane at a right angle	Flexion, Extension, & Hyperextension Dorsi Flexion & Plantar Flexion	Hip, Shoulder, Elbow, Wrist, Fingers and Thumb, Pelvis, Knee, Ankle, Toes, Spine (lateral flexion to reduction)
Transverse - Runs parallel to the ground dividing the body into upper and lower halves	Vertical - Runs up and down intersecting the transverse plane at a right angle.	Internal & External Rotation Transverse (horizontal) Abduction & Adduction	Hip, Shoulder, Scapulothoracic, Radioulnar (pronation and supination), Knee (limited internal and external rotation), Atlantoaxial (neck), Spine

Additional movement terms describe movements at joints that are typically multiplanar (combined movements in planes) or in the "oblique" plane. These terms with an example include:

- Elevation & Depression: scapulothoracic joint (shoulder blade)
- Lateral & Medial Tilt: scapulothoracic joint, pelvis
- Upward & Downward Rotation: scapulothoracic joint
- Diagonal Abduction & Adduction: shoulder, hip
- Opposition & Reposition: thumb
- Inversion & Eversion: subtalar joint
- Pronation & Supination (foot): combined joint movement in the ankle/foot

Muscle Actions

Pure movement refers to movement that is unrestricted by environmental considerations. This is a great way to start learning what muscle moves what joint. It gives you a fundamental reference point for movement from which you can build knowledge of how the body works in different environments and with different types of equipment.

Pure movement does not typically happen because we live in a gravity environment, but it would occur in outer space where there is no gravity or water viscosity. If you are not certain of pure movement for each primary joint and muscle in the body, it is good to go back and review. After you review primary muscles, challenge yourself to step up one more rung of that anatomical ladder of knowledge by adding additional secondary or smaller muscles to your knowledge base. There are approximately 640 skeletal muscles, or 320 pairs of muscles in the human body. That's a lot of opportunity to learn!

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There are two primary muscle actions used in everyday movement and exercise – isotonic and isometric. An isotonic muscle action occurs when you move a constant load through a range of motion. The muscle shortens and lengthens and movement occurs at the joint. In some environments when equipment is added, the isotonic muscle action can be differentiated by a concentric and eccentric contraction.

- Concentric: The muscle shortens and pulls on another structure, such as a bone, to produce movement and to reduce the angle at the joint. Concentric muscle actions are usually "resisted" contractions. The muscle generates force while shortening; the actin filaments slide over the myosin cross bridges being pulled closer together.
- Eccentric: The muscle length increases during contraction. Eccentric muscle actions are used to control movement in "assisted" movement. The muscle generates force while lengthening; the sarcomere is stretching as actin filaments are pulled farther away from the center.

An isometric or static muscle action occurs when the muscle does not or cannot shorten, but the tension on the muscle increases. Tension occurs in the muscle without movement at the joint. An example would be holding a book out in front of your body or pressing against an immovable object.

Although muscle actions are combined throughout the body in movement, this article will concentrate on looking at the isotonic muscle action occurring at the primary joints, and primary muscles involved. If you are new at this, this perspective is a great place to start. If you are a veteran, this is a great foundation to build from.

Identifying Muscle Actions

In order to determine which muscle is the primary mover for an exercise or movement, three factors must be considered.

1. How is each joint moving and in what plane? This will help you identify the muscles involved and the anatomical movement occurring.
2. Is each part of the movement sequence assisted or resisted? This is determined by the environment (gravity or water) and by the type of equipment you are using (weighted, buoyant, drag, rubberized, etc.).
3. What muscles are doing the work and what is the muscle action for each part of the movement sequence?

The classic example is to use the Forearm Curl (elbow flexion and extension) from an upright anatomical position.

On land without equipment or with weights.

Environmental factors: Gravity and the weight.
Flexion of the forearm at the elbow:
Resisted by gravity = concentric (shortening) contraction of the biceps.
Extension of the forearm at the elbow:
Assisted by gravity = eccentric (lengthening) contraction of the biceps.

In pure movement the biceps flex the forearm and the triceps extend the forearm. With gravity, the isotonic muscle action now involves a concentric and eccentric contraction of the biceps muscle only. In order to work the triceps muscle, you have to reposition the upper arm against gravity.

In water without equipment.
Environmental factors: The water's viscosity and buoyancy.
Flexion of the forearm at the elbow:
Resisted by water = concentric contraction of the biceps.
Extension of the forearm at the elbow:
Resisted by water = concentric contraction of the triceps.

So the water's viscosity creates resistance to movement in all directions yielding a paired concentric action, similar to pure movement. Paired concentric contractions are economical (two muscles worked with one exercise) and help create muscle balance.

In water with drag equipment.
Environmental factors: The water's viscosity and buoyancy, the water's viscosity becomes more dominant.
Flexion of the forearm at the elbow:
Resisted by water = concentric contraction of the biceps.
Extension of the forearm at the elbow:
Resisted by water = concentric contraction of the triceps.

The same muscle equation created in the water without equipment. You are just increasing the effect of the water's viscosity or drag properties, creating more resistance by increasing the surface area with the drag equipment.

In water with buoyant equipment
Environmental factors: The water's viscosity and buoyancy, however buoyancy becomes more dominant.
Flexion of the forearm at the elbow:
Assisted by buoyancy = eccentric contraction of the triceps.
Extension of the forearm at the elbow:
Resisted by buoyancy = concentric contraction of the triceps.

Many people are misinformed that if you turn the hands over, you change the muscle group with a buoyant hand bar. This is not true because turning the hands is pronation and supination of the forearm – a different joint, movement and muscles engaged. Regardless of the hand position, the muscle action at the elbow for a forearm curl is still flexion and extension; the same primary muscles are used regardless of hand position.

With buoyancy, things get turned upside down… literally. The buoyant equipment muscle equation is directly opposite the land gravity muscle equation, simply because the resistance is flipped. To work the biceps with buoyancy equipment, you would need to reposition the muscle against the water's buoyancy.

- In Gravity: movement is resisted up and assisted down
- With Buoyancy: movement is assisted up and resisted down

There are actually a few muscle groups that are not easily worked in the water with buoyant equipment because it is difficult to position the body in the water to use buoyancy as resistance.

- A side arm raise is great work for the latissimus dorsi muscles. (Buoyancy assisted up/abduction, buoyancy resisted down/adduction = eccentric and concentric latissimus dorsi.) But in order to work the deltoid muscles in that muscle pair, you would need to stand on your head.

- A side leg raise with buoyant cuffs on the ankle is great work for the inner thighs. (Buoyancy assisted up/abduction, buoyancy resisted down/adduction = eccentric and concentric inner thigh/adductors.) But the side lying position in the water to work the outer thighs/abductors against buoyancy is awkward and not very effective.

This information is a basic review, barely scratching the surface of applied anatomy. But reviewing and building on the basics is essential to growing your career and your effectiveness as a fitness professional. If you are already comfortable with the basics, start challenging yourself to put together multi-joint muscle equations. Take another step up the ladder of knowledge. It is amazing how the body's muscles and joints work together in myofascial chains (groups of muscles bound together with connective tissue) to allow complex movement in the body.

Knowledge is power. Knowledge allows you to understand each movement you create and execute during exercise. Understanding how the body moves is important to safety and effectiveness. Being a fitness professional requires a life-long commitment to the pursuit of knowledge.

RESOURCES

Chewning, J. (2013). Applied Anatomy: Land and Water. Fitness Learning Systems. www.FitnessLearningSystems.com.

Thompson, CW, Floyd, RT. (2012). Manual of Structural Kinesiology. 18th Edition. McGraw Hill Publisher: New York, NY.

This information is adapted from Applied Anatomy: Land and Water with video and graphics to help you understand these concepts. This course is available with AEA CECs on the AEA eLearning platform. For more information go to www.aeawave.com, click on Education, CEC Providers, eLearning. Fitness Learning Systems is proud to be an IACET accredited continuing education provider. Use Coupon Code "Anatomy" at check out to receive a 20% discount on the course. 888.221.1612.

June Chewning MA, BS, has served as an educator since 1978 as an elementary physical education teacher, a college adjunct professor, an instructor for community fitness and wellness, children's courses, as a master trainer, and an instructor for continuing education lectures and workshops internationally. June has created curriculum for accredited college courses, continuing education courses and workshops, wellness courses, certification/certificate programs, and community education. She is currently the education director of Fitness Learning Systems, a continuing education company for health-fitness professionals.