























## **Physical Preparation**

### 1. Neural Impulses

- Neural signals determine the **strength**, **speed** and **duration** of muscle contractions
- They are also responsible for patterning every movement
- Therefore they are the **drivers** of most **physical** and **motor** enhancement





#### **Physical Preparation**

- **1. Neural Impulses**
- We will see later that there are several ways

to improve strength by

enhancing the neural signals to muscles

### **Physical Preparation**

What are the two things needed for muscles to contract?

- 2<sup>nd</sup> part of Answer
- 1. Neural Impulses
- 2. Energy

## **Physical Preparation**

## Energy = ATP (Adenosine TriPhosphate)

- Used by most living organisms as their source of energy for chemical reactions
- We have very limited stores of ATP in muscle
- BUT we manufacture (synthesize) it very quickly from **raw material** in muscle...

#### **Creatine Phosphate (CP) and Glucose**

 Glucose comes from carbohydrates which are the sugars and starches in our diet

## **Physical Preparation**

#### Energy = ATP (Adenosine TriPhosphate)

- It is extremely quick to get ATP from CP,
  - and very quick from glucose,
  - both do not need Oxygen (Anaerobic)
- There is a slower, but more economical way (uses less glucose) using Oxygen (Aerobic)
- These processes take place locally in muscle
- For most gymnastics activities, we want to improve the anaerobic capacity

## **Physical Preparation**

Energy = ATP (Adenosine TriPhosphate) Question 2

What is **fatigue** 

## **Physical Preparation**

Energy = ATP (Adenosine TriPhosphate)

### Answer

Muscle **fatigue** = depleted **glucose** and **CP** Therefore no **ATP** Therefore **no contraction** 



## **Muscular Endurance**

Energy = ATP (Adenosine TriPhosphate)

### **Question 3**

What is the **best training method** to increase **muscular endurance**?

#### **Muscular Endurance**

#### Energy = ATP (Adenosine TriPhosphate)

#### Answer

- Fatiguing muscles in 15 30 repetitions to exhaustion (Rep's Maximum or RM's) depletes local stores of glucose
- This stimulates the muscle to restore depleted CP & Glucose
  - to a slightly higher level than previous!

## **Muscular Endurance**

## Energy for muscle contractions Summary

- Muscle fatigue = no glucose = no ATP
   = no energy for contractions
- Muscle endurance = having sufficient stores of CP and Glucose for continued contractions
- Glucose comes from carbohydrates which are the sugars and starches in your diet
- Training to fatigue, in 15 30 repetitions increases reserves of glucose (stored in chains called 'glycogen')

### **Muscular Endurance**

### **Question 4**

Why should we train **muscular endurance** (ME), **before strength**, and **power**?

#### **Muscular Endurance**

#### Answer

- ME training increases the stores of glycogen (glucose) thus allowing greater work capacity
- Less fatigue = less injuries due to fatigue
- ME training of **15 30 RM's** uses **medium resistance**...
- Therefore you **slowly** and **safely PREPARE muscles**, **tendons and bones**...
- for the greater stresses when you change to strength & power training

#### **Muscular Endurance**

Note to Coaches

- Muscular Endurance training should be reduced as strength training increases, and as skill repetitions increase...
- Otherwise you increase the risk of overuse injuries!
- You can **maintain Muscular Endurance** by training it only **once per week..**.
- Especially with **High Intensity Interval Training** (HIIT)
- Use good postures and technique always!

### **Muscular Endurance**

#### **Question 5**

Is there only ONE type of skeletal muscle fibre?

#### **Muscular Endurance**

#### Answer No...

- There are predominately **2 types** of musle fibres:
- Fast Twitch contract quickly, fatigue quickly
- **Slow Twitch** contract slowly, fatigue slowly
- Normally we have about 50% of each fibre type in our muscles, but this is extremely variable between people
- Athletes with higher % of fast twitch fibres do
   better in power sports

#### **Muscular Endurance**

#### **Question 6**

Can we **selectively recruit and train** fast twitch (or slow twitch) fibres?

### Muscular Endurance

## Answer Yes

- Understanding this will be **important** in **selecting** (and **eliminating**) exercises
- Good selection will allow us to train SMART rather than train MORE, thus reducing overuse injuries
- Training for Muscle Endurance, for example, selectively recruits slow twitch fibres...
- Training for Power selectively recruits fast
  twitch fibers

## Universal Training Principle #1

 This is a good time to introduce the first of several Universal Training Principles









## Universal Training Principle #2

This brings us to our 2nd Universal Training
 Principle



- If gymnasts are training 10 RM's, they will soon be able to do **12 or more repetitions**
- Increase load so they are back to 8 or 9 RM's.
   Do not let number of reps increase higher than 12 RM (progressive loading)



## Flexibility

- What changes to tissues takes place...
- When you increase your flexibility (Range of Motion ROM) ?





## **Connective Tissue Stretch**

## Flexibility

- What changes to tissues happens...
- When you increase your flexibility (Range of Motion ROM) ?
- Connective tissue (tendon, ligament) elongates (creeps) when stretched repeatedly
- Prolonged and vibratory stretches are most effective
- Youthful collagen is more responsive than older



## **Muscle Tissue Stretch**

- Each sarcomere consists of overlapping proteins (contractile proteins actin and myosin)
- This is what we train ... where most physical preparation adaptations take place !



#### **Muscle Tissue Stretch**

### Flexibility

- What changes to tissues takes place...
- When you increase your flexibility (Range of Motion ROM) ?
- **Connective tissue** (tendon, ligament) elongates (creeps) when stretched repeatedly
- Muscle tissue actually "grows" longer ...
- ...by increasing the number of sarcomeres at the ends of muscle fibres

## **Physical Preparation**

#### Flexibility

Are you **stretching to warm-up**? Or, are you **warming-up to stretch**?

We should emphasize the 2<sup>nd</sup> option

- Flexibility is critical to **safe** and **effective** performance in gymnastics, thus it must be **specifically trained**
- The general warm-up is NOT the best time for flexibility training – NOR is static stretching a good warm-up for dynamic activity !

#### **Flexibility**

### Flexibility

### **Question 7**

Is there **more** than **one Range of Motion** (ROM) about a joint

#### **Flexibility**

#### Answer Yes

- PASSIVE Range of Motion uses an external force to move a limb to its end range:
- Splits on floor relies on the external force of gravity
- Partner stretching uses external force of partner
- A gymnast holding a limb in stretched position or positioning limb with external force



## Flexibility

- 2) ACTIVE Range of Motion uses internal muscle force to move limb to its end range
- Most gymnastics skill require ACTIVE ROM



## Flexibility



### Flexibility

There are **two pairs of terms** that are **often confused** in flexibility discussions:

PASSIVE and ACTIVE Range of Movement Static and Dynamic

- Static means NO MOVEMENT
- Dynamic means MOVEMENT

Can you see that each ROM (PASSIVE or ACTIVE) can be achieved by:

- Holding (static)
- Or by **Moving** (dynamic)

## Flexibility

#### Assignment

Give **one** example of an activity showing **each** of the following:

**PASSIVE ROM - Static** 

PASSIVE ROM - Dynamic

ACTIVE ROM - Static

**ACTIVE ROM - Dynamic** 

videos of examples

#### **Flexibility**

To train **PASSIVE** Range Of Motion

- You only have to **stretch tissues**...either statically or dynamically. You elongate tissues
- Over-stretching is only for **PASSIVE ROM**.
- It is NOT necessary to achieve a good ACTIVE ROM and it can be detrimental to joint stability



# Flexibility

- It is very possible to stretch tissues and have a very good PASSIVE ROM...
- but, a **poor ACTIVE ROM**





#### Flexibility

#### To train **ACTIVE Range of Motion**

- You stretch tissues on one side of a joint, and strengthen muscles on opposite side (to actively move the limb to its end range)
- Thus ACTIVE Range of Motion training is: - 50% stretching
  - 50% strengthening (opposite side of joint)
- This is best done statically first and eventually dynamically

#### Flexibility

### Flexibility

There are **pros** and **cons** to having coaches stretch gymnasts

- In most disciplines it is not necessary, and it can lead to awkward and compromising postures for coaches, especially coaches of opposite gender
- In disciplines where it is traditionally done, and perhaps considered necessary, special education on appropriate and inappropriate stretching must be done

#### Flexibility

## Flexibility

- Another stretching method that is very effective is **PNF** stretching (the full name **p**roprioceptive **n**euromuscular facilitation is not important)
- The essence of this method is that you stretch and then you contract (try to shorten) the muscles that are being stretched!
- Amongst other things, this gives the tendons at each end of muscle a second stretch. Tendons are stretched, then you contract the muscles - further stretching tendons

#### Flexibility

There are two variations of PNF stretching: For **PASSIVE ROM** 

- At end range of stretch, contract muscles **that are being stretched** (antagonist) 5 -10 sec
- When the contraction is released you should immediately move the limb to a slightly more stretched position and hold (Passive PNF)

#### Flexibility

#### For ACTIVE ROM

- At end range of stretch, contract muscles that
   are being stretched (antagonist) 5 -10 sec
- When the contraction is released, you should immediately move the limb to a slightly more stretched position and AT THE SAME TIME...
- Contract the 'agonist' muscles (muscles on opposite side to stretched muscles) that move limb to the new position - thus increasing strength of these muscles (Active PNF)

#### Universal Training Principle #3

#### Specificity

- In all aspects of physical preparation SPECIFICITY is paramount
- We get adaptive changes specific to the stimuli we use
- Coaches must select exercises specific to the desired outcome (speed of movement, contraction, movement pattern)
- Avoid non-specific exercises. They contribute to over-training and overuse injuries

## Universal Training Principle #4

## Individuals Vary (Differ)

- Hereditary (genetics)
- Maturational stage
- Nutrition
- Levels of physical / motor fitness
- Rest / sleep
- Motivation

## Universal Training Principle #4

## Individuals Vary

Individuals respond differently in all aspects of physical preparation

Coaches may start season with exact same training program for a group of gymnasts, but it should be changed:

- And become tailored for each gymnast as each gymnast adapts to the training
- Monitoring really helps coaches do this
- Good record keeping or gymnasts' logs also helps with this individualization







## Strength

#### **Question 9**

What are the two ways to increase muscular strength?



- Increasing muscle size increases the amount of contractile proteins in each fibre (not increasing number of muscle fibres)
- As we increase our hypertrophy we **increase** our **ABSOLUTE** strength...
- But, we need to be careful not to add too much mass and thus decrease our RELATIVE strength (relative to body weight)
- Hypertrophy, however, is important in the initial phases of all strength training

#### Strength

#### **Question 10**

What is the **MOST EFFECTIVE** way to stimulate muscle **hypertrophy?** 

#### Strength

## Answer Hypertrophy is maximized by fatiguing muscle in about 10 Repetitions Maximum

- But, as gymnasts get stronger they will be able to **do more repetitions**
- So, instead of letting the repetitions increase past 12, increase the load so they are back to 8 or 9 RM's
- It is important to progressively increase the resistance so only 10 reps can be done

#### Strength

What are the two ways to increase **muscular strength**?

Increase the **neural signals** to muscles (which also **increases muscle force)** 

As you load muscles more, you train your nervous system to:

- Send more rapid signals
- Send better synchronized signals
- Recruit more neurons
- etc.

Most early gains in strength, are from neural adaptations

#### Strength

#### **Question 11**

What is the **MOST EFFECTIVE** way to stimulate **neural signals for strength gains?** 

To increase the **neural signals** to muscles (which also **increases muscle force**)

Load muscles using:

- High Speed
- High Force
- Note to Coaches

High force **DOES NOT** necessarily mean heavy weights !

### Strength

#### **Question 12**

Do muscles always shorten when they "contract"?



#### Answer

# Concentric contractions occur on all Springs and whenever you move your body upward or move a weight upward.

Strength

For example: upward phases of push-up and chin-up, bar curl

• Eccentric contractions occur on all *Landings* and whenever you **lower** your **body** or **lower** a **weight**.

For example: lowering phase of push-up, chinup, bar curl (these are also called **negatives**)

#### Strength

### Implications for coaching?

- To satisfy the **Specificity** Principle, coaches should design **physical preparation** training...
- Specific to the contraction states for skills
- For example: All *Spring* are concentric, and all *Landings* are eccentric
- Many skills are mixtures of isometric, concentric and eccentric, thus should be prepared accordingly

#### Strength

#### **Question 13**

Does muscle generate the same force in :

- isometric state (no shortening)?
- concentric state (shortening)?
- eccentric state (lengthening)?

#### Answer No

- When a muscle **shortens**, it generates **its least force** (concentrically)
- Isometrically, the same muscle can generate greater force
- And when a muscle contracts and then is lengthened... It generates its greatest forces

#### Strength

## Implications for coaching?

Sometimes a gymnast does **not have sufficient strength** to do a specific skill or progression...

For example, a press to handstand (which is a series of concentric contractions)

Since you are stronger **eccentrically** you could **start in handstand**, and very **slowly lower** to the start position thus training and **strengthening** the **same muscles** 

You could also **stop** (**isometric**) at various levels

#### Strength

### Implications for coaching?

- Imagine a gymnasts doing maximum number of chin-ups.
- If they can absolutely do no more, have they depleted their energy and are finished ?
- NO, they only exhausted their muscles concentrically. They are stronger isometrically
- So, they can immediately jump up and hang bent arm for quite some time...
- Then they are exhausted?

#### Strength

#### No!

- They are strongest eccentrically. They can still lower SLOWLY from a chin-up to a hang, several times....thus still training those muscles
- When they cannot lower slowly....then they have exhausted their muscles
- This "burn" training works well when you want to do "shock" training, or when gymnasts are plateauing, or for variety

#### Strength

#### **Question 14**

Can a muscle generate the **same force** throughout the **range of movement** (ROM)?

- Joint ROM almost fully open?
- Mid range of ROM?
- Joint ROM almost fully closed?





### Implications for coaching?

- Thus, if we have a **load** (a dumb bell) that the muscle can 'just move' in **joint open state...**
- That **same load** will be **too light** to really stimulate the muscle at its **mid-range**...
- And, then it will be correct load at end range



#### Strength

#### **Isokinetic** Training

- If you train with weights or bungee, it is not possible to maximally load a muscle through a whole range
- This is only possible if the resistance is variable
- Less resistance where the muscle is weaker, More where the muscle is stronger !
- **Isokinetic training** occurs when muscle contracts at its **maximum**...
- throughout the whole range of movement



#### **Question 15**

#### **Isokinetic Training**

Can you think of easy ways to train with variable resistance throughout the range of movement?

#### Strength

#### Answer

#### **Isokinetic Training**

· Partner or coach assisted strength training

#### Strength

#### Answer

#### **Isokinetic Training**

• Some bungee resisted exercise can give less resistance at beginning range and greater resistance at mid ranges...but will then be too great at end range

### Implications for coaching?

- Isokinetic training works very well when a gymnast has **insufficient strength**...
- Or, you wish to mimic the speed and contraction type of some progression or skill (specificity)
- Isokinetic training also works well when you want to do "shock" training, or when gymnasts are plateauing, or for variety







#### **Power**

#### **POWER training**

- · Best trained with high speed or high force
- Best trained with 1- 5 RM

#### Power

## Note to coaches

Power training **should NEVER be initiated** before **good ME and Strength** are developed Once **ME** and **Strength** are developed then:

- 1. Progressively increase speed (unresisted)
- 2. Then do resisted movements more quickly
- 3. Then train for maximum force (1-5 RM)
- 4. Then higher forces at higher speeds
- 5. Then do resisted plyometrics
- 6. Use good postures and technique always!

#### Power

**Plyometric training** involves a **fast stretch** followed **immediately** by a **fast contraction** of the **same** muscles...

As when you do:

- Repeated rebounds across the floor
- Jump from a height and immediately rebound

 Stretch arm quickly backward before throwing Some plyometric exercises can cause injuries if not properly planned...

#### Power

#### **Plyometric training**

- **Unloaded** plyometric *Springing,* and other light plyometric exercises are suitable for Muscular Endurance training but...
- Be cautious jumping from elevated surfaces, or exercising to excess
- When doing plyometrics be very certain to maintain good postures and techniques
- Monitor gymnasts carefully for any joint or muscle attachment soreness

#### Power

### **Plyometric training**

- Plyometric training for power can be loaded if the loading is gradual and coaches monitor gymnasts carefully for pain
- Power training decreases number of repetitions and adds loads and speed
- It is important to greatly reduce Muscular Endurance training of the same muscles

# Power

#### Plyometric training

- Recall that 'connective tissue' covers every single muscle fibre and bundles of fibres, etc. These extend throughout the muscle and join together at the ends - to form Tendons
- Tendons are wavey fibres of protein collagen
- When a muscle contracts, the waves are pulled straight, then the tendon becomes taut
- The natural recoil of these waves adds to the force generated, and plyometric training helps develop this recoil effect

#### Power

### **Plyometric training**

Another **neural mechanism** is involved in plyometric training:

- There are special sensory receptors in muscles (muscle spindles)...
- that send signals to the Central Nervous System...
- whenever a muscle is stretched (part of the proprioceptive sensory system that tells you where your body parts are... relative to your body)

#### **Power**

## **Plyometric training**

- Any time a muscle is stretched rapidly
- These sensors cause a reflexive contraction
- Of that stretched muscle

#### This is called the Stretch Reflex

- We can use the **stretch reflex contraction** to **ADD FORCE** to a voluntary contraction
  - Stretch a muscle quickly...
  - Just before contracting it...
  - And it will always generate more force...
  - Than a normal contraction



#### Power

Training with **high speed** or **high force** (1-5 RM) or **plyometrically** are examples of training the **nervous system** (**neural training**)

These techniques are very **effective** for POWER development, BUT also can **cause injuries** so...

- Proceed carefully
- Prepare tissues **first** by training Muscular Endurance, Strength and **unresisted** Speed
- Carefully monitor for adaptive changes
- Reduce any power training immediately if injury symptoms appear

#### Power

By doing **high speed**, **high force** or **plyometric** exercises you are **very effectively:** 

Increasing neural signals to muscles

#### and

Selectively recruiting fast twitch fibres

#### plus

There is not much hypertrophy

#### Universal Training Principle **#5**

### REVERSIBLE

- The **habitual level of activity**, is what the body will ADAPT to !
- Thus, reduced stimulus will result in **reversing the adaptations** to this new habitual state
- All training adaptations are reversible
- It is, however, possible to maintain trained states by doing maintenance training

#### Universal Training Principle #5

#### All gains are Reversible

- In order to keep gains from reversing...
- we must continue training
- at a level that MAINTAINS the gains

This means training at a **level of last gains** as often as necessary (to retain that level)

 This will vary between individuals and physical qualities (M.E., Strength, Power...)

Normally this is once every 7 to 14 days

#### Universal Training Principle #6 RECOVERY

In order to maximize gains

we must allow sufficient recovery

### for adaptive changes to happen in the tissues

- The amount of recovery time needed...
- varies with the physiological system

## Universal Training Principle #6

## Recovery

- Insufficient stimuli or insufficient recovery, will not produce adaptive change
- Insufficient recovery will result in plateauing or performance decline



## Universal Training Principle #6

#### Recovery

In general the following guidelines are a good **starting point** for **planning recovery times**:

- Aerobic training Work : Recovery Ratio = 1:1 30 min aerobic training = 30 minutes recovery
- Muscular Endurance Work : Recovery Ratio 1:3-4 2 minutes of training = 6 - 8 minutes Recovery
- Strength training Work : Recovery Ratio 1:4-5 1 minute of training = 4 - 5 minutes Recovery
- Power training Work : Recover Ratio 1:10+ 15 seconds training = 2 ½ minutes+ Recovery

#### Universal Training Principle #6

#### Recovery

For strength and power training, longer rests between sets gives:

- Greater training effect
- Greater volume of work can be done at a given work load (less fatigue = more total work = greater gains)
- More rest between sets = less fatigue = probably fewer injuries

### Universal Training Principle #6

### Recovery

Other **Recovery Strategies** that should be planned are:

- Recovery from single training sessions
  - hard days followed by less hard days
- hard strength training only every 2<sup>nd</sup> or 3<sup>rd</sup> day
- Recovery from 4-6 days training with days off
- Recovery from 3 weeks with a reduced week



#### Universal Training Principle #6

#### Recovery

Lack of recovery is particularly a problem in some Gymnastics disciplines, and it leads to **overuse injuries** and **insufficient recovery** from injuries

## We must pay attention to recovery strategies

- We can reduce unnecessary repetitions by:
  - Being **specific** in our physical preparation
- Carefully sequencing ME, strength and power training (reducing one when changing to next physiological system)

## Universal Training Principle #6

The consequence of Inadequate recovery is:

- Overuse injuries
- Then re-injuries from insufficient recovery
- Then chronic injuries

Insufficient Recovery reduces adaptation!

'Adaptation occurs during recovery'

## Universal Training Principle #7

#### Variation

- Given the same constant stimuli even if progressively increased - the body will habituate, and adaptation will plateau
- Change exercises. They can be for the same movement pattern or same set of muscles...but change is needed!
- Occasionally "shock" the nervous system with very different, or very hard, or very novel training

## Universal Training Principle #8

### **Diminishing Returns**

- As skill levels increase, and fitness levels increase, the adaptations will diminish for the same amount of work
- Be aware of this plateauing, and change training accordingly, but most importantly prepare the gymnasts psychologically for this effect

## Physical Preparation - SUMMARY

#### First train Muscular Endurance (15 - 30 RM)

• At the same time train **Passive ROM** flexibility by doing static and dynamic stretching

#### Next, train Strength (hypertrophy) (=10 RM)

- At same time train Active ROM flexibility by doing 50% stretching and 50% strengthening
- Next train Power with neural training techniques (1-5 RM, high speed, high force, plyometrics)

**Continually** do **Flexibility** training using 50% stretch / 50% strengthen (plus PNF methods)

## Physical Preparation - SUMMARY

The two main tissues we train are:

### Muscle

and

**Connective Tissue** 

That attach to bone, thus training also affects

## Bone

## **Physical Preparation - SUMMARY**

- Thus, there are many positive changes in the body's tissues in response to training in the different gymnastics disciplines
- But also, the potential for negative effects

There is, however, another part of this story...

• Growing tissues have unique characteristics which must be considered separately