EXERCISE AND HEATH – BODY MACHINICS

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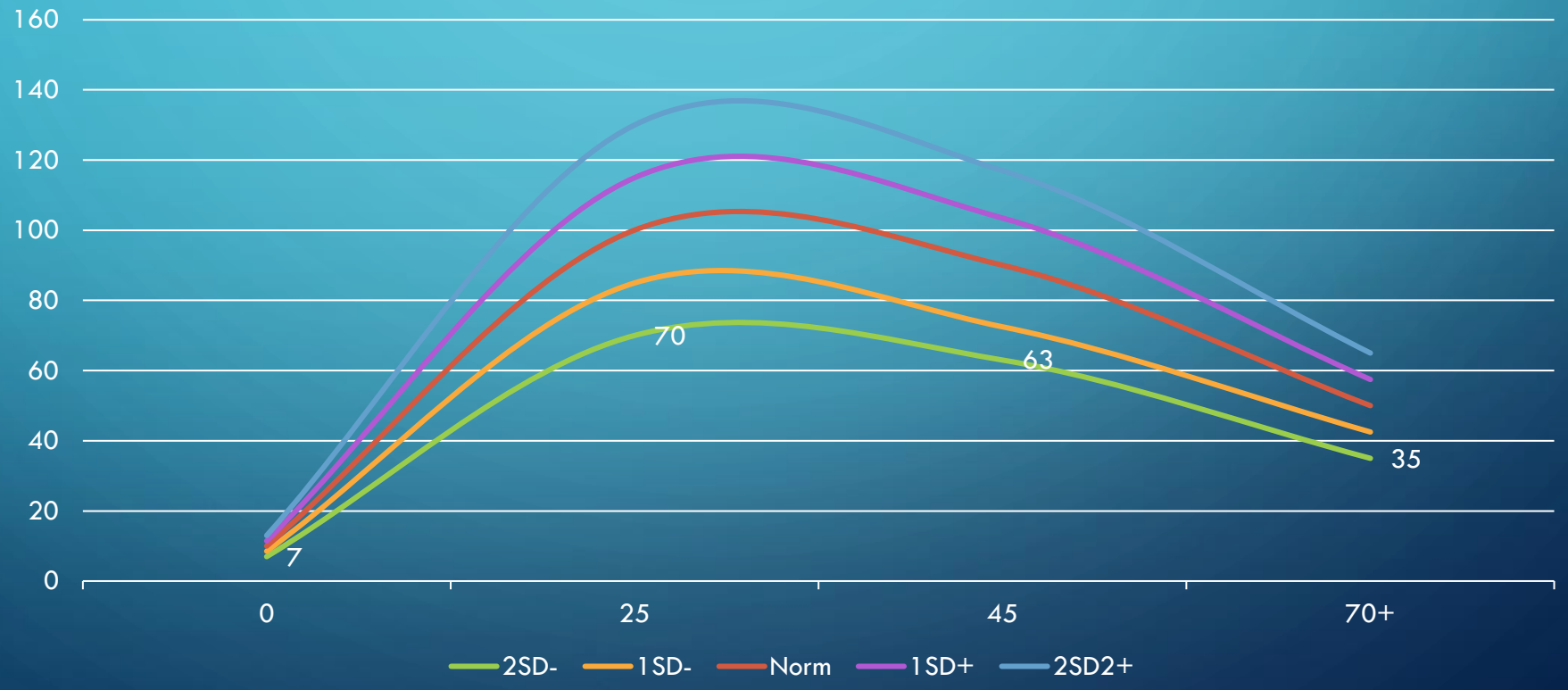
TWGHS REHABILITATION CENTRE

PHYSICAL FITNESS TREND ON AGE

- Physical fitness VS age

FACTORS AFFECT THE TREND

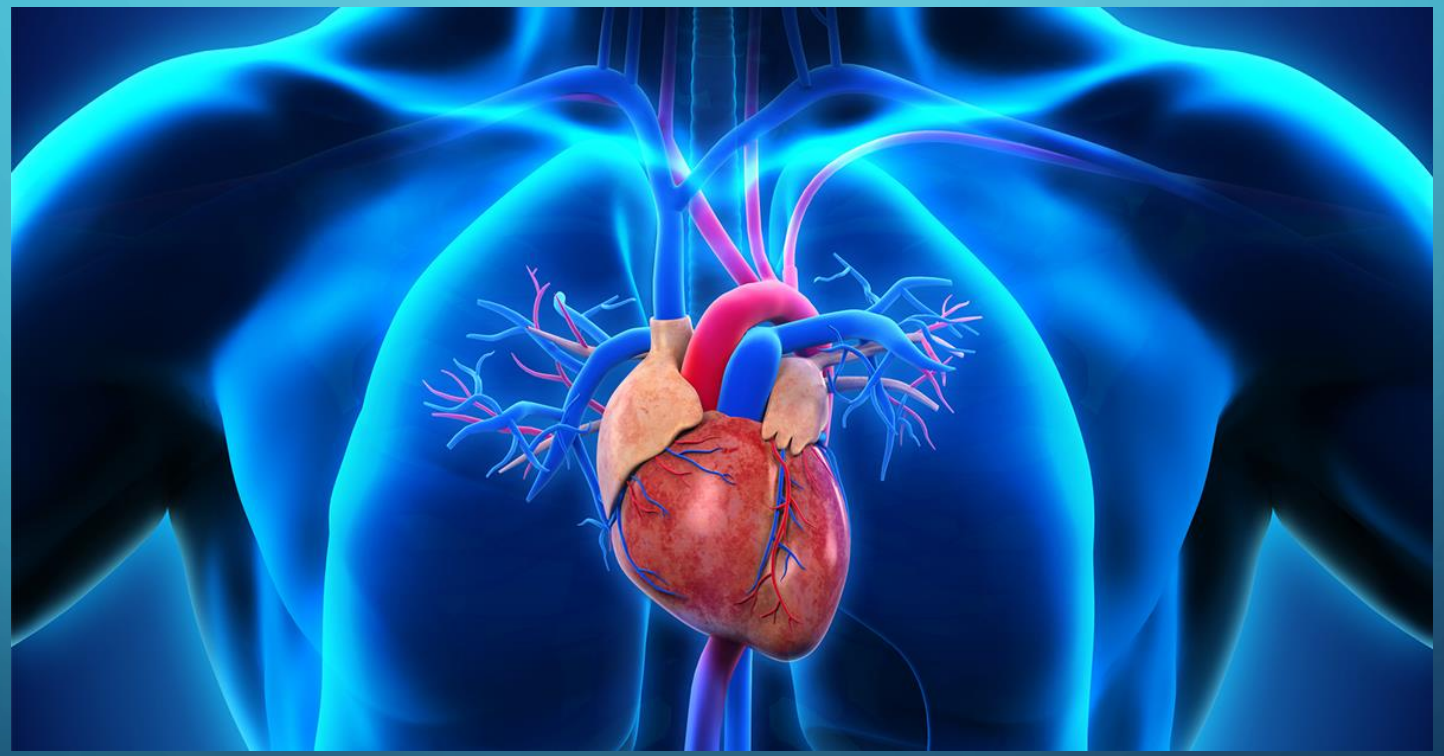
- PF Variation with different factors



UNDERSTANDING FITNESS

- Cardiopulmonary Function
- Muscle strength
- Range of motion
- Balance and coordination
- Injury and recovery

CARDIOPULMONARY



TEST

- Resting Heart rate (RHR)
- SPO2

RESTING HEART RATE (HR)

- Count number of the pulse in 15s
- Count after sitting 15min
- When you wake up on your bed

SPO2

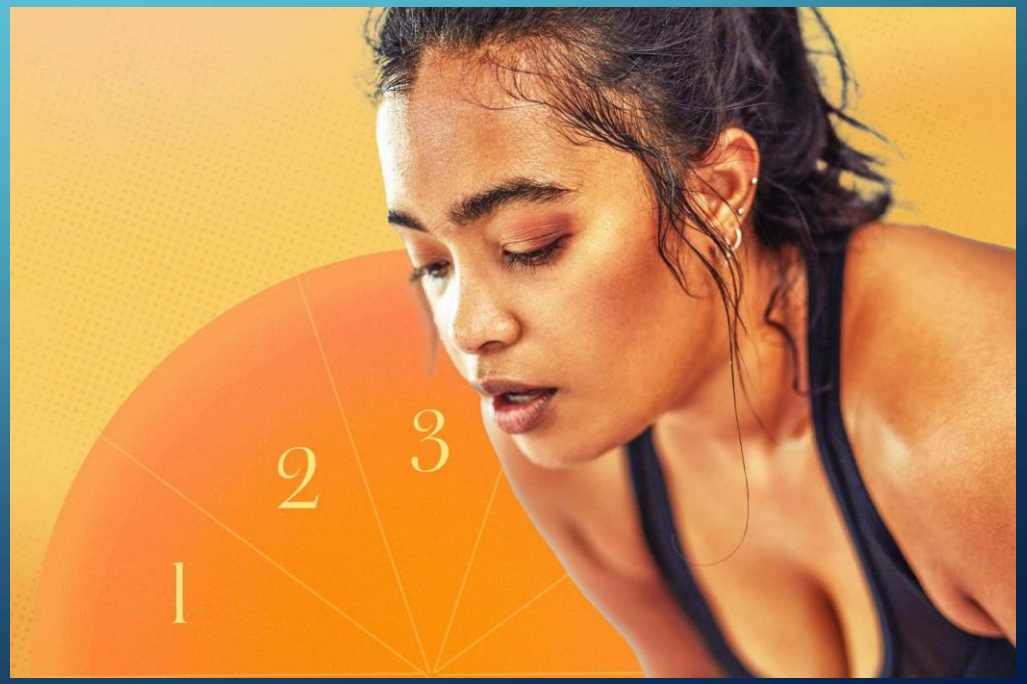
- Oximeter

MAXIUM HEART RATE (HR^{MAX})

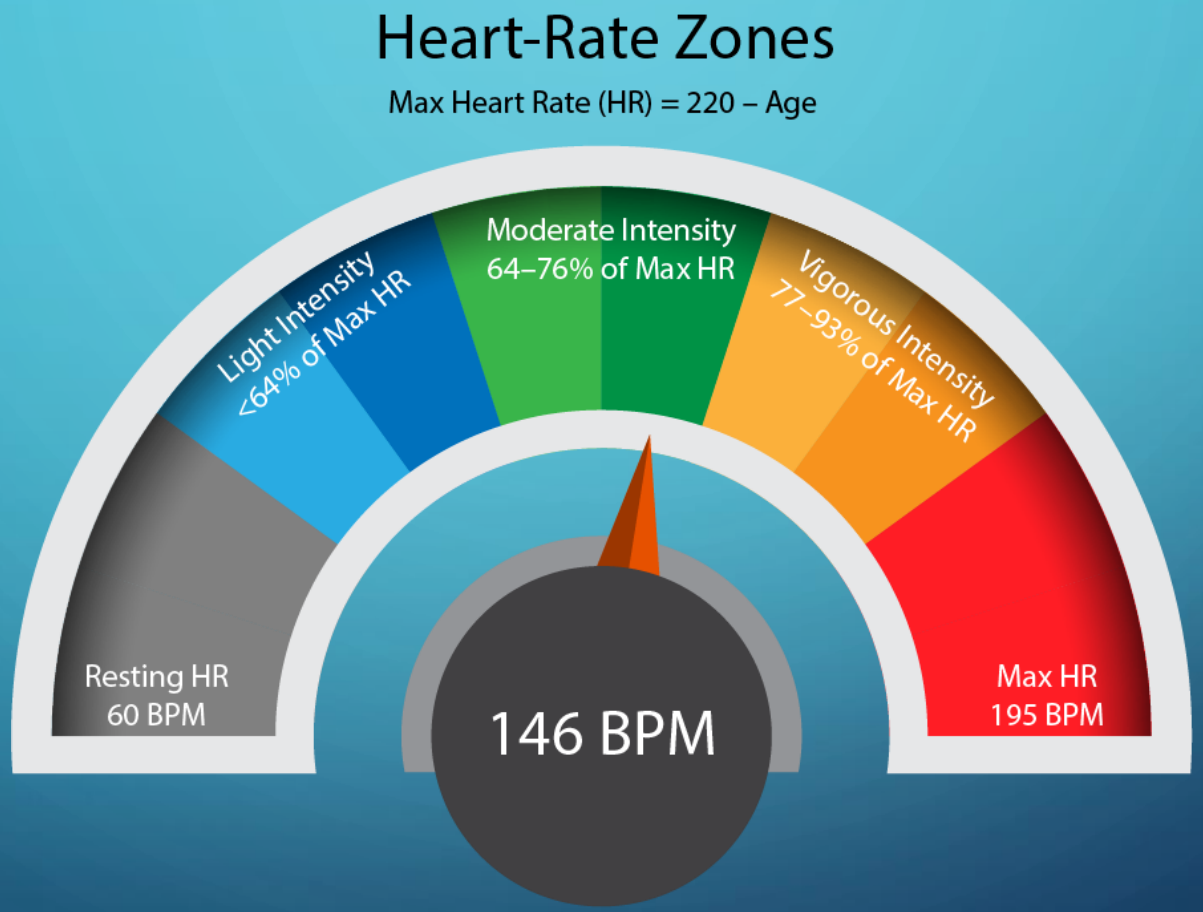
- = 220 – age
  - E.g. HR^{MAX}
    - 20 y.o. = 200/min
    - 30 y.o. = 190/min
    - 40 y.o. = 180/min
    - 50 y.o. = 170/min
    - 60 y.o. = 160/min
    - 70 y.o = 150/min

TRAINING INTENSITY

- Target HR
- Rate of Rate of perceived exertion



TARGET HR



Example for 25-year-old:
Max HR = 220 – 25 = 195 beats per minute (BPM)

RATE OF PERCEIVED EXERTION

SIMPLIFIED RATING

- Objective rating
  - HIGH
    - >80% HR^{MAX}
    - Cannot talk fluently
  - MORERATE
    - >70% HR^{MAX}
    - Can talk while cannot sing
  - LOW
    - <60% HR^{MAX}
    - Can sing and talk

RESULT

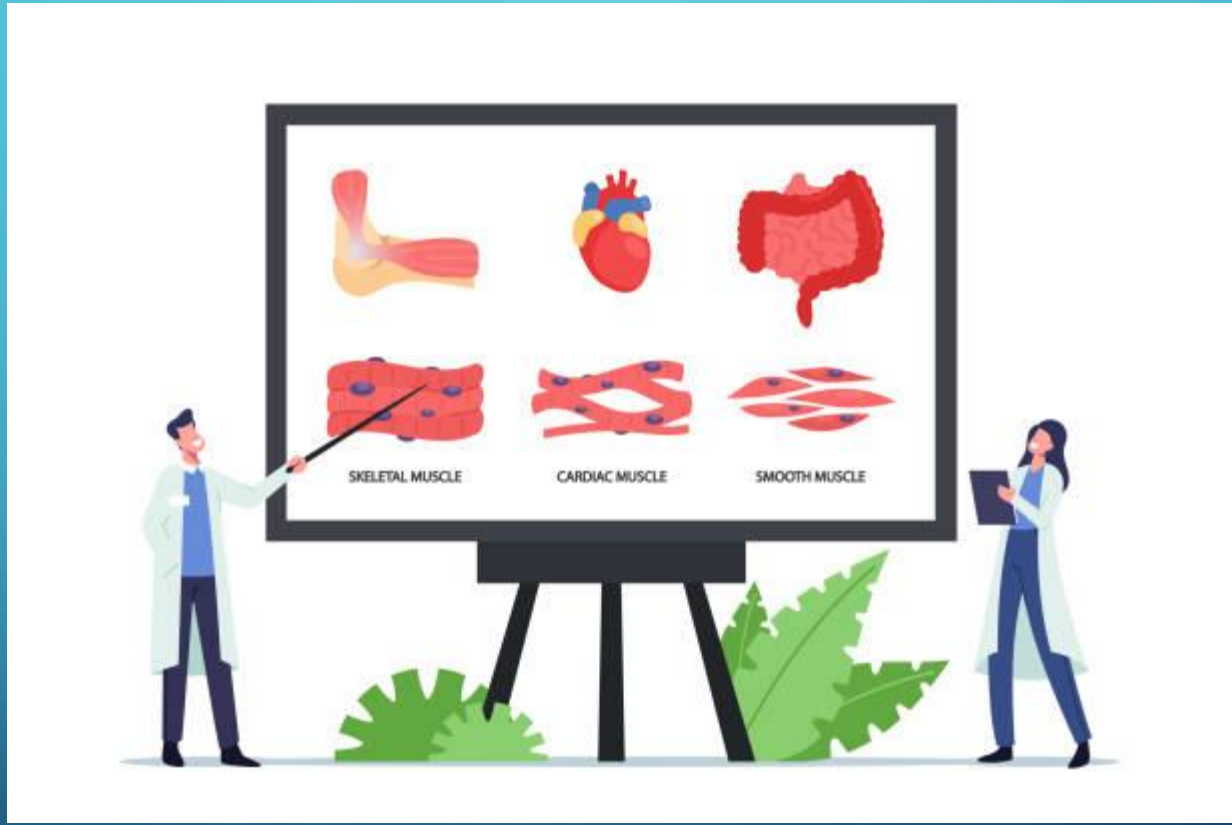
- RHR (adult)
  - Athlete = <60/min
  - Norm = ~72/min
  - Inactive = >72/min
- Breathing rate 12/min
- SPO2 >98%

MUSCLE STRENGTH

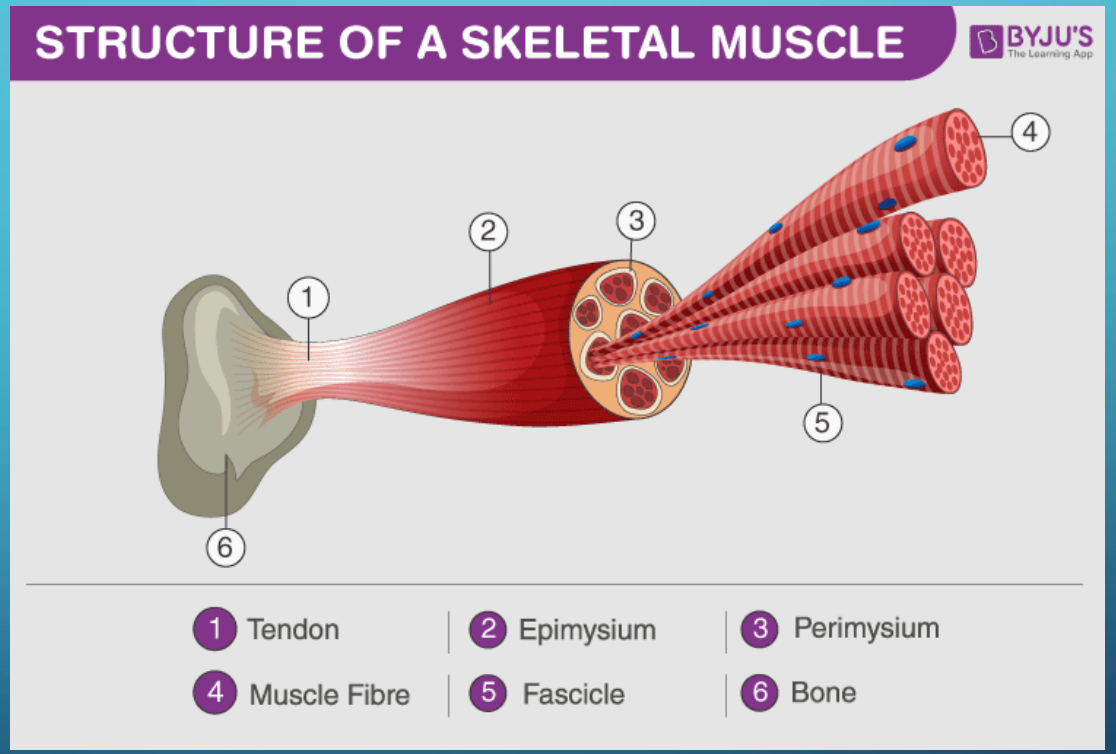
TEST

- 30CST
- Hand grip

MUSCLES



SKELETAL MUSCLE



MHC ISOFORMS AND FIBER TYPE

- MHC I processes ATP the slowest and is found in slow-twitch muscle fibers,
- MHC IIa processes ATP faster and is found in many fast-twitch fibers,
- MHC IIx processes ATP fastest of all and is found in few fast-twitch muscle fibers

- MHC I (pure isoform)
- MHC I/IIa (hybrid)
- MHC IIa (pure isoform)
- MHC IIa/IIx (hybrid)
- MHC IIx (pure isoform) – rare
- MHC I/IIa/IIx (hybrid) – rare

PLASTICITY AND EXERCISE

MHC I	MHC I/IIa	MHC IIa	MHC IIa/IIx	MHC IIx	
Sedentary	40%	10%	35%	15%	0%
Average Resistance Trainer	25%	8%	60%	7%	0%
Elite Weightlifter	25%	2%	73%	0%	0%
Marathoner	65%	10%	25%	0%	0%

PLASTICITY AND EXERCISE

Sedentary

- ▲ Hybrid
- ▲ Type I
- ▼ Type IIa

Resistance Trainer

- ▼ Hybrid
- ▼ Type I
- ▲ Type IIa

Elite Weightlifter

- ▼ Hybrid
- ▼ Type I
- ▲ Type IIa

Runner

- ▼ Hybrid
- ▲ Type I
- ▼ Type IIa

MUSCLE CONTRACTION

- Concentric: shorten
- Eccentric: lengthen
- Isometric: unchanged

MUSCLE STRENGTHEN

- Strengthen proportional to Muscle Cross-section area

TRAINING INTENSITY

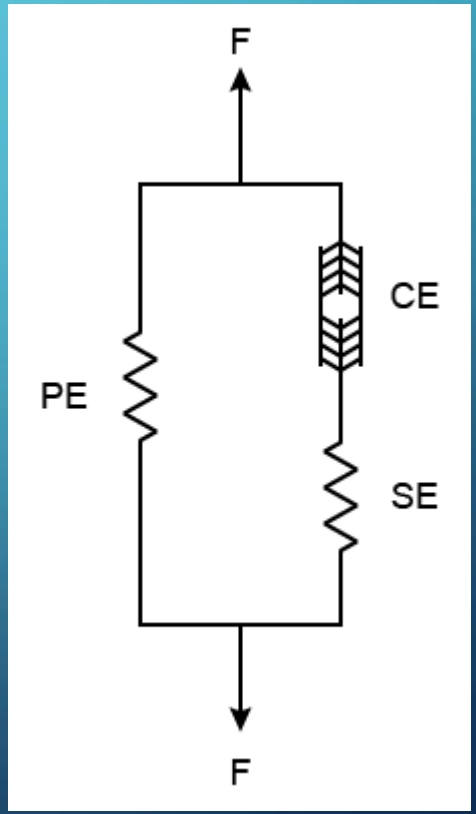
- Repetition-Maxium
  - 1RM
  - <8RM (125% 1RM)
  - 8-20RM
  - 20-30RM (200%-400% of 1RM)
- LIHR (coordination and synergy)
- HILR (muscle strength)
- HIIT (CPF/strength etc.)

TENDON AND FASCIA

- Collagen fiber
  - Aggrecan binds water and resists compression
  - Decorin promotes fibrillar slippage.
  - Elastin, fibronectin, and tenascin-C function to enhance mechanical stability, aid tendon healing, and allow tendons to revert back to their pre-stretched lengths after normal physiological loading, respectively

MUSCLE BIOMECHANICS COMPONENTS

- The Series Elastic Component (SEC)
  - Tendon
  - Spring
  - Store energy/absorb shock/enhance power and response time
- The Parallel Elastic Component (PEC)
  - Fascia
  - Frame
  - Direct Force/maintain structure
- The Contractile Component (CE)
  - Muscle
  - Generator
  - Gengerate force



MECHANICAL LOAD EFFECTS ON TENDON

Mechanical Load Level	Effects on Tendon
Low	• ↓ Tensile strength • ↓ Size • ↓ Collagen production • ↓ Anabolic activities • ↑ Catabolic activities
Moderate	• ↑ Tensile strength • ↑ Collagen synthesis • ↓ Collagen degradation • ↓ Adhesions • ↓ Inflammatory mediator (e.g. prostaglandin E2) • ↑ Tendon stem cells (TSCs) differentiating into tenocytes
Excessive	• ↓ Tensile strength • ↓ Collagen organization • ↑ Myofibroblasts • ↑ Inflammatory mediators • ↑ Tendon stem cells differentiating into non-tenocytes (adipocytes, osteocytes, chondrocytes) • ↑ Leukotrienes (↑ edema)

EXERCISE FOR TENDON AND FASCIA

- Eccentric
- Plyometric

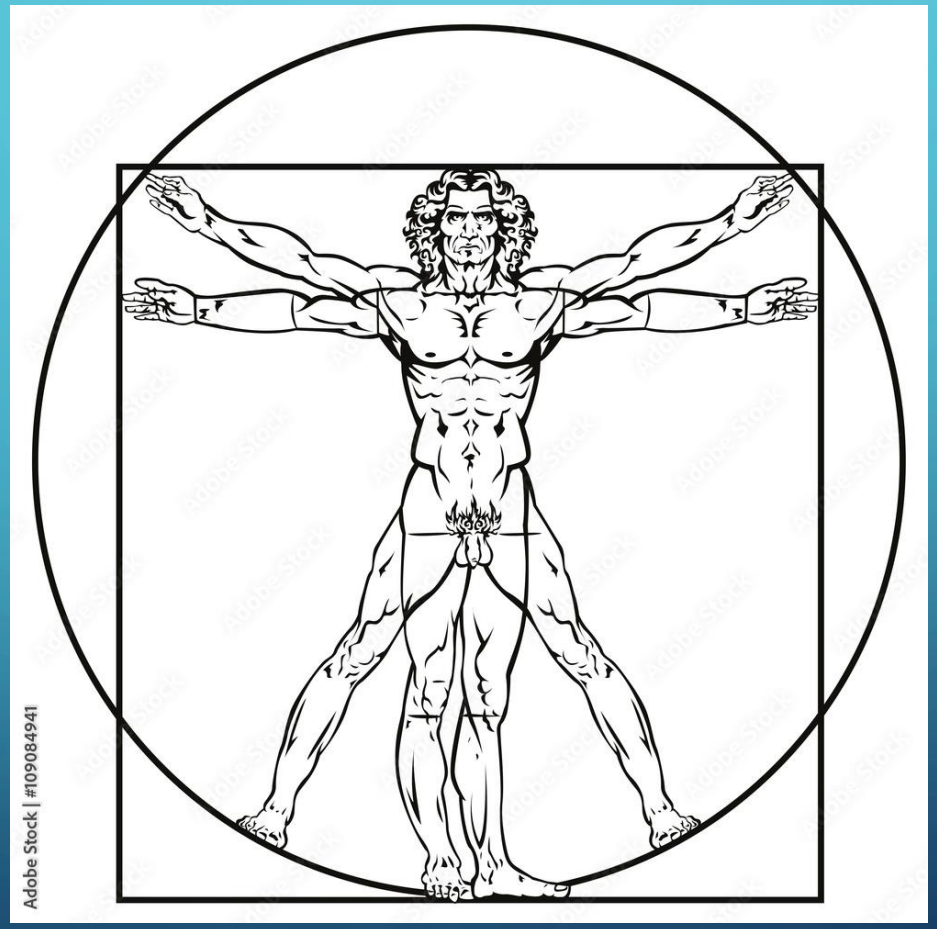
RESULTS

- Hand Grips

	MALES		FEMALES	
rating*	**(lbs)**	**(kg)**	**(lbs)**	**(kg)**
excellent	> 141	> 64	> 84	> 38
very good	123-141	56-64	75-84	34-38
above average	114-122	52-55	66-74	30-33
average	105-113	48-51	57-65	26-29
below average	96-104	44-47	49-56	23-25
poor	88-95	40-43	44-48	20-22
very poor	< 88	< 40	< 44	< 20

- 30CST 20rep

RANGE OF MOTION



TEST

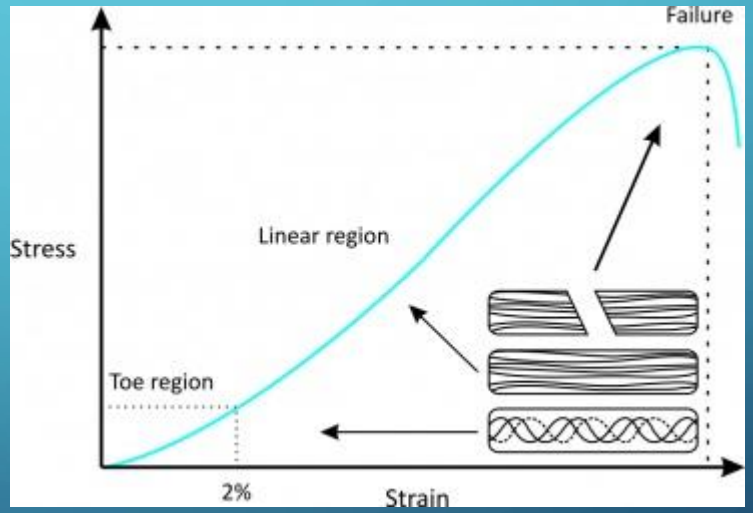
- Muscle length
  - Toe touch
- Joint mobility
  - Beighton score

RANGE OF MOTION FACTORS

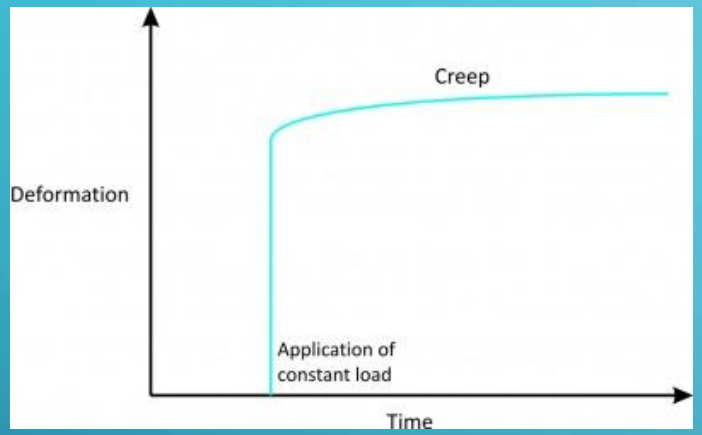
- Joint stiffness
- Muscle/tendon length
- Coordination

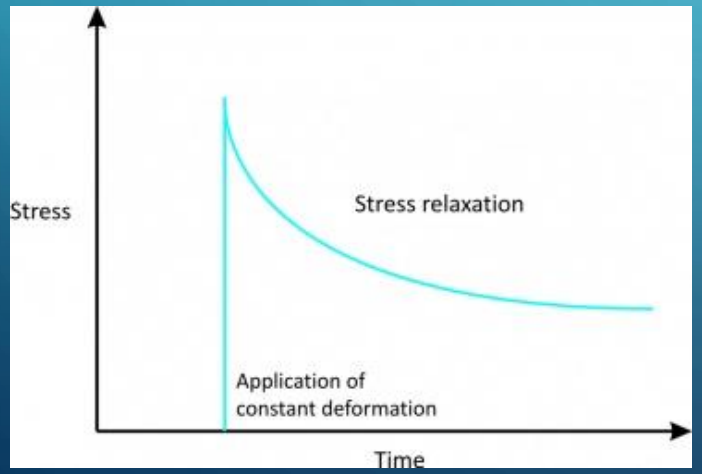
TENDON MECHANICAL PROPERTIES:

- Non-Linear Elasticity

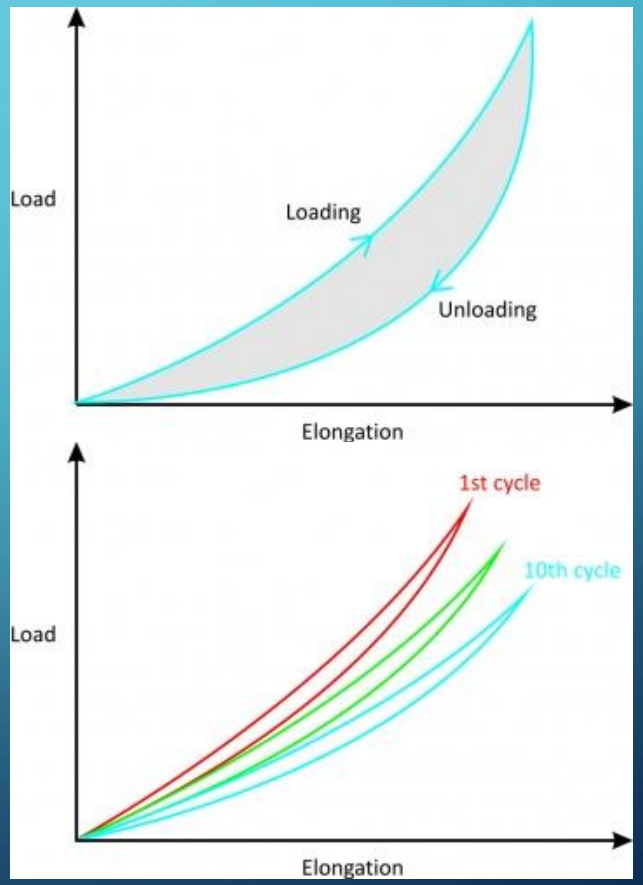


TENDON MECHANICAL PROPERTIES: VISCOELASTICITY





Hysteresis or energy dissipation



RESULTS

- Muscle length
  - Toe touch
- Joint mobility
  - Beighton score

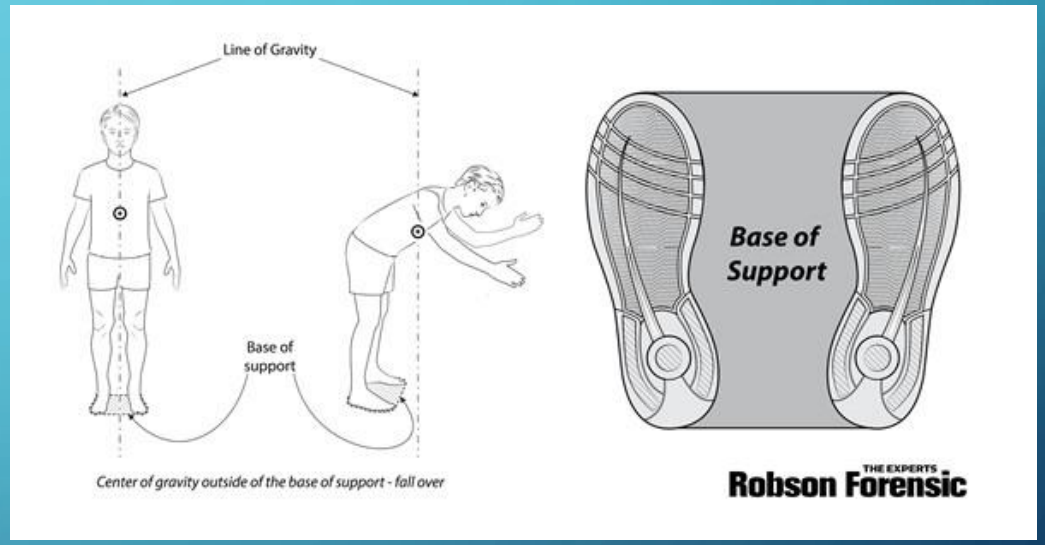
BALANCE AND COORDINATION

TEST

- Stepping with eye close
- SLS

BALANCE

- Centre of Gravity (CG)
- Base of Support (BOS)
- Balance = Control CG within BOS
- Stability = Area BOS + control of CG

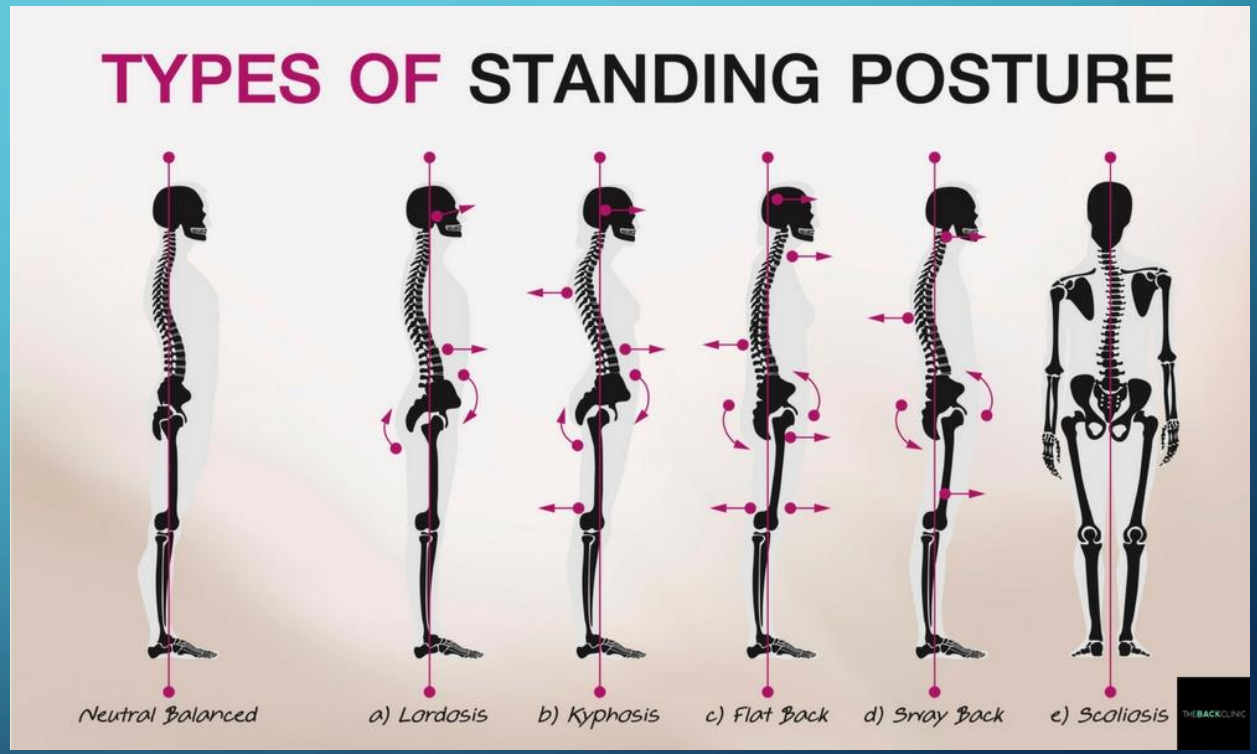


POSTURAL PROBLEMS

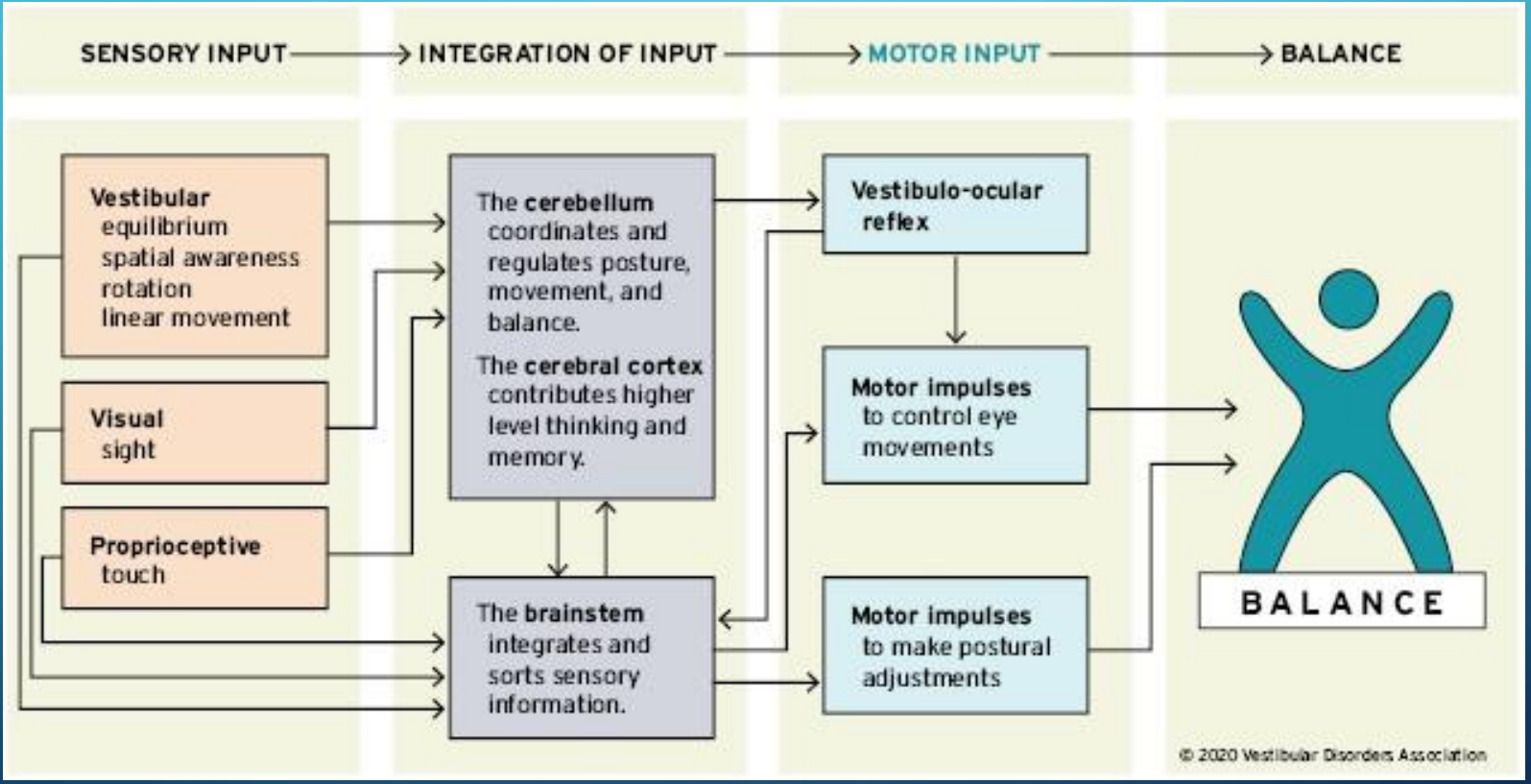
- Neck pain and cervical spine problems
- Shoulder pain
- Elbow and Hand pain
- Back pain
- Knee pain
- Ankle and foot pain
- Other health problem

POSTURAL CONTROL

- Head
  - Chin-in
- Pelvic
  - Belly-in
- Foot
  - Weight on heel

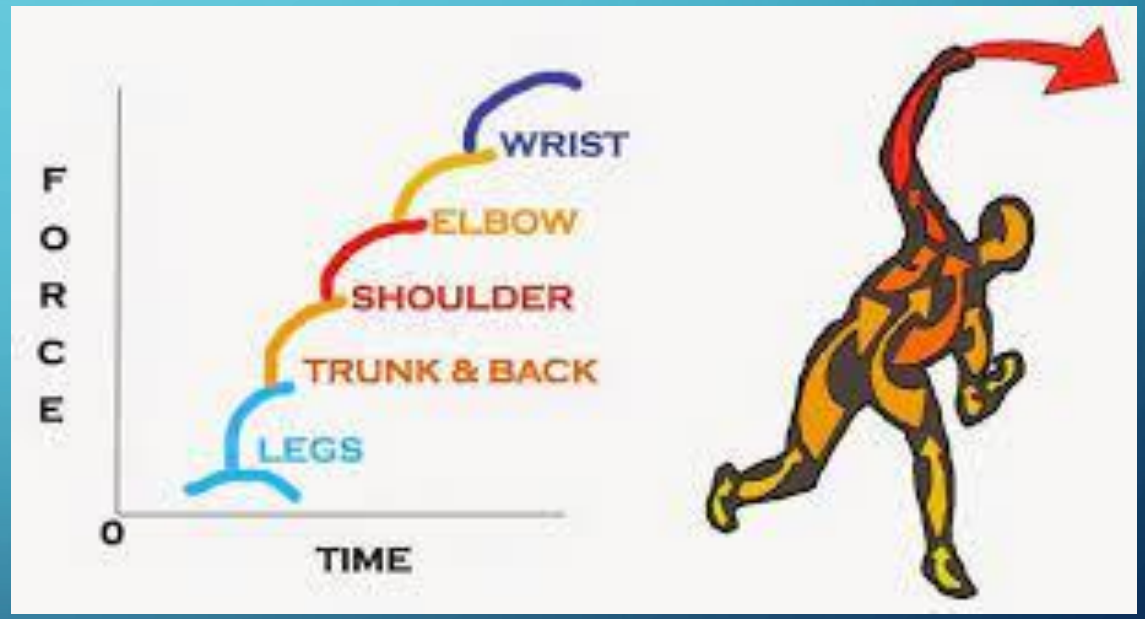


BALANCE AND COORDINATION



FUNCTIONAL MOVEMENT

- Muscle synergy
  - Joint mobility
  - Muscle strength
  - Coordination
- Kinetic Chain (e.g. Whiplash)
  - Tendon>muscle>joint



RESULT

- SLS

Age in Years	Average of 3 trials eyes open in seconds
18-39	43.0
40-49	40.3
50-59	37.0
60-69	26.9
70-79	15.0
80-99	6.2

- Reference: Springer BA Marin R, Cyhan T, Roberts H, Gill NW. Normative values for the unipedal stance test with eyes open and eyes closed. Journal of Geriatric Physical Therapy, 2007; 30:8-15.

INJURY AND RECOVERY

INJURY AND RECOVERY

- Injury and Recovery
  - Acute
  - Sub-acute
  - Chronic
  - Recovery

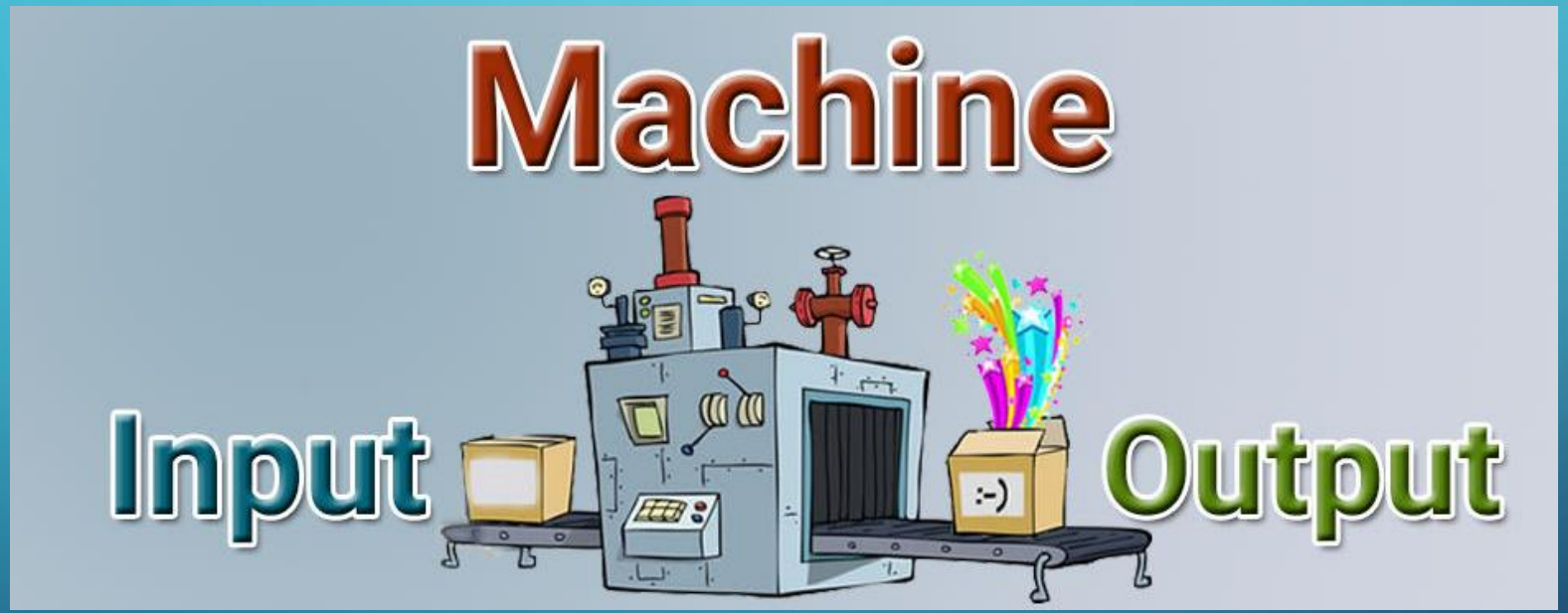
CHRONIC PAIN

- Chronic = Pain > 3mth
- Repetitive injury

ACCUMULATIVE INJURY

- Wear and tear rate
  - Exercise
  - Poor habits
  - Injury
- Recovery rate
  - Nutrition
  - Rest
- Recovery rate > Wear and tear rate = Accumulation

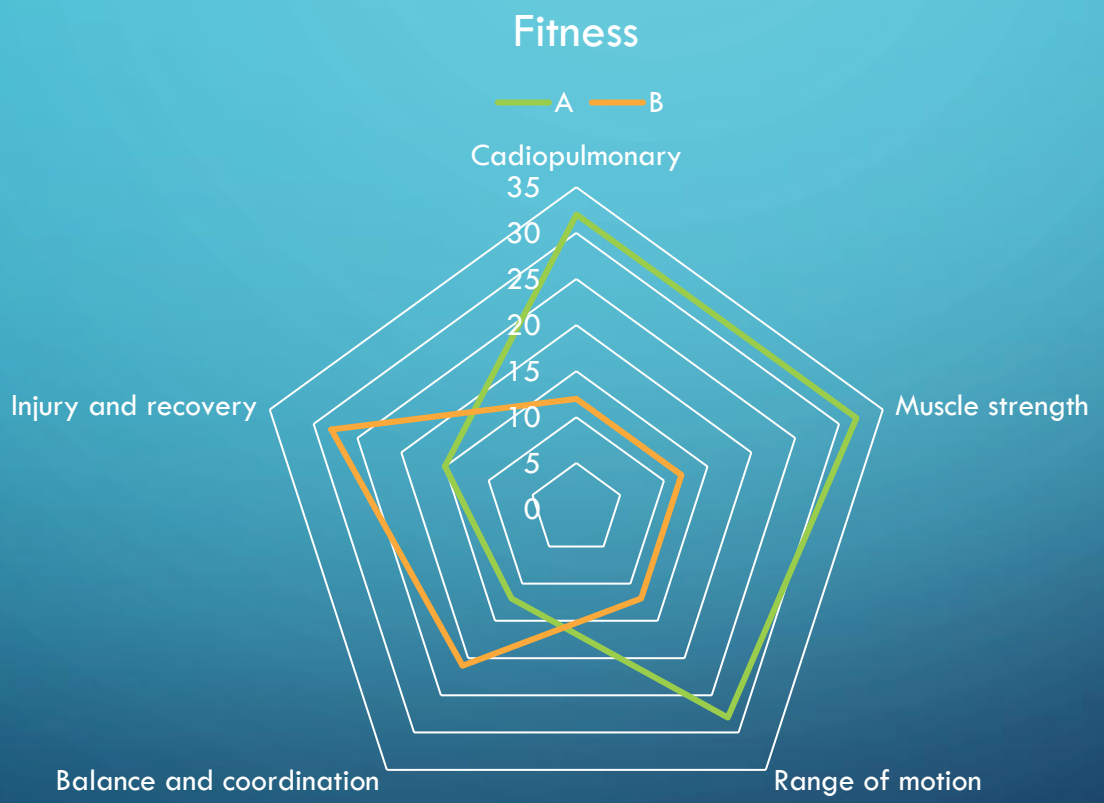
BODY MACHINE



TRAINING

- Input
  - Any kind of stimulation to body
- Process
  - Recovery
  - Physiological changes
- Output
  - Health and fitness

TRAINING METHOD



Q&A

- Thanks!