IB BIOLOGY B3.3 HL

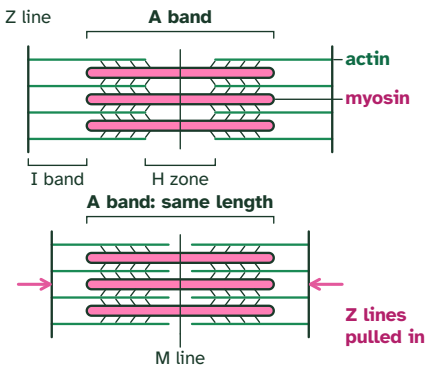
REVISION ON TWO PAGES

Muscles only *pull*

What to know, what to draw and what to say. Nothing else.

THE ONE IDEA

Actin slides between myosin to shorten each sarcomere. Muscles only pull, so skeletons, joints and antagonistic pairs turn that pull into movement.



Top relaxed, bottom contracted. Draw Z lines at the ends, actin from them, myosin in the middle; label the bands.

B3.3.2 START HERE

Sliding *filaments* shorten the sarcomere

- A muscle fibre is packed with myofibrils, each a chain of **sarcomeres**. One sarcomere runs from **Z line to Z line**.
- Thin **actin** filaments are anchored to the Z lines. Thick **myosin** filaments lie in the middle, centred on the M line.
- In contraction the actin **slides between the myosin** towards the M line. **Neither filament shortens**.
- So the **I band and H zone shorten**. The A band, the length of the myosin, stays the same.

THE CYCLE, REPEATED WHILE CALCIUM IS PRESENT

Cats use big paws, always

C Calcium released by the impulse	**U** Uncover tropomyosin moves aside	**B** Bind heads latch onto actin	**P** Pull the power stroke	**A** ATP head lets go, cocks again

B3.3.1

Everything alive *moves*

- Movement is universal, and each body is **adapted to how it moves**.
- It lets organisms find food, escape, find a mate and disperse.

Motile moves its whole body
Atlantic salmon: blocks of muscle down each side bend the streamlined body and sweep the tail.

Sessile fixed in one place
Acorn barnacle: cemented to rock, it sweeps feathery legs out to catch plankton; its larva swims. A **Venus flytrap** snaps its leaf shut.

B3.3.3

Titin and *antagonistic* pairs

- A muscle exerts force **only when it contracts**: it pulls, and cannot push itself long again.
- **Titin**, the largest protein in the body, runs from Z line to myosin. It **recoils after contraction** and **prevents overstretching**.
- The **biceps** bends the elbow and the **triceps** straightens it: as one contracts, it **stretches the other**.

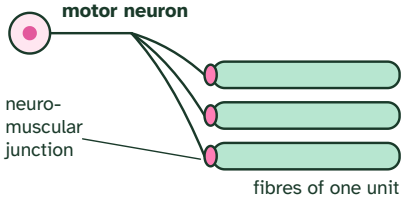
LENGTHENED BY **Titin** elastic recoil

LENGTHENED BY **Antagonist** stretches it

B3.3.4

The *motor unit*

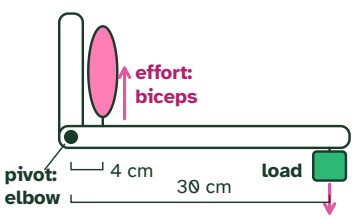
- **One motor neuron and the fibres it supplies**, each met at a **neuromuscular junction** (a synapse).
- A unit's fibres contract together. More force means **recruiting more units**: small ones (eye) for fine control, large ones (thigh) for force.



B3.3.5

Skeletons: *anchorage* and levers

- A muscle must pull on something firm: the skeleton is its **anchorage**, joined to it by tendons.
- **Arthropods:** an **exoskeleton**, muscles inside. **Vertebrates:** an **endoskeleton**, muscles outside.
- Bones are **levers**: the joint is the pivot, the muscle the effort, against a load.
- With these distances the biceps pulls with **7.5 times the load**, but moves the hand far and fast.



B3.3.7 APPLICATION OF SKILLS

Range of *motion*

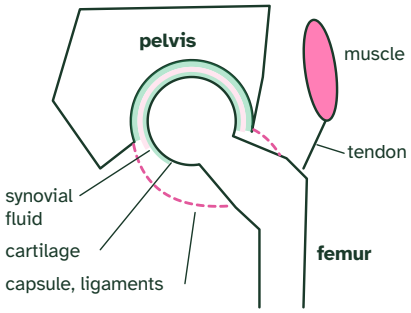
- The **angle a joint moves through**, in each direction.
- **Measure it** with a **goniometer**, arms along the two bones, or by computer analysis of images.
- Ranges differ between people: bone shape, ligaments and muscles set them.

Hinge knee, elbow
One plane: flexes and extends.

Ball and socket hip, shoulder
Many: flexion and extension, abduction and adduction, rotation.

B3.3.6 A BALL AND SOCKET SYNOVIAL JOINT

Inside the *hip joint*



PART	WHAT IT DOES
Femur and pelvis	The levers. The head of the femur is a **ball** in a **socket** in the pelvis.
Cartilage	Smooth cover on the bone ends: **reduces friction**, absorbs shock.
Synovial fluid	Fills the cavity in the capsule and **lubricates** the joint.
Ligaments	Join **bone to bone**: hold the joint together, limit movement.
Muscles, tendons	Muscles pull the femur; tendons join **muscle to bone**.

Name the femur and pelvis; you need not name the muscles or ligaments.

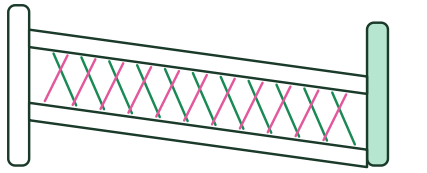
B3.3.8

Intercostals: an *antagonistic* pair

- Two layers between each pair of ribs, **fibres at right angles**, so they move the ribcage in **opposite directions**.
- **Breathing in:** raised ribs increase the volume, so pressure falls and air enters. Quiet breathing out is passive recoil.
- As one layer contracts it stretches the other, **storing potential energy in titin**.

I E **Inhale: External**
ribs up and out

E I **Exhale: Internal**
ribs down and in, forced only



Green: external, down and forward. Pink: internal, down and back.

B3.3.9

Four reasons for *locomotion*

- Moving costs energy and risk, so it must pay. Know **one example of each**.

REASON 1
Foraging
Honeybees fly to flowers.

REASON 2
Escaping danger
A gazelle outruns a cheetah.

REASON 3
Finding a mate
Male moths follow a scent.

REASON 4
Migration
Arctic terns, pole to pole.

B3.3.10

Marine mammals built to *swim*

- **Streamlined:** smooth and tapered, few projections, so **less drag** and less energy used.
- **Flippers:** forelimbs, bones still inside, that **steer and brake**.
- **Fluke:** the tail **beats up and down**, driven by back muscles; a fish tail beats side to side.
- **Blowhole:** nostrils on top of the head, closed on a dive, for **periodic breathing**. One breath swaps most of the lung air.

WATCH OUT

Six mistakes that *cost marks*

- ✕ **Neither filament shortens.** Actin slides between myosin.
- ✕ **The A band keeps its length.** It is the length of the myosin; the I band and H zone shorten.
- ✕ **Muscles never push.** Titin and the antagonist lengthen them.
- ✕ **Ligaments join bone to bone; tendons join muscle to bone.** They are often swapped.
- ✕ **Quiet breathing out is passive.** The internal intercostals contract only to force air out.
- ✕ **More force means more units.** The fibres of one unit all contract together.

COVER THE SHEET

Can you *answer these?*

1. Distinguish motile from sessile organisms, with examples.
2. Explain how a sarcomere shortens.
3. Outline how a muscle returns to its resting length.
4. State what a motor unit is made of.
5. Outline two roles of a skeleton.
6. Outline the roles of the parts of the hip joint.
7. Compare the range of motion of the knee and the hip.
8. Explain how the intercostals act as an antagonistic pair.
9. State four reasons for locomotion, with examples.
10. Describe two swimming adaptations of whales.

IN THE EXAM

Say what slides ("actin slides between myosin"), then **what shortens** (sarcomere, I band, H zone) and **what does not** (both filaments, the A band).

GO FURTHER

Animated figures, a dry lab and a marked Check are in the full guide online.