HIGH JUMP

High jumper needs to receive:

- a large vertical force
- over a relatively long time
Making the ground reaction force be large:

High jumpers plant the foot of the takeoff leg markedly ahead of the body.

This increases the force that the athlete can exert on the ground, as will be shown next.

In a standing vertical jump the legs extend as the upward velocity is generated, so the takeoff leg muscles are in **concentric** conditions:

In contrast, in the **first half of a high jump takeoff** upward velocity is generated while the takeoff leg flexes, so the takeoff leg muscles are in **eccentric** conditions → large forces:
Making the ground reaction force be exerted over a relatively long time:

Combining a fast run-up with a low position at the end of the run-up:
Another way of making the ground reaction force be large: arm and lead leg actions
Injury risk when takeoff foot is not well aligned with final direction of the run-up:

**ankle pronation**

Translation: c.m. path = fixed after takeoff.

Still, to some extent ...

- One part of the body can be lifted higher if another part gets lowered down.

Rotation: angular momentum = fixed after takeoff

Still, to some extent ...

- If moment of inertia gets reduced, angular velocity will increase.
- If one body part is made to rotate slowly, another will speed up to compensate.
High jump = twisting somersault

Need angular momentum for the twisting and angular momentum for the somersaulting:
Twisting component of angular momentum:

Generated during the takeoff phase by:

- throwing the lead knee diagonally upward and slightly away from the bar
- twisting the shoulders in the direction of the desired twist rotation
Somersaulting angular momentum:

Generated also during the takeoff phase.

To understand how the somersaulting angular momentum is generated, we need to separate it into two components relative to the final direction of the run-up:

(The white arrow indicates the final direction of the run-up.)
Generation of **forward** somersault angular momentum requires a backward lean at the plant. so that the body can be vertical in a side view at the end of the takeoff:

![Side view diagram](image)

Generation of **lateral** somersault angular momentum requires a lean toward the left at the plant. so that the body can be vertical in a back view at the end of the takeoff:

![Back view diagram](image)

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The lean during the run-up is affected by two factors:
  * the radius of the curve
  * the speed of the run-up
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The curve has two purposes:
  * to make the athlete have a tilt away from the bar at the plant
  * to lower the c.m. without having to flex the legs very much
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After takeoff is completed, a lot of things are fixed:

- The path of the c.m. is fixed.
- The angular momentum is fixed.

But you still have a certain degree of freedom:

- You can lift one body part by lowering other body parts. Important to arch

- You can make one body part rotate faster by making other parts rotate slower.

- You can make the whole body rotate faster by reducing the moment of inertia. For the somersault rotation this can be achieved by:
  - putting the hands near the hips
  - bending the knees a lot, as if to kick the bar from below with the heels
One last thing: Strong double-arm and lead leg actions help in the generation of vertical velocity, but they can also interfere with the generation of the forward component of somersaulting angular momentum. To minimize this interference, it is useful to execute a “diagonal” arm action during the takeoff phase.

needed for good technique:
* fast run-up
* low hips at end of run-up
* strong arm and lead leg actions during takeoff
* generate appropriate angular momentum
* body vertical at end of takeoff