Hadrons

- Hadrons are particles that can feel the **strong nuclear force.** (force that holds the protons together)
- Hadrons are made up of smaller particles called **quarks.** (hence hadrons are not fundamental particles)
- There are two types of hadrons — **baryons and mesons.**
- Baryons and mesons are classified according to the number of quarks that make them.

baryons: 3 quarks
mesons: 2 quarks

Baryons

What are baryons? (3 quark composition)

- **Protons and neutrons** (nucleons) are both baryons
- There are also other baryons that you don't get in normal matter like sigmas (Σ).
- All baryons except a free proton (i.e not in a nucleus) can be unstable.
- This means that all **baryons apart from protons decay to become other particles.** (eventually a proton)
- Baryons must contain **3 quarks** in its composition.

Antiprotons and antineutrons are antibaryons

- Antiparticles are annihilated when they meet the corresponding particle — which means that you don't find antibaryons in ordinary matter.

Conservation of baryon number

- Baryon number is basically nucleon number (if you ignore unusuals like Σ)

Protons/Neutrons/Σ:	$B = +1$
Antiprotons/Antineutrons:	$B = -1$
Non-baryons (mesons/leptons):	$B = 0$

The total baryon number in any particle interaction never changes.

- Using beta-minus decay as an example, we can see the conservation of baryon number come into play here:

$$n \longrightarrow p + e^- + \bar{\nu}_e$$

$B=+1$ $B=+1$ $B=0$ ← they are leptons

Mesons

What are mesons? (2 quark composition)

- All mesons are **unstable.**
- Mesons are not observable in day-to-day life. However, large amounts are observable in high-energy particle collisions like in the CERN particle accelerator.

Examples of mesons

- Pions (π^+, π^0, π^-) are the **exchange particle of the strong nuclear force.**
- π^+ and π^- are particle – antiparticle pairs.
- Kaons (K^+, K^-, K^0) are **heavier** and more **unstable** than pions.
- Kaons have a very short lifetime