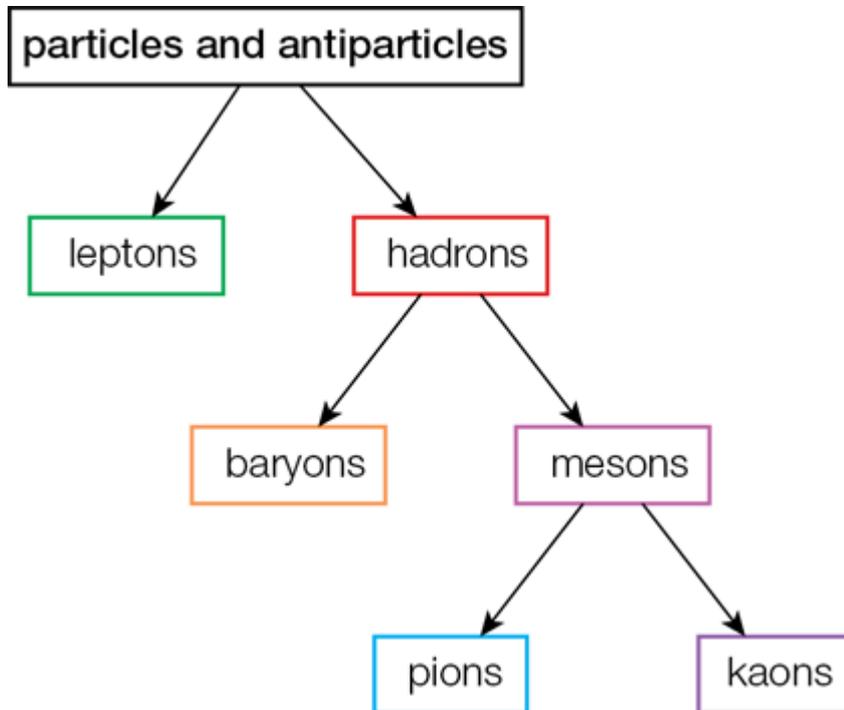


## Constructing a particle family tree



**Figure 1** *The particle family tree*

The two main families are the **leptons** and the **hadrons**. Each family contains both **particles** and **antiparticles**.

### Leptons

Leptons are **fundamental**; they have no internal structure.

All leptons have a lepton number =  $\pm 1$ .

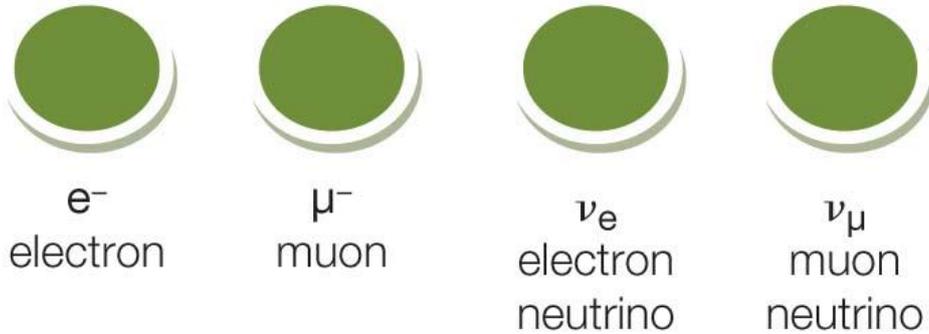
All leptons have baryon number = 0 (as they are **not** baryons).

All leptons have strangeness = 0 (as they do **not** contain strange quarks).

Neutrinos have no charge.

You will need to know the names of the leptons and their symbols, as shown in Figure 2.

Particles (lepton number = 1)



Antiparticles (lepton number = -1)

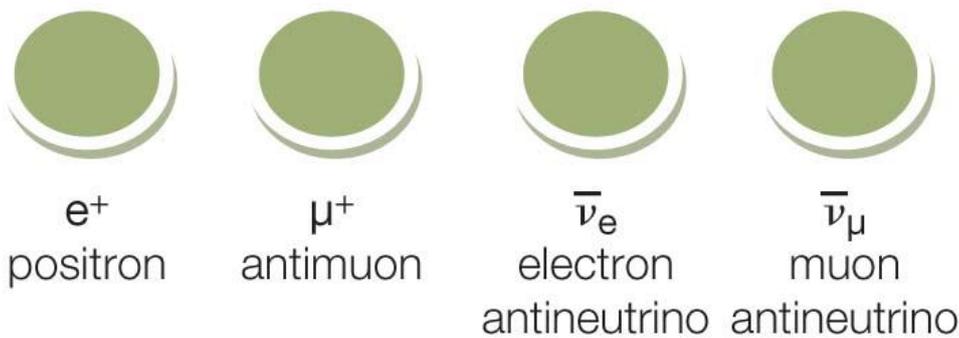


Figure 2 Leptons and antileptons

**Hadrons**

Hadrons are not fundamental as they all contain quarks.

Hadrons consist of two families: **baryons** and **mesons** (see Figure 1).

To show the quark composition of the baryons and mesons you might find it useful to choose a colour to represent each quark.

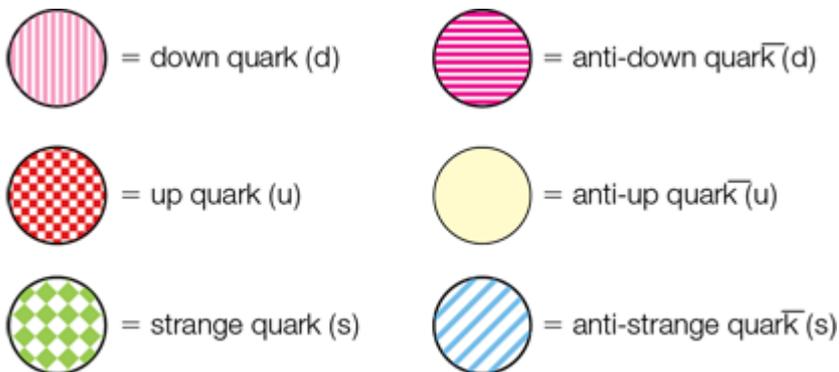


Figure 3 Colour coding the quarks and antiquarks

**Baryons**

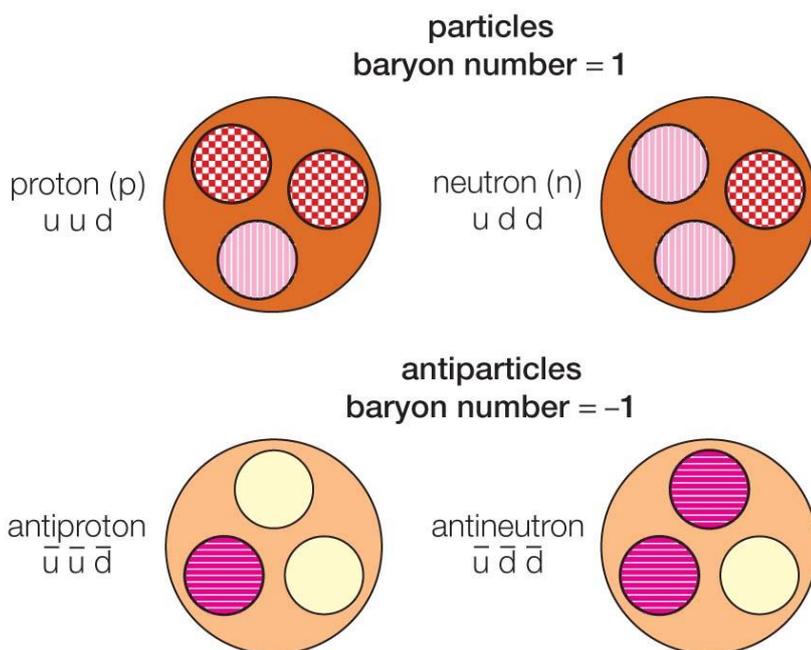
Baryons contain three quarks, and antibaryons contain three antiquarks.

All baryons have baryon number =  $\pm 1$ .

All baryons have lepton number = 0 (as they are not leptons).

All baryons have strangeness = 0 (as they do not contain strange quarks).

You will need to know the names of the baryons, their symbols, and their quark composition, as shown in Figure 4.



**Figure 4** Quark compositions of the baryons

**Mesons**

Mesons contain one quark **and** one antiquark.

All mesons have baryon number = 0 (as they are not baryons).

All mesons have lepton number = 0 (as they are not leptons).

Mesons decay into photons and leptons.

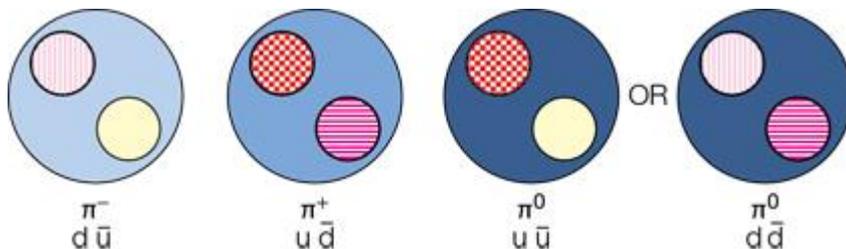
Mesons consist of two more families: **pions** and **kaons**.

You will need to know the names of the mesons, their symbols, and their quark composition – see the information on pions and kaons below.

**Pions**

Pions contain a quark–antiquark pair; see Figure 5 for the possible quark combinations.

All pions have strangeness = 0.



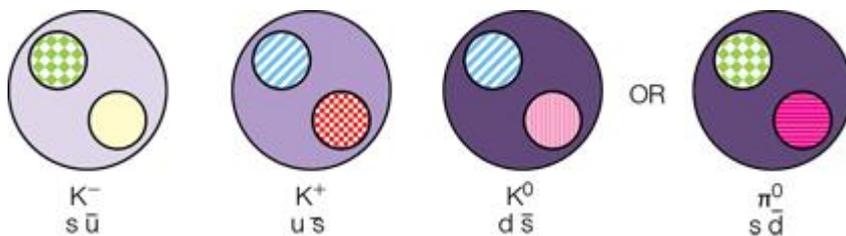
**Figure 5** Quark combinations of the pions

Note that the  $\pi^0$  meson can be any combination of a quark and corresponding antiquark. You may wish to add the information to your family tree.

**Kaons**

Kaons contain a strange quark or antiquark **and** either an up or down quark or antiquark, in a quark–antiquark pair.

All kaons have strangeness =  $\pm 1$  as they contain strange quarks.



**Figure 6** Quark combinations of the kaons

**Task**

Construct the basic particle family tree including all of the particles and other essential facts.

- Make each particle out of a circle of different coloured paper and label the particle with its symbol. (If no coloured paper is available then you could colour in white paper, or use different coloured sticky labels.)
- Stick quarks (smaller circles of coloured paper) on to the hadrons correctly, using one colour for all the up quarks, one for the down quarks, and one for the strange quarks. It would be useful to also label each quark with d, u, and s.
- Group the particles together in families with family titles.
- Make labels for each family, summarising the information given at the beginning of each section about the lepton number, baryon number, and strangeness.
- Add further labels with any facts you discover as you work through the topic.