Particle Physics

Forces in nature:

1. Gravity
2. Electromagnetism
3. Weak (has been unified with Electromagnetism)
4. QCD (describes forces between quarks)
5. Strong (describes forces between nucleons, not "fundamental")

Conserved quantities:

1. Baryon number = (Number of quarks - number of anti-quarks)/3
2. Lepton number = (Number of electrons, muons, taus and neutrinos - number of antielectrons....)
3. Electric Charge
4. Energy, Angular Momentum, Momentum

Fundamental symmetries:

1. Charge conjugation (For every particle there must be an equivalent anti-particle with opposite charge.)
2. Parity (Left-handed universe should be equal to right-handed universe.)
3. CP (If particles are interchanged with anti-particles and left-handed is flipped with right-handed, universe should look identical.)

Assorted facts:

1. Charge conjugation symmetry and parity is broken in nature because neutrinos spin only one way (left-handed) and all antineutrinos spin oppositely. However, the combination of the two symmetries, CP,is not violated by the properties of the neutrinos, since if I change particle to antiparticle and change left-handed to right-handed, the corresponding particle exists.
2. CP symmetry is violated only extremely slightly. CP violation is seen in kaon decays, where the kaons decay into certain particle states slightly differently than they decay into the corresponding anti-particle states. The other place where CP violation is evident is in the fact that there is more matter than anti-matter in the universe.
3. Quarks come in three colors, but only exist inside of color-neutral objects. Color neutral objects are either 3 quarks of different colors or a quark and anti-quark of opposite color.
4. Three quarks make a baryon. For example, two *up* quarks and a *down* quark can make a proton. A quark-antiquark pair makes a meson. For example, an *up* quark and an $anti-down$ quark can make a π^+ meson.
5. Despite the fact that quarks have charges of $\pm 2/3$ or $\mp 1/3$, baryons and mesons always have integral charge.