Question 1:

Dear Cheap Astronomy – What do different pulsar frequencies mean?

A pulsar is really a neutron star, which forms after a big star goes supernova and its remnant core collapses down into a very dense object. Star routinely spin, for example the Sun rotates around once every 25 days, so when the core of a really big star collapses right down to an object that's only 20 kilometres in diameter, conservation of momentum means that object will spin really fast, like when the spinning ice skater pulls her arms in.

Although a neutron star is primarily composed of lots of neutrons, largely arising from the compressed fusion of electrons and protons, a substantial number of free charged particles still remain which gives neutron stars powerful magnetic fields, which when spun up create electrical fields which channel the charged particles up towards the poles where they are squeezed together until they shoot out, as though by a firehose, because the electromagnetic forces pushing on them overcome the gravity of the neutron star. Through a mechanism that is not well understood the ejected particles electrically dissociate in some way causing a powerful emission of radio waves in line with the particle jets, which is what we detect from Earth. Two radio beams come from each of the magnetic poles, which do not precisely align with the neutron star's rotational poles. So, when the neutron star's rotational axis approximately aligns with Earth, its spin can bring that beam into line with us once per rotation. And since neutron stars spin fast, generally many times a second, we detect this as rapid flashes of radio light.

Pulsars do eventually die – that is, there's a point where their polar jets switch off so there's no more pulses. This is because their charged particle beams and other radiative outbursts, represent loss of mass and energy density, which will slowly reduce a pulsar's angular momentum. We think well over 90 percent of pulsars produced since the beginning of the Universe have since switched off and are just floating around as invisible balls of compact mass along with all the invisible non-accreting black holes out there. These wouldn't account for all the dark matter that we need to explain galaxy behaviours, but they do make some contribution.

Anyway, it is the case that the pulse of a pulsar is partly related to its age, but there are various exceptions to that rule. Many active pulsars have occasional glitches, where they collapse further in on themselves – so conservation of momentum makes them spin faster, although this is just a temporary thing and they will start slowing again. Also, dormant neutron stars in binary or multiple star systems can be reawaked if they begin accreting mass from a neighbouring star, as that additional mass spins them up again and reactivates the pulsar mechanism

Finally, while pulsars do primarily broadcast in the radio spectrum, there are some that broadcast in other wavelengths, all the way from radio up to to x and gamma rays. This is partly about age, where young neutron stars seem to broadcast across multiple wavelengths, like the Crab Pulsar, the remnant of a supernova that exploded in 1054. It's possible that the Crab pulsar has standard radio jets, but these are producing synchrotron radiation as they blast through the wind nebula that still surrounds the site of the recently exploded supernovae. It's also the case that reawakened neutron stars in binary systems generally radiate in x-ray. And of course, there are magnetars, which are neutron stars of a certain configuration, where not only the spin and charge, but also temperature seem to all work together to produce a much more powerful magnetic field than pulsars have.

Rather than blasting out two jets of charged particles, magnetars mostly hold on their charged particles, but still release energy through irregular blasts of X and gamma rays. The lifetime of a magnetar is relatively short, after about 10,000 years it ceases radiating and may then settle down to become a normal pulsar. It's even speculated that magnetars are a phase that pulsars may shift in and out of more than once in their lives, whenever they achieve just the right configuration of spin, charge and temperature. There's still a lot of pulsar physics that we just don't fully understand yet.

Question 2:

Dear Cheap Astronomy – How are stars named?

The naming of stars goes back a long way and crosses many cultures so it's immediately difficult to suggest that a name from one cultural background should supercede any other names. Some of the oldest names familiar to anyone with an interest in astronomy are Arabic names –Achernar, Sirius and Betelguese for example. But not all those names stuck, so for example Polaris, which is just a portmanteau of Latin words for pole and star also has an Arabic name, as well as Pacific islander, Hindu and Unuit names – not to mention also being Alpha Ursae Minoris, because it's the brightest star in the constellation of Ursa Minor.

So, at least for at least most of the English-speaking world, some bright stars have Arabic names that stuck, while others may names from different cultures and others like Alpha Centauri fall out of the Bayer system where the stars in a constellation are named from brightest to dimmest as Alpha, Beta Gamma etc. But there's also the Flamsteed system which was also based on the constellations, but it uses numbers – an improvement on only having 24 Greek letters available – and rather than ordering by brightness, Flamsteed just ordered from east to west. So, for example, it turns out that Deneb (Arabic name), which is also Alpha Cygni (Bayer system) is also 50 Cygni under the Flamsteed system.

But all that mostly pre-dates telescopes. Once you move beyond naked eye astronomy there are suddenly billions of stars needing designation. So the best thing to do is just designate them with their position with right ascension and declination. Where right ascension is measured in times units (hours minutes and seconds, where a full circle if 24 Objects like star clusters and galaxies are often named after the sky survey catalogue they were identified with, with abbreviations like NGC for New General Catalogue and thse days were naming things HST after the Hubble Space Telescope. And really there's nothing wrong with all that, there really are just vastly too many objects out there to bother giving them all proper names.

But anyway, this podcast is about naming the visible ones. And recently, since 2016,that naming process has gained a whole new level of rigour. The International Astronomical Union, who are officially tasked with naming celestial objects and their surface features decided to turn its hand to naming the visible stars. There are over three hundred names now in a list developed by the WGSN – the working group on star names. The list retains most of the familiar names – like Altair, Barnard's star, Fomalhaut, Mimosa (which is in the Southern Cross) and Polaris, Betelguese and Rigel. But also the WGSN assigned some Chinese names for some, like Fang and Tianguan and also some Indigenous Australian names like Wurren and Larawag – and various other cultures get a look as well. It's an attempt at inclusiveness, while still holding to some historical familiarities.

The IAU has established a few general rules to visible star naming - names can't be offensive or about people or their pets – and they can't recall historical events, political parties or commercial interest. There's also some general rules around the name ideally being a single and ideally a short word, although a few exceptions like La Superba and Kaffaljidhma did make it through.

And who the heck are the IAU? Apparently a union of about 14,000 professional astronomers (they're the ones that get paid), who have meetings and working groups, which generally meet in Brussels – and they also give out various awards to people and of course they name things. They were established in 1919 and just celebrated their centenary in April 2019. Between June and November 2019 they've been inviting any country to name an exoplanet and its host star. For example, Australia named the exoplanet Pollux b Thestias – well, we actually named it Leda, but when the IAU checked the books Leda had already been used, on a tiny moon of Jupiter for example. Leda was apparently Pollux's mum. Pollux is probably best known for being one of the Gemini twins, the other being Castor. As for Leda also being called Thestias, that's apparently where she's the daughter of Thestius where daughters can take on the feminized name of their father, at least back those fabulously patriarchal times of Greek-Roman mythology. And who is Thestius, you ask… well, it turns out that...

Oh right. Well, I guess that it then