Question 1:

Dear Cheap Astronomy – Is there hope?

Well, sure. The question arises where the Drake Equation, aiming to quantify the likely number of detectable intelligent civilizations out there includes a term representing the inherent risk of any intelligent civilization destroying itself. It is just a risk, could be low could be high, but its wide acceptance as a part of the whole equation does suggest we have some pessimism about our own future. Our own existence supports the view that intelligent life can arise from a relatively mundane set of circumstances and so it is kind of puzzling that our observations to date have found no evidence of anyone else out there. This is essentially the Fermi Paradox, and one solution to the paradox is that intelligent civilisations snuff themselves out soon after they appear.

Our history to date is worrisome. I'm old enough to have seen the world's population double within my lifetime and have seen much of the planet's untamed wildernesses contract to collections of isolated reserves in that same period. There's no doubt we are changing the planet's climate and that impact seems likely to accelerate, where for example more greenhouses gas increase the likelihood of forest fires, which results in more greenhouse gases and less carbon absorption capacity.

We're doing a fabulous job of understanding how greenhouse gas physics works and we're making some great documentaries about it too, but our ability to effectively change our behaviour, so as to limit further damage, is yet to be demonstrated. But there is hope.

The bigger picture of whether any intelligent species carries an equivalent risk of self-annihilation is difficult to answer in the absence of examples. Humans' success largely arises from their capacity to cooperate, as well as to communicate and pass on knowledge, but this is tempered by varying degrees of selfishness and desires for immediate gratification – which results in our apparent unwillingness to deal with the steady degradation of our environment, not mention wars and other destructive behaviours. Of course, one could argue that much of our technological advancement has been driven by our selfishness and desire to outcompete others. We are a complex mix of dark and light and there's no reason to think that this formula will be common across other organisms that achieve technological advancement – even though it might be.

A species that works as a colony, with members who are there to support a queen or a group of favoured breeding individuals might be similarly-driven to improve and advance, but with less focus on self and selfishness. Indeed, if the queens were cooperative the whole concept of war would make no sense – noting most of us humans would like to think wars make no sense anyway. Species with longer life spans anything up to regenerative immortals, would be more conscious and concerned about their impact on their environment, while species like us with a lot of generational turnover tend to accept the world we are born into as base normal, which just then declines a bit before we die. Concern for your children does extend your concern for the state of the world a bit further, but it's still just a matter of decades rather than centuries.

Once again, shows like Star Trek have us thinking that aliens will be pretty much like us, apart from some slightly different personality traits and lumpy bits on their foreheads. In reality, aliens are likely to be of a completely different nature to us, both physically and motivationally. So, it’s not all that likely that inevitable self-annihilation is an explanation for Fermi’s paradox – it’s more likely that the last term of Drake’s equation is an expression of our own self-doubt. But there is hope and at least that might be a universal trait of self-aware beings.

Question 2:

Dear Cheap Astronomy – Could dark matter be black holes?

Well, no. Firstly, we've discussed before how black holes can't really be dark matter. Dark matter is not only invisible, but it's also transparent. Black holes can be invisible against a black background and after all space is a black background. But given that dark matter is estimated to be 85% of all matter in the Universe, you'd think those generally invisible black holes would occasionally make themselves known by occulting a star or a nebula, where occulting means they move in front of that star or nebula and block it out. So black holes can't really be dark matter because they're not transparent.

It's also the case that the black holes that we know about form from collapsed giant stars, or maybe neutron star mergers, or even black hole mergers, where two small black holes form from one bigger one. But dark matter, with its apparent overarching influence on the organisation and distribution of light matter, seems likely to have been around from the very early stages of the Universe, since dark matter’s influence was apparent even then.

Furthermore, where we say dark matter is invisible and transparent, that means it neither absorbs or emits light, and that's light in its broadest sense - anything from gamma rays to radio waves. Also, dark matter is weakly interactive. So, despite it being 85% of all known matter, it doesn't appear to attract, repel, or even accidentally collide with light matter. All we do see is that dark matter seems to gravitationally influence the organisation and distribution of light matter at galactic scales.

And this brings us to the issue of why dark matter can't be black holes any more than black holes can be dark matter. We know that black holes are the result of massive gravitational collapse. But things can't just gravitationally collapse spontaneously. Two massive objects can influence each other’s movement and even orbit each other. But that orbit won't decay unless the orbiting objects can somehow lose momentum energy. This normally happens through objects colliding and repelling – interactions that will radiate energy in an explosive manner. This phenomenon is most obviously seen in the accretion disks around black holes, where the crushing collapse of the accreted material radiates huge amounts of energy, that can be seen across galaxies in the case of supermassive black holes – that appear as active galactic nuclei due to the vast amount of energy their ginormous accretion disks generate.

We usually say that the accreting material generates the energy radiation but it's equally the case that you can't have the accretion without the energy radiation otherwise the material would just keep moving around the black hole in an unchanging orbit. So, it's not out of the question that some dark matter might get caught in the collapse of a dying star or a compact object merger, but that would be more an incidental thing than the dark matter making a major contribution.

So, in a nutshell, black holes are mostly collapsed light matter and while we don't know what dark matter is, we're pretty sure it’s not black holes. As to what the heck dark matter actually is, we have no clue. An internet search these days will tell you that no-one really knows, but it might be axions. The same search 10 years ago would have told you that no-one really knows, but maybe its neutralinos and and before that you would have heard that dark matter is probably WIMPs, weakly interactive massive particles but probably not MACCHOs, massive compact halo objects – which essentially means that dark matter isn’t invisible black holes that are distributed in a halo around galaxies and galactic clusters.

This is the process of science by elimination. Once we discovered evidence of missing mass that was needed to explain the behavior and organization of galaxies, we started with the idea that maybe there were lots of undetected black holes floating outside those galaxies. But after ten years of pursuing that possibility, we failed to find any evidence for it and so have mostly ruled it out. Then neutralinos started looking good at a hypothetical level, since hypothetically they are invisible, weakly interactive and massive. But being supersymmetric particles, their existence has mostly fallen out of favour in the same way that supersymmetry has fallen out of favour. So today it’s axions, whose existence is also considered a bit dubious – but what the heck, we’ll run with it for now.