Consensus, why are in science certain things accepted as true

After numerous debates on scientific issues, I realize certain issues and aspects of science are not commonly understood by the public.

Before going further, it's necessary to define some terms used by scientists. The terms are conjecture, hypothesis, theory, and law. Assume I'm putting scientific prior to each term to differentiate it from those terms used in everyday conversation.

- Conjecture - an idea. Typically, this is usually like its common usage and often what people think scientific theories are.
- Hypothesis - a conjecture that is testable.
- Theory - a coherent group of propositions formulated to explain a group of facts or phenomena in the natural world and *repeatedly* confirmed through experiment or observation. (Dictionary.com)
- Law - Scientific laws or laws of science are statements, based on repeated experiments or observations, that describe or predict a range of natural phenomena. The term law has diverse usage in many cases (approximate, accurate, broad, or narrow) across all fields of natural science (physics, chemistry, astronomy, geoscience, biology). Laws are developed from data and can be further developed through mathematics; in all cases they are directly or indirectly based on empirical evidence. It is generally understood that they implicitly reflect, though they do not explicitly assert, causal relationships fundamental to reality, and are discovered rather than invented. (Wikipedia).

  Laws tend to be simple and don't change with newly discovered information.

Notice that there can be both a law and a theory concerning the same subject. For instance, the law of gravity and the theory of gravity. The law refers to the direct mathematical relationship of forces between objects with mass. The theory concerns the why and how of gravity and its mechanisms.

A scientific theory differs from a scientific fact or scientific law in that a theory explains "why" or "how" concerning scientific observations or facts, whereas a law is a statement (often a mathematical equation) about a relationship between facts.

Scientific Consensus

Say we are arguing over Quantum Gravity vs Superstring. If you think about it, (unless you're a physicist) that would be ludicrous. Neither of us have the background, especially in math, to

argue well about it. Without at least a master's and preferably a PhD in that subject, such arguments are little more than ego contests.

The same can be said of many arguments going against scientific consensus. Let me clarify. Scientific consensus is a rare thing. It does not come from a single study or a few, but a large body of research, where studies and opposing studies are considered by major scientific societies who consider the evidence overwhelming. These societies are those such as the American Chemical Society, the American Institute of Physics, The American Medical Association, The Royal Society of Chemistry, or The National Academy of Sciences, to name a very few. Like scientists, they live by their reputation. Like scientists, if they are found knowingly backing anything scientifically fraudulent or dishonest, they would be doomed and disgraced in the scientific world from then on. They would never recover. A politician or religious leader can do something illegal or unethical and be forgiven. It does not happen in the scientific field. These institutes will occasionally come to a consensus on a major issue, like Relativity or Quantum Mechanics of the early 20th century. These were and are not taken lightly. If an institute puts its reputation behind something seriously flawed, the damage to the institute's reputation could be major if it appears they should have known better.

Scientific consensus occurs when not one, but a number of these institutes, usually the one primary in that field of the issue involved, along with fields ancillary to the issue involved backs a conclusion involving that issue. This is done when the major players in the organizations feel the evidence is overwhelming. A current example is Anthropomorphic Global Warming. The lead was taken by the IPCC and American Meteorological Society, followed by the ACS and AIP. For some time, this was opposed by the American Geological Society, not a primary or ancillary field in atmospheric science. The AGS, like all major societies and science bodies, have dropped their opposition to anthropomorphic global warming. All don't support it, but have dropped opposition, rather than risk the loss of reputation when the level of evidence currently is so high. At this point most societies and science bodies support human-caused global warming, along with all the societies for the directly related fields. Saying this type of consensus is difficult to arrive at is an understatement. Scientists, by nature, tend to try to disprove what their colleagues come up with. They do this by repeating the original experiments first, then my altering the experiment to see if they get the same results from a different direction. If they confirm the results, at least they come up with a paper to publish. If the paper contradicts the original, it makes a name for the scientist involved. Many scientists who have done this have made their name and career in disproving what came before. Darwin showed biological science was wrong about the apparent fixed nature of species. He is now a household name. Einstein disproved a small corner of Newtonian mechanics (for the very large and/or the very fast), now Relativity and Einstein are known to everyone. Schrodinger and his fellow QM scientists disproved a small corner of Newtonian mechanics (for the very small) and now Quantum Mechanics, with all its bizarre strangeness, is now taken for granted as true. It's in a scientist's blood to find out

something wrong in their fellow's work so it is difficult for a large group to come to a consensus about an issue. The weight of evidence must be very large. This is why consensus carries are great deal of gravitas.

It's easy to find a list of studies supporting a side. But, how do you know if the studies mentioned in an article were not cherry picked to support one side of the research? Unless you do research in the field you won't have any clue what counter studies and papers exist. The people writing the article rarely include them because their goal is to persuade. All studies of this sort will have been re-run several times by others. If it supports the conclusions, the researcher has another paper under his/her belt. If they disprove it, then they have gained a significant bit of stature in that someone will have to directly consider what they've found. The more generally accepted what they disprove is, the higher the stature they gain from their research when it's confirmed.

Unless you do research in a field, you are not familiar enough with the subject to know the literature on it. Most online articles have one goal, to convince the audience of one side - a sure sign it's not a scientific research paper. A scientific paper should address the bad AND GOOD in the counter arguments.

If I wanted to produce an article about cold-fusion and how the establishment was subverting it, I could find research and papers supporting it. One of the first I could point out was done by nuclear physicist Dr. Mahaffey, of Georgia Tech, who detected neutrons emitted while repeating the experiment - solid evidence of fusion. If you didn't know the literature well, you wouldn't have known he retracted his findings about a week later when he realized the neutron detector used was subject to falsely reporting neutron radiation if the detector temperature was elevated. He re-ran the experiment, controlling for temperature and the neutron radiation readings disappeared.

The problem with any subject having deeper underpinnings than we can knowledgeably investigate directly is we must rely on others. It's a question of their credulity and qualifications. This goes to what we base our conclusions on. Do we accept articles by people we don't know a lot about, potentially using cherry picked data? Or even those of a small set of scientists who oppose the larger consensus. If we don't have their level of expertise in the subject, how can we knowledgably support the position. Moreover, if we do, is it because we like their conclusions, which may have nothing to do with the logic and evidence used to arrive at those conclusions? Accepting the consensus of a large group of respected scientists, who would love nothing more than to prove each other wrong, is safer, better, and a more rational position to take, unless your knowledge in the field is extensive.

A common position I hear, whether anti-vaccine, anti-global warming, or anti-evolution is the consensus is due to a conspiracy by scientists. Accusing scientists of conspiracy is a bit absurd but an easy accusation to make. It falls apart when realizing how vast the conspiracy would have

to be, the fact the motivations just are not there to support such a conspiracy, and that the dangers of being caught supporting scientific fraud is professional suicide for any scientist. It's just plain opposite of the motivations of most scientists. If there is consensus, you are saying this of most scientists in each field to maintain your assertion.

This isn't to say they couldn't be wrong; they most certainly can be. However, one must keep in mind the complete overthrow of a theory or major field idea is almost unheard of in the 20th or 21st century. A small part of it can certainly be overturned, but very rarely the whole idea or theory. Einstein only overthrew a tiny corner of Newtonian mechanics in an area they couldn't test at the time. The same can be said of Quantum Mechanics. As revolutionary as they were, these were evident in small areas which were only able to be investigated starting around the time the ideas were posited and usually to explain something that didn't quite fit the main theory.

Considering overthrowing an accepted and major scientific assessment is vanishingly unlikely, going with the consensus of scientific thought is the most rational position, assuming you don't have serious expertise and knowledge in the field. That lack of knowledge means accepting any other conclusion isn't supportable and the reasons for choosing it should be seriously examined. How do you know choosing any other position isn't falling into one's own ego trap or worse, one of another's making?

A scientist must constantly question their own position because they are dead certain their colleagues will. Shouldn't we hold ourselves to the same standard?

Video with Neil DeGrasse Tyson, including consensus at minutes 7 through 10.

Wikipedia entry on Scientific Consensus

I hope this has provided you with food for thought.