Thanks to Chris Gerling and Melissa Aellen for the thorough answers.

Note: A couple of questions below touch on what is allowable (or not) according to federal regulations. Code of Federal Regulations (CFR) is the reference for our answers and the place to go when any such questions arise. Here is a link to the code, organized by wine area:

http://www.ttb.gov/wine/wine_regs.shtml

1. Are there any rules of thumb for what type of filters to use based on volume of wine production? Does it make sense to start with a cartridge filter for small (~1000 gal) volumes and move up to larger filters with greater volumes?

There are a lot of ways to think about choosing the appropriate type/ size filter. Each type of filter is also available in a wide range of sizes and options. While the volume of liquid to be filtered is one consideration, others include the level of filtration required, the flow-rate, the volume that can pass through before the media must be changed, and the cost per gallon. For these reasons it can be hard to make blanket recommendations. Below are the most commonly filters and their characteristics. There are four main types of filters that are used in wineries: pad filters, cartridge filters, earth/ pressure leaf filters, and cross-flow filters.

Pad filters are very common and are relatively inexpensive. They work by having the wine pumped through cellulose or diatomaceous earth pads. The larger particles are trapped in the pads as the wine is filtered through. These filters, commonly called plate and frame filters, allow for two different filtration levels to occur at the same time, potentially speeding up the filtration process. Plate and frame filters can also be used for filtering out yeast after fermentation is complete. These filters are a bit labor intensive to set up and can have a fair amount of leakage due to the filter's design. Pad filters tend to be able to deal with a moderate amount of flow rate and turbidity.

Cartridge filters are very easy to set up and have low leakage rates. They also allow the wine to be filtered through two grades with a single pass (if you have the appropriate set-up). The cartridges can be made of a cellulose based product, such as cellulose nitrate, or a polyvinyl based product like polyvinyl chloride. However, these cartridges can be pricey so it is important to clean and store the cartridges properly to extend their usable life. This filter is the only filter that is classified as an **absolute** filter since cartridges are available with standardized pore sizes that allow only particles meeting certain conditions through. The rest of the filter grades and sizes are classified as "**nominal**," meaning their rated size is based on an average. Cartridge filters are best for final filtration but tend to have less surface area, making them a poorer choice for rough filtration or large amounts of wine.

Earth filters, also known as pressure leaf filters, use diatomaceous earth (DE) to create a pad on a plate. The wine is then pumped through the filter and the larger particles remain with the DE. These filters have a high initial cost but the cost per liter is very low after the filter is bought. A respirator should be worn when using DE since DE can be easily inhaled and may become an irritant in the lungs. Other materials for pressure leaf filters such as cellulose and perlite are now available. Earth filters tend to be able to deal with high turbidity and allow for lots of flow, but are least equipped for final filtration.

Cross-flow filter Pad, cartridge and earth filters all function by pushing the wine through a medium in an effort to trap particles that may be too large. Over time this process will cause the filter surface to become fouled and the wine will no longer be able to flow through. The pads, cartridges or DE will have to be changed and the filtration will have to be restarted. Cross-flow filtration allows the wine to flow parallel to the filtering medium continuously as the smaller particles move to one side of the membrane and out of the filter. The cross-flow also periodically back-flushes the surface, clearing off potential fouling particles. These systems are highly efficient, allow for very tight filtrations (0.2 nominal in a single pass, while the other types of filter usually require at least two: one "rough" and another finer grade) with minimal oxygen pick-up and are usually fully automatic. While shrinking in size and price every year, these filters are still relatively large and expensive and therefore probably not feasible for a very small winery.

Most established small wineries employ a pad or earth filter while the wine is in tanks, and then use a "sterile" (0.45 micron or smaller absolute- the word sterile is in quotes because 0.45 is considered adequate for winemaking but does not meet the microbiological definition of the word) cartridge while bottling. Traditionally the pad filtration has been to 0.45 or smaller (nominal) and the filter used for bottling is there only to catch the occasional missed particle. This manner of usage ensures a longer life for the expensive cartridge. Earth filters are most often used for juice, tank bottoms and other high-solids liquids.

So, to return to the beginning and attempt to answer your question, a cartridge filter is probably a good place to start since you will have the all-important ability to use an absolute membrane for final filtration before bottling. A small pad filter (they are available in table-top sizes for a few hundred dollars) may also be useful in short order, however, as you look for ways to get more volume in less time.

2. Can more stable sweet wines be made by adding non-fermentable sugars and/or alcohol?

Non-fermentable sugars cannot be added to wine since they are not listed in the CFR (see link above). Alcohol can be used as a stabilizer, but many yeast strains can tolerate up to 18% EtOH, which will increase the tax rate and is most likely undesirable in a sweet wine.

3. I have some single use sterile vacuum filter funnels for use in the lab that after filtering I can move the media to a petri dish. I would like to try random sampling bottled wines as a way of testing the effectiveness of our filtering, but don't know what types of culture nutrients to use, or what temperature I would need to hold the samples, or for how long.

We use a yeast extract agar that is designed to support yeast, bacteria and other "aciduric organisms" that might live in wine. The media is sometimes designated "YM" by some suppliers. You can leave the plates at room temperature (as long as that room is not particularly cold) and most organisms should appear after 2-5 days. At the wine analytical lab, we observe the samples for 10 days. See question #9 for more about the sterility check.

4. Thanks for the YAN numbers I've been wondering what's normal / ideal. How about recommendations for Sorbate additions? The bottles usually only give a usage range. I don't know how to judge.

The amount of sorbic acid cannot exceed 300 ppm (see CFR link above). Most organisms (yeast and mold, but NOT bacteria- sorbic acid has no inhibitory effect on them) are inhibited in the 100-200ppm sorbic acid range. Keep in mind while performing calculations that typically wineries are adding potassium sorbate, which is 74% sorbic acid.

5. What about use of potassium sorbate (g/L) based on alcohol levels? More with 10% alcohol versus 12% alcohol?

Less sorbate is needed at a higher alcohol level. Peynaud (1980) recommends adding 150 mg/L sorbic acid to a wine with 10% EtOH and 100 mg/L to a 12%EtOH wine.

Peynaud, E. 1981. Knowing and making wine. John Wiley & Sons, New York

6. What practical steps are needed to sanitize and sterilize a semi-automatic corker for reliable sterile bottling? I am specifically worried about the area in and around the corker jaws, which seems to be tough to reach completely with 70 % EtOH, especially during brief breaks in the bottling cycle. Should I disassemble and clean the whole assembly after each bottling? I know wine sometimes splashes up into it.

During brief bottling breaks, a spray bottle with 70 % EtOH should be enough. 70% is the correct ethanol concentration, by the way, and the most effective. Higher concentrations are actually LESS effective at killing microbes. After bottling, I would advise taking the assembly apart to see how things look. If it's a mess, it probably needs to be cleaned every time. It sounds to me like you'll sleep better having done it, which is another important part of winemaking.

7. What temperature do you suggest bringing the wine down to stop fermentation?

4°C should be adequate, although 0°C often makes people feel more comfortable. Keep in mind that the time it takes to reach that temperature is equally important.

8. When using sorbate in sweet wines, how much more SO2 should be added above the recommended for a specific pH?

You should not necessarily increase SO2 above the recommended amounts for the pH of the wine, but you should definitely not have less than that amount either. Recommendations often call for lower amounts in red wines as opposed to whites, and in the case of a sweet red with sorbate you might consider sticking closer to the white wine level.

9. I wish there were a way to measure the effectiveness of pre-bottle filtering after bottling. Then I would feel more comfortable with trying to back off on the sorbate. If using fresh juice for back

sweetening, should the juice first be pasteurized for safety, since now all fresh juice sold for consumption must be pasteurized?

There are a couple of ways to check to see if your filtration is effective. Before filtration you can test the integrity of the membrane with a bubble test, and afterwards you can perform a sterility check. The protocol for conducting some of the membrane tests can be found here: http://wine.appstate.edu/sites/default/files/Bubble%20Point%20Test.pdf

After bottling, you might conduct or hire someone to conduct a sterility check, which involves examining the wine for viable microorganisms that may still be present (see question #3 above for a basic protocol). There are two main problems with a sterility check: 1.) Since the microbes need time to grow, the test takes days to obtain results, and 2.) If the check takes place after bottling, it's now too late to do anything should something surprising appear. Some wineries have a sterility check done on wine before bottling, but this method can't account for contamination during bottling. Those who really want to know what's going on might consider sending before and after samples to a lab. I can imagine that paranoia might be running high for some people right now, but keep in mind that wine is a fairly stable product inherently, and most of the time things tend to work out.

Juice that is added to wine does not have to be pasteurized since it is being added to a solution with so much ethanol (wine). There is less concern of a human pathogen surviving in this environment. That said, the juice will need to be stabilized in some way so that it will not ferment before it is added back to the wine, and pasteurization is one of the more effective ways to accomplish that.