Making your own microsyringe

Figure 1 - The 3 items of equipment needed.

Background

The Arrangements Documents for the Revised and *CfE* Highers in Biology [1, 2] and Human Biology [3, 4] as well as the Revised Advanced Higher in Biology [5] recommend a variety of practical work that will require the measurement of small volumes of samples. Microsyringes are available from a range of suppliers and can vary in both price and complexity. For measurement of single volumes, we find the range of Volac Minipipets from NCBE [6] is particularly useful - allowing reliable measurement of volumes of 5 µl, 10 µL, 20 µl, 25 µl, 50 µl and 100 µl, although at a price of £16 per syringe class sets might be difficult to obtain. NCBE also provide packs of microsyringes which are suitable for measuring volumes as small as 2 µl and 5 µl when using graduated tips.

In this short paper we wish to show you how you can make your own perfectly serviceable microsyringe capable of measuring volumes from 10 µl to 200 µl in 10 µl increments; the cost of 10 such syringes is approximately £2.00.

The equipment

To make your microsyringe you need 3 pieces of equipment (see Figure 1):

- a disposable 1 cm^3 syringe;
- a small (ca. 1 cm) length of plastic tube;
- a graduated pipette tip.

The first 2 items in the above list are available from a number of suppliers at low cost (for example packs of 200 disposable 1 cm^3 syringes (catalogue number OU-07940-99) are available from Cole-Parmer (www.coleparmer.co.uk) at a cost of £21; Scientific and Chemical (www.scichem.com/) supply rolls (10 m) of silicone tubing (catalogue number TSR-020-090) for £28.20. The graduated pipette tips (catalogue number FR0250) are available from Alpha Laboratories (www.alphalabs.co.uk) at a cost (May 2012) of £20.00 for 960 tips.

Construction of the syringe is straightforward. Simply cut a piece of silicone tubing and connect the pieces as shown in Figure 2.

What is not immediately obvious from the images in Figures 1 and 2 is that the pipette tip is graduated with markings at 10 µl, 20 µl, 50 µl, 100 µl and 200 µl. These graduations are shown more clearly in Figure 3 although in our experience the graduation is sometimes difficult to see especially the one at 200 µl.

Operation

The syringe is relatively straightforward to use provided the following simple steps are followed:

1) Before drawing liquid into the pipette tip make sure that a small volume of air has been drawn into the barrel of the syringe. When expelling the contents of the tip this volume of air will ensure that no liquid remains in the syringe.
2) Make sure that a maximum of 200 µl of liquid is drawn into the tip. Volumes much greater than this will lead to liquid being drawn into the tubing and possibly the barrel of the syringe leading to contamination. Whilst all of the elements of the syringe are of low cost careful adherence to this aspect will mean that only tips need to be changed/discarded.
3) When drawing liquid into the syringe take up a slightly larger volume than is required and use the air in the syringe to slowly expel the excess until the graduation mark is reached. Remove any excess liquid (present as a small droplet) from the end of the syringe tip by gently touching against a surface.
4) Slowly expel the desired volume into the receiving vessel.
5) Some volumes (e.g. 50 µl) are straightforward to measure and require a single manipulation whereas others (e.g. 40 µl) may require two or more manipulations.

Figure 2 - A syringe in its constructed form.

How reliable are the measurements using the syringe?

With practice we find that the 'homemade' syringe performs pretty well. Delegates at a recent (June 2012) Summer School for Biology teachers were invited to make a syringe and test its reliability. Delegates were asked to measure 50 µl or 100 µl aliquots of

distilled water into a weighing boat of known mass. The experiments were carried out using distilled water at a temperature of 18° C and the density of pure water under those conditions is reported to be 0.9986 g cm^{-3} [7]. Once 10 such aliquots had been added to the weighing boat, the mass of water present was recorded and the data gathered in the table shown.

The variation between the recorded masses is small; in fact the data in each row of the table shown were obtained using different balances (all of which read to 2 decimal places). No attempt to undertake statistical analysis has been made, although the results lend themselves to such an approach especially if class data sets were available.

Mass of distilled water (g) recorded from the combination of 10 aliquots each of 100 µl.	Mass of distilled water (g) recorded from the combination of 10 aliquots each of 50 µl.
1.03	0.51
1.00	0.48
1.03	0.50
0.94	0.51
1.02	0.46
0.98	0.50
0.99	0.49
0.95	0.48
1.00	0.48
0.97	0.50

Mass of distilled water (g) recorded from the combination of 10 aliquots each of 10 µl.	Mass of distilled water (g) recorded from the combination of 5 aliquots each of 20 µl.
0.095	0.098
0.101	0.100
0.097	0.099
0.996	0.101
0.102	0.100

Using a balance capable of measuring to 3 decimal places, we obtained the data in the lower part of the tables for 10 µl and 20 µl aliquots of water.

From the data in both the above tables it can be seen that the syringes yield results very close to the predicted mass and consequently with practice they could be used with confidence when measuring small volumes of liquids. Their cost and ease of replacement, if necessary, should make them a useful addition to the range of equipment available in schools.

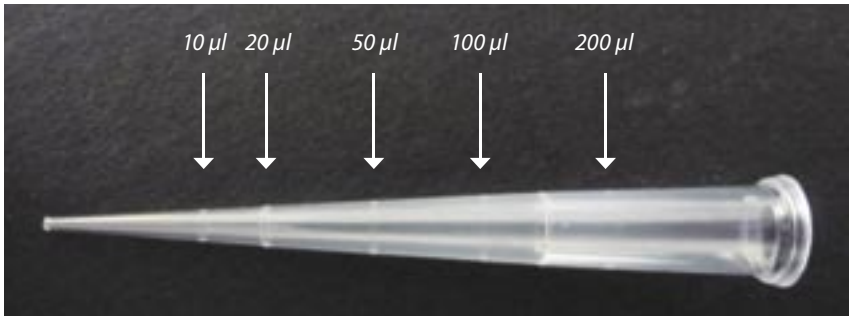

Figure 3 *- Syringe tip showing graduation marks.*

Acknowledgements

The original idea for this device has its origins in the mists of time but we are pretty sure that both Rodger McAndrew and Kirsty Menzies during their time working with SAPS Scotland will have been involved at some point and so our thanks go to them!

References

[1] SQA (2010) Biology (revised) Higher - the Arrangements Document can be downloaded at http://www.sqa.org.uk/sqa/files_ccc/HigherBiologyCourseSpec.pdf (accessed 25th April 2012).
[2] SQA (2012) Higher Biology Course Support Notes - can be downloaded at http://www.sqa.org.uk/files_ccc/CfE_CourseUnitSupportNotes_Higher_Sciences_Biology.pdf (accessed May 12th 2012).
[3] SQA (2010) Human Biology (revised) Higher – the Arrangements Document can be downloaded at http://www.sqa.org.uk/sqa/files_ccc/HigherHumanBiologyCourseSpec.pdf (accessed 25th April 2012).
[4] SQA (2012) Higher Human Biology Course Support Notes - can be downloaded at http://www.sqa.org.uk/files_ccc/CfE_CourseUnitSupportNotes_Higher_Sciences_HumanBiology.pdf (accessed May 12th 2012).
[5] SQA (2011) Biology (revised) Advanced Higher: Arrangements Document - can be downloaded at http://www.sqa.org.uk/sqa/files_ccc/Biology_Advanced_Higher_Revised.pdf (accessed July 3rd 2012).
[6] The National Centre for Biotechnology Educationn price list is available at http://www.ncbe.reading.ac.uk/NCBE/MATERIALS/PDF/NCBEpricelist.pdf (accessed April 6th 2012).
[7] Mass, Weight, Density or Specific Gravity of water at various temperatures C and thermal coefficient of expansion of water - see http://www.simetric.co.uk/si_water.htm (accessed 24th April 2012).