



UNIVERSITY OF
BATH

Department of
Pharmacy & Pharmacology

**Pre-entry Guide 2020-21 for
Master of Pharmacy (MPharm)
and
Master of Pharmacy (MPharm)
with integrated pre-registration
year**

Dear Student,

Congratulations on passing your exams and achieving the necessary qualifications to enter the Department of Pharmacy & Pharmacology at the University of Bath! You can be confident that you are embarking on a degree programme which is widely respected in the UK and further afield, and which will give you a strongly positive start to your chosen career in pharmacy.

It is my responsibility as Director of Teaching to ensure that our Department and its academic staff provide you with every opportunity to achieve your potential. We do this primarily by designing integrated MPharm programmes, in which core pharmaceutical sciences, pharmacology and biomedical sciences are taught in a way that emphasises their importance to clinical pharmacy practice. Our MPharm programmes undergo regular review and updates, both to keep their content in line with recent scientific and clinical research, and to take advantage of technological developments so that at least some of that accumulated information can be made available in an easily digestible form to you.

A brief outline of the first year of your MPharm programme is provided in this booklet, together with some instructions on **what we would like you to do before arriving in Bath to commence your studies**. However, the most important point that I wish to emphasise is that, at University, your success (or otherwise!) is much more in your hands than it is in ours. Alongside the pleasures of making new friends and maturing as a person, you need the organisation and self-discipline to work on your own, to read around and to extend the information provided in lectures, workshops, practicals and during clinical learning in practice visits etc., to ask questions and to take responsibility for your own learning. Our academic members of staff and teacher-practitioners offer you their expertise, support and advice, but you are the one who has to show that you have earned your degree award in 2024, or 2025 for those of you studying on our 5 year MPharm with integrated pre-registration year!

Please take the time to read this guide, and to make sure that you have a good knowledge and understanding of the topics included. We will assume that you have this knowledge at the start of the degree programmes, so use some of the time between now and starting University to revise these subjects from your school notes or from the various sources of information provided in the booklet.

I look forward to meeting you during Welcome Week.

A handwritten signature in black ink that reads "Philip J Rogers". The signature is written in a cursive, flowing style.

Dr Philip J Rogers
Director of Teaching

Overview

Although all successful students entering our MPharm programme will have a good qualification in Chemistry, there are a number of differences both between the various A Level specifications and between, for example, the A Level Exam Boards and the International Baccalaureate. In other subject areas, some of you will not have taken post-GCSE Biology and some of you will not have taken Mathematics. Extra classes are offered in Biology during the first year to help you catch up, and additional support in Mathematics is also included in Semester 1. However, we want all incoming students to share a core of knowledge in these subjects, so that semester 1 units can start from a common base. If you take the time to ensure you are familiar with the topics listed in this guide prior to starting your studies then you will find it much easier to follow the lectures and engage with the new material.

The main purposes of this booklet are:

- **to outline the ‘core knowledge’ in Chemistry, Biology and Mathematics which we expect ALL students to have prior to starting their degree programme in Bath;**
- **to provide you with guidance on preparing for a piece of assessed coursework in the semester 1 unit, Preparing for Professional Practice (1);**
- **to give you an overview of the content of Year 1 of the MPharm programme, and the pattern of formal (“summative”) assessments that take place at the end of each semester.**

Each of these areas is covered in following sections of this booklet.

Master of Pharmacy (MPharm) programme

General background

Pharmacists are the principal experts in medicines and pharmacy is currently one of the fastest growing areas of healthcare. Pharmacists have a commitment to improving people's lives through the optimal use of medicines. Pharmacy career opportunities are fast-developing, and pharmacists today can be found in many different settings including community pharmacies, hospitals, GP practices, industry and universities.

Pharmacy is usually regarded as a vocational subject and many of our graduates go on to establish careers as practitioner pharmacists in community, primary or secondary care pharmacy. The role of the pharmacist in each of these sectors is developing significantly with a shift away from the more traditional activity of dispensing supply to taking greater clinical responsibilities. These include: offering treatment advice on minor ailments; offering prescribing advice and support to all healthcare professionals but especially doctors, and managing patients with long-term conditions. In hospital pharmacy, pharmacists have a well-established role in providing specialist advice and expertise on treatment regimens across a wide range of specialties. In each of these sectors, pharmacists with specialist training can practice as independent prescribers. Pharmacists employed in industry bring their own specific knowledge of pharmaceuticals (how drug molecules are 'formulated' into medicines that people actually take) to developing new ways of delivering medicines effectively and safely.

Since 1997, all undergraduate Pharmacy programmes in the UK have been of 4-year duration and lead to the award of the Master of Pharmacy degree (MPharm). Almost without exception, pharmacy graduates then proceed to the one-year pre-registration training that leads to registration with the General Pharmaceutical Council (GPhC). Bath, alongside a few other UK schools of pharmacy, offers a 5 year MPharm with integrated pre-registration year for international students. As for all UK Schools of Pharmacy, the Pharmacy degree at Bath is accredited by the GPhC, most recently in April 2016 for the maximum period of six years. We ensure that our teaching is at the forefront of current practice through an expert Pharmacy Educational Advisory Group bringing together leading scientists, practitioners, educators and policy experts.

The academic year is organised into two fifteen-week semesters, each composed of eleven teaching weeks followed by periods of revision and assessment. Semester 1 begins in late September, and Semester 2 starts in February with the usual Christmas, Easter and Summer vacations. Degree programmes at Bath are modular, and the first year comprises five modules or 'units'. Each unit, when successfully completed, is worth 12 credits (compatible with the European Credit Transfer System). Thus a full year of study consists of 60 credits and the award of the MPharm degree after 4 years requires earning a total of 240 credits.

Overview of the MPharm programme, Year 1

The programme is delivered by integrated teaching teams drawn from into five main subject areas – Physiology & Pharmacology, Molecular Cell Biology, Medicinal Chemistry, Pharmaceuticals & Microbiology, and Pharmacy Practice. These areas form themes, e.g. drug discovery, cardiovascular health that develop through the MPharm degree from introductory units in Year 1 to advanced units in Years 3 and 4. They reflect the breadth of pharmacy as an academic discipline, and equip our graduates for career opportunities in all aspects of the profession. The MPharm is

designed as a “spiral curriculum” where topics and themes are revisited in later years with increasing complexity.

The table below gives the pattern of units approved for MPharm Year 1, and emphasises the five integrated units comprising the first year.

Year	Period of Study	Unit Code	Unit Title	Unit Status	Credits	DEU Status
Year 1	AY	PA10310	Preparing for professional practice 1	Compulsory	12	Y
			Year 1 Professional progression assessments	Compulsory	0	
	S1	PA10306	Fundamentals of pharmacy: From molecules to medicines 1	Compulsory	12	Y
		PA10307	Fundamentals of pharmacy: The healthy body 1	Compulsory	12	Y
	S2	PA10308	Fundamentals of pharmacy: From molecules to medicines 2	Compulsory	12	Y
		PA10309	Fundamentals of pharmacy: The healthy body 2	Compulsory	12	Y

Each semester as two 12 credit units, and the fifth unit is an all-year (AY) unit.

Year 1 of the Bath MPharm programme is foundational and provides a transition from A Level, or equivalent, to University study and provides students with a sound basis in the pharmaceutical sciences whilst learning the role of the pharmacist in practice. This enables student pharmacists with different A level or other qualifications to achieve a common standard of level of performance before progressing onto subsequent years. In particular, the Department offers additional classes in Biology (*PA10121 Introductory Biology*) for students lacking a formal qualification in this area. Exercises in basic mathematics and statistics also form part of the first semester to enable everyone to undertake numerical calculations with greater confidence. Additional support is provided both within the MPharm programme and by the University’s MASH (Mathematics And Statistics Help) initiative, and more generally through the University’s Academic Skills Centre.

The unit *PA10310 Preparing for professional practice 1* provides students with key skills required for study on an undergraduate programme. This unit also provides an introduction to the profession of pharmacy, the various roles of the pharmacist in science and healthcare, and an opportunity for experiential learning in four different practice settings. Integration between the core scientific themes of pharmaceutical & medicinal chemistry, physiology & pharmacology, molecular & cellular biology and pharmaceuticals is provided by four integrated 12 credit units covering the fundamentals of pharmacy from molecules to medicines, and the healthy body. Further integration in year 1 is supported by problem-based learning, facilitated by Personal Tutors.

Assessment

Each unit of the programme is assessed, although a number of different assessment methods may be used, including continuous assessment of coursework, written assignments and reports, and end-of-semester examinations. All units, and end-of-year professional progression assessments, must be successfully completed in order to obtain the necessary credits and progress to year 2.

Core knowledge - sources of information

- Your A Level notes and/or A Level textbooks.
- Recommended textbooks for Year 1 of the programmes in Bath. There are only a few key textbooks that we consider as “absolutely necessary”, and those that are especially relevant to the material in this booklet are listed below. A number of other titles, listed as **Essential**, **Recommended** or **Background** reading, will be shown on your virtual learning environment on arrival in Bath.
- Where possible we have recommended core textbooks available as e-books via the University Library website. If available as an e-book this symbol ● **Online access** will be shown in the library catalogue, normally linked to the ‘Library List’ for each Unit. This gives you the option of viewing the book on a PC or tablet without needing to buy the book. Please note: Online access is only available once you are a registered student so will be available to you once you have completed your registration in Welcome Week.
- For those not available as e-books we recommend that you purchase the book– they can be fairly expensive, but they cover material that will be useful throughout Years 1, 2 and beyond. You may wish to wait until your arrival before purchasing any books as the Pharmacy and Pharmacology (student) Society (PaPs) plans to run a secondhand book sale.

Chemistry

McMurry, J. 2015. *Organic chemistry with biological applications*, 3rd ed. Belmont, Calif.: Brooks/Cole, Cengage Learning. (ISBN 9781285842912)

Essential reading ● **Online access**.

NB. Access to the second edition is fine, e.g. as a second-hand copy. There are also a lot of organic chemistry books published by this author. Please note the right one! The ISBN number of the current 3rd edition is 978-1285842912.

Clayden, Jonathan. Warren, Stuart G. 2012. *Organic chemistry* 2nd edition Oxford University Press ISBN: 9780199270293 **Recommended reading** ● **Online access**

Florence, A.T. and Attwood, D. 2016. *Physicochemical principles of pharmacy: in manufacture, formulation and clinical use*. 6th ed. London: Pharmaceutical Press.

Essential reading but available as an e-book ● **Online access**.

Biology

Woodbury C. 2012. *Biochemistry for the Pharmaceutical Sciences*. London: Jones & Bartlett Learning

Recommended reading

Widmaier, E.P., Raff, H. and Strang, K.T., 2016. *Vander's human physiology: the mechanisms of body function*. 14th ed. New York: McGraw-Hill.

Essential reading (N.B. the 11th, 12th or 13th editions are acceptable, and the Library holds about 60 copies in total.) ● **Online access** planned to be available from September 2020.

Rang, H.P., Ritter, J.M., Flower, R.J. and Henderson, G., 2016. *Rang and Dale's pharmacology*. 8th ed. Edinburgh: Churchill Livingstone. (This book is used primarily from year 2 onwards.)

Essential reading available as an e-book ● **Online access**.

Prior to arrival students without A-Level Biology should obtain a copy of Catch Up Biology and work through the key topics:

Bradley, P. Calvert, J., 2013. *Catch Up Biology for the Medical Sciences*. 2nd ed. Bloxham, Scion.

● **Online access** Available as an e-book after registration at The University of Bath.

Please work through this book between now and coming to Bath. Introductory Biology (PA10121) tutorial sessions for those without A-Level Biology will be based on this book.

Mathematics

Croft, A., Davison, R., 2016. *Foundation Maths*. 6th ed. Harlow: Pearson Education, published by Pearson/Prentice Hall.

Recommended reading available as an e-book ● **Online access**.

Harris, M., Taylor, G. and Taylor, J., 2013. *Catch-up maths & stats: for the life and medical sciences*. 2nd edition. Bloxham, Scion.

Recommended reading for students without AS or A-Level Mathematics.

Students without AS or A-Level Mathematics will be offered extended maths tutorials and drop-in sessions during Semester 1.

Rees, J.A., Smith, I. and Smith B, 2015. *Introduction to pharmaceutical calculations*. 4th ed. London: Pharmaceutical Press.

Recommended reading available as an e-book ● **Online access**

Core knowledge in Chemistry

1. Nomenclature

Recognition of the common functional groups: alkanes, alkenes, aromatic compounds, alcohols, phenols, carboxylic acids, amines, acid derivatives (esters, amides, acid chlorides), aldehydes, ketones.

2. Bonding and structure – shapes of molecules, stereochemistry

The shape of simple molecules, for example based on the tetrahedral nature of carbon. Recognise the type of bonding in the common functional groups mentioned above. Appreciation of the terms “cis” and “trans” (in alkenes) and enantiomers. How do you recognise the components of a hydrogen bond?

3. Basic organic chemistry

How do you recognise the common acidic and basic groups in compounds above (i.e. phenols, carboxylic acids on the one hand and amines on the other)? How do salts of these functionalities form?

4. The expression of concentration

Concentrations of drugs and other materials in medicines, biological fluids (e.g. blood, urine, breast milk), analytical solutions etc may be expressed in a variety of ways. It is axiomatic of the pharmaceutical sciences that its practitioners can, as a matter of course, precisely define and interconvert between the following modes of expression thus allowing accurate preparations of solutions and formulations both in pharmacology and in pharmaceutical practice:

Molarity (millimolarity) Percent concentrations

In the same context, it is also necessary to understand the meaning of statements such as "one part in ten parts of water" which are found in "official compendia" such as the British Pharmacopoeia (BP).

The objectives of this section are to ensure that you understand the meaning of the various terminologies, how they are interconnected and how concentration statements can be translated to actual weights and volumes of components in a given formulation composition. We want you to practise your skills in such computations. Thus, at the end of this section, you will find a set of self-assessment problems to solve. Make sure you obtain the correct solutions. Further problems involving the calculation and interconversion of concentrations will be considered during coursework. Your skills in this area will be subject to tests and examination throughout the degree programme.

Molarity (M)

The molarity of any component is the number of moles of that component contained in 1.0 dm³ of the total system.

NOTE: 1.0 dm³ = 1000 cm³ (or effectively one litre or 1000 ml).
Volumetric glassware is calibrated at 20°C - consequently the molarity of a solution prepared in volumetric glassware at 20°C will change with temperature due to contraction or expansion of the system.

Molarity should always be expressed to at least 4 significant figures.

Example A 0.4310 M aqueous solution of dextrose (RMM = 180.2) contains 0.431 moles of dextrose per litre (dm³).

To prepare 0.4310 M aqueous dextrose you require:
 $0.4310 \times 180.2 = 77.6662$ g dextrose

Formula Dextrose 77.67 g
Water to 1000 ml

NOTE: The dextrose would be dissolved in water and then made up to volume with water. You do NOT simply mix together 77.67 g of dextrose and 1000 ml of water as the dissolution process may increase or decrease the total volume relative to that of the solvent component.

Millimolarity (Millimolar, mM)

The millimolarity of any component is the number of millimoles of that component in 1 dm³ (one litre) of the total system. *One millimole is one thousandth of a mole.*

The use of "millimoles" to express concentration is still frequently used in the fields of biochemistry and body fluid analysis/composition, because solute concentrations are often very low and it is more convenient, for example, to state that blood is 4.5 mM in potassium ions than to quote a molarity of 0.0045 M.

Example Calculate the quantity of potassium chloride (RMM = 74.56) required for preparing 500 ml of an aqueous solution containing 4.5 mM potassium.

4.5 mM potassium = 4.5 mM KCl = 4.5×10^{-3} M KCl
 4.5×10^{-3} M KCl = $(4.5 \times 10^{-3}) \times 74.56$ g KCl
i.e. 0.33552 g KCl per litre.

Formula Potassium chloride 0.1678 g
Water to 500 ml

Percent Concentrations

Percent weight by volume (% w/v)

% w/v of any component is the number of grams (g) of that component contained in 100 cm³ (100 ml) of the total system.

Example An aqueous solution of 0.9 % w/v sodium chloride contains 0.9 g of sodium chloride in each 100 ml of solution. This would be prepared by weighing 0.9 g of NaCl, dissolving in water and making up to a final volume of 100 ml (cm³).

NOTE: Because 0.9% w/v aqueous NaCl has the same tonicity (osmotic pressure) as body fluids it is often referred to as "**physiological saline**" or "**normal saline**".

Percent weight by weight (% w/w)

% w/w of any component is the number of grams of that component contained in 100g of the total system.

NOTE: % w/w concentration is used in expressing the concentration of solids in solid compositions such as semi-solid formulations like dermatological creams and ointments.

Example 0.5% w/w hydrocortisone acetate ointment will contain 0.5 g of the drug in 100 g of the final product. This would be prepared by mixing 0.5 g of hydrocortisone acetate with 99.50 g of the ointment base (the latter is likely to be a mixture of surface active agents and paraffin hydrocarbons).

NOTE: The preparation of % w/w systems does not involve adjustment "to" a final weight, as masses are always additive whereas volumes or combinations of weights and volumes are not.

Percent volume by volume (% v/v)

% v/v of any component is the number of cm³ (ml) of that material in 100 cm³ (ml) of the total system. It is used when mobile (non-viscous) liquid materials are dispersed or dissolved in a fluid preparation.

Example 70% v/v ethanol (alcohol) would comprise 70 ml (cm³) of absolute ethanol in 100 ml of final aqueous solution. This could also be prepared from 96 % v/v ethanol as follows:

$$70 \text{ ml of absolute ethanol} = \frac{70 \times 100}{96} = 72.92 \text{ ml of 96 \% v/v ethanol}$$

<i>Formula</i>	96% Ethanol BP		72.92 ml
	Purified Water	to	100.0 ml

NOTES: Unless otherwise stated, % w/v or % v/v refer to solutions or dispersion made up to volume with water.

The dissolution of ethanol in water is an exothermic process accompanied by a significant contraction in total volume. The mixture above would therefore be cooled to room temperature before finally adjusting to volume.

Liquids that are very viscous and therefore difficult to measure accurately by volume (e.g. glycerol) are usually formulated as % w/v or % w/w as appropriate.

Miscellaneous Expressions of Concentration

Component concentration expressed as "Parts Component"

The expression of concentration in terms of "so many parts" of a particular component in a system still finds some use in pharmaceutical and medical practice, as evidenced by its inclusion in the BP 1993 (Vol. 1 pp 14).

"Parts" is understood to mean parts by weight (g) of solids or parts by volume (ml) of liquids associated with parts by weight (g) of solid product or parts by volume (ml) of liquid product. For solutions of gases in liquids, "parts" refers to parts by weight of gas in parts by weight of the final solution.

Some confusion can arise because the word "part" can be omitted from the statement of concentration (e.g. 1 in 4). The preposition "in" may also be replaced by "to" – this changes the dilution factor as illustrated below.

Examples A solution containing carbon dioxide in water, 1 **part in** 5000 means 1.0g of carbon dioxide is present in 5.0 kg of solution. (**It does NOT mean 1.0 g of carbon dioxide has been added to 5.0 kg of water**).

An aqueous solution containing 1 **in** 10 sodium salicylate means 1.0 g of sodium salicylate is dissolved in water and made up to 10 ml final volume with water; this would be equivalent to a concentration of 10 % w/v.

Dilution of the 10% w/v sodium salicylate solution, 1 **to** 8 means 1.0 ml of the solution diluted to 8.0 ml (final volume) with water; an alternative would be 25 ml diluted to 200 ml with water. (**It does NOT mean 1.0 ml of the solution mixed with (added to) 8.0 ml of water**).

Solubility Expressions in the BP 1988 (see Vol. 1 pp7)

The solubility of a solute in a solvent is the maximum concentration of solute, which can be attained at a given temperature at equilibrium, i.e. when the solution is at equilibrium with an excess of the solute. (Solubility theory will be discussed later in the course). Pharmacopoeial monographs frequently use "parts" terminology to give an approximate value for the solubility of a drug in a variety of solvents. In this particular context of solubility, the term "part" refers to the VOLUME OF SOLVENT which will dissolve 1.0 g or 1.0 ml of solute to give a saturated solution.

Examples The BP monograph for Ethacrynic Acid states that this drug (used in the treatment of fluid retention) is "very slightly soluble in water, soluble in 1.6 parts of ethanol (96 %), 6 parts of chloroform and 3.5 parts of ether". This means a saturated solution (at 20°C) occurs when 1.0 g of drug is dissolved in 1.6 ml of 96 % ethanol or 6.0 ml of chloroform or 3.5 ml of diethyl ether.

"Very slightly soluble in water" means that 1.0 g of drug will dissolve in a volume of water lying in the range 1000-10,000 parts (ml) and is designed to convey an approximation of the drug's solubility. Other such statements as "very soluble" or "slightly soluble" are also defined in Vol. 1 pp7 of the BP 1988.

***** Useful formula for preparation of solutions from stock solutions *****

In practice, the stock solutions prepared by methods outlined above could be readily used for the preparation of new solutions. For this purpose we use the following formula:

$$C_1 \times V_1 = C_2 \times V_2$$

where: C_1 = concentration required , V_1 = volume required
 C_2 = concentration available (stock), V_2 = volume available (stock)

Example Write a formula for preparation of 3 litres of 20% v/v ethanol from 85%v/v ethanol solution.

$C_1 = 20\% \text{ v/v}$, $V_1 = 3000 \text{ ml}$, $C_2 = 85\% \text{ v/v}$, $V_2 = \text{volume available?}$

$$20 \times 3000 = 85 \times V_2 \quad \longrightarrow \quad V_2 = 705.88 \text{ ml}$$

Formula Ethanol 85% v/v = 705.88 ml = 0.70588 litres.
Distilled water to 3000 ml = 3 litres.

SELF-ASSESSMENT

1. 1.0783 g of anhydrous sodium carbonate (RMM = 106.0) are dissolved in distilled water and the volume adjusted to 250 ml in a volumetric flask. Calculate the molarity and percentage concentration of the solution.
2. Sodium chloride and glucose injection BP contains 0.18 % w/v and 4.0 % w/v respectively dissolved in Water for Injections and is supplied in 500 ml quantities.
 - a) Write down the formula for the preparation of a 30-litre batch for injection.
 - b) How many bottles of product would this yield?
 - c) Calculate the molarity of each solute component in the injection (RMM_{NaCl} = 58.44; RMM_{Glucose} = 180).
3. 0.47 g of glacial acetic acid (RMM_{Ethanoic Acid} = 60.05) are added to 492 g of water to give a solution whose volume is 500 ml. Calculate the molarity, % w/w and % w/v of the acetic acid in solution.
4. Calculate the amount of potassium permanganate (RMM = 158.0) required to make 250 ml of a 0.12% solution. Is this a % w/v or % w/w solution? What is the molarity of this solution at 25°C?
5. Thiomersal is used at a concentration of 1/25000 as a preservative in eye drops. Express this as a percentage concentration.
6. Write down a formula for preparing 500 ml of normal saline (RMM = 58.44) and calculate its molarity at 25°C.
7. Calamine Ointment is prepared according to the following formula:

Calamine (finely sifted)	150 g
White Soft Paraffin	850 g

What is the % w/w concentration of calamine in Calamine Ointment?

The answers to these questions are at the back of this booklet.

Core knowledge in Biology

This section is somewhat different from that describing core Chemistry as a number of you will not have studied Biology beyond GCSE level. For this reason, the core knowledge is based on GCSE material, but you are invited to read beyond this, perhaps looking at information which will be covered in the first few lectures. The “**Recommended reading**” book *Biochemistry for the Pharmaceutical Sciences*. (Woodbury, 2012), is recommended reading, and we would encourage you to obtain it early. Additional (PA10121) Introductory Biology classes are offered throughout the first year, particularly for those students lacking A Level Biology/Human Biology.

Depending on your Biology background, you should be familiar with the following:

- The basics of prokaryotic and eukaryotic cells, sizes and shapes of cells, cell structure, organelles as specialised compartments within eukaryotic cells, plus a quick overview of the major classes of large molecules within cells - proteins, nucleic acids, carbohydrates, lipids and phospholipids.
- Principles of diffusion, osmosis; active transport in animal cells.

Alongside the cell biology described above, the major ‘biological’ unit in Year 1 allows you to study the major physiological systems of the body – for example, the heart, various types of muscle, nerves, etc. A simple introduction to some of these tissues and systems (e.g. nervous system, endocrine system) will probably have formed part of your GCSE Biology course.

We strongly encourage you to read the **Essential reading** book (Vander’s Human Physiology 14th edition, published by McGraw Hill) and to read Chapter 1 (an overview) and the first sections of Chapters 4 and 6. These latter sections cover aspects of cell membranes and their function as a controllable permeability barrier, which is the essential starting point for understanding much about how cells work in the body. This information on membrane structure and function needs to be integrated in your head with the structure of membranes from cell biology. Such integration is vital in subjects like pharmacy – as an example, the study of membranes is central to cell biology, to the physiology of tissues such as nerves and muscles, to the pharmacology of drugs that affect membrane permeability and so help to control disease states such as high blood pressure, and to biopharmaceutics and the uptake (or not) of drugs into cells.

Core knowledge in Mathematics

Values in parentheses indicate chapter numbers in the **Recommended** text book "Foundation Maths" (Croft, A. and Davison, R. 6th ed. published by Pearson Education, 2016). Those of you who have achieved a respectable pass at A Level or the equivalent may not need to buy this book, but it will be a useful resource throughout your 4 years of undergraduate study, especially if you have not studied post-GCSE Maths or if you simply lack confidence with using numbers.

1. Simple numeric manipulation (**1-4**).
2. Re-arrangement of equations (**4, 5, 7-10**) - eg making x the subject of the straight line equation $y = mx + c$
3. Solving equations containing a number of unknown values (**5, 11**).
4. Manipulation of powers and exponential values (**6, 8, 16**).
5. Manipulation of both natural logarithms (base e) and logs to base 10 (**17**).
6. Solving simultaneous equations (**11**).
7. Performing differentiation (**25-28**).
8. Presentation of data as tables, line graphs, bar charts etc (**14, 15, 29**).
9. Use of linear and semi-logarithmic graph paper (**14, 15**).
10. Understanding the concept of normal distribution, mean, mode, median, variance, standard deviation and probability (**30, 31**).

**Additional material for early biopharmaceutics in the unit (module)
Fundamentals of Pharmacy: From Molecules to Medicines 1**

In the early workshops in biopharmaceutics, you will also be taught about:

Molality

Mole Fraction

These entities are introduced in this booklet, although they are not part of all A Level specifications. Read the relevant sections as part of the preparation for the semester 1 unit Fundamentals of Pharmacy: From Molecules to Medicines 1.

Molality (m)

The molality of any component in a solution is the number of moles of that component associated with one kilogram (1000 g) of solvent.

NOTE: Molality is the primary expression of concentration in the SI unit system with regard to solutions; for theoretical purposes, it has a marked advantage over concentration expressed as molarity since, unlike the latter, its numerical value is independent of temperature.

Remember that solution volumes vary with temperature whereas weights do not.

Practically, it is simpler to prepare solutions in terms of their molarity using volumetric glassware. The molality of such solutions can be calculated from knowledge of their densities (see below).

Molality should be expressed to at least 4 significant figures.

Example A 1.032 m solution of ascorbic acid (Vitamin C; RMM = 176.1) in water contains 1.032 moles per kilogram of water.
1.032 moles = 1.032 x 176.1 g = 181.7352 g

<i>Formula</i>	Ascorbic acid	181.74 g
	Water	1000.0 g

NOTE: The ascorbic acid would be added to 1000 g of water and dissolved. There is no final adjustment to volume, although the final weight of the solution could be adjusted to 1181.74 g.

Mole fraction (x)

The mole fraction (x) of any component in a system is the ratio of the number of moles of that component to the total number of moles of all the components present in the system e.g. for a binary system containing n_A moles of component A and n_B moles of component B, the mole fractions of each component are given by:

$$X_A = \frac{n_A}{n_A + n_B} \quad \text{and} \quad X_B = \frac{n_B}{n_A + n_B}$$

NOTE: Mole fraction is a dimensionless concentration term. It is the fundamental unit of concentration with respect to many theoretical

aspects of physical chemistry. The mole fraction of any pure material is unity - **why?**

Example An aqueous solution is 0.2200 m dextrose (RMM = 180.2) and 0.0410m potassium chloride (RMM = 74.56). Calculate the mole fraction of the two solute components.

From the definition of molality, the solution must contain 0.22 moles of dextrose and 0.041 moles of potassium chloride in one kilogram of water (RMM = 18.02).

$$\begin{aligned}1000 \text{ g H}_2\text{O} &= 1000 / 18.02 = 55.4939 \text{ moles} \\ \text{Total moles in solution} &= 55.4939 + 0.22 + 0.041 = 55.7549 \\ \text{Mole fraction of dextrose} &= 0.22 / 55.7549 = 3.946 \times 10^{-3} \\ \text{Mole fraction of potassium chloride} &= 0.041 / 55.7549 = 7.354 \times 10^{-4}\end{aligned}$$

The following section has further examples that include A level work, but also includes calculations of molality and mole fractions.

Interconversion between concentrations

Given the concentration of a solution in one form, together with its density (g/ml) it is possible to calculate the concentration in other units as shown in the examples below:

Example A 5.9% w/v solution of succinic acid (CH₂ COOH)₂ in absolute ethanol has a density of 0.820 g/ml at 20°C. Express the succinic acid (RMM = 118.0) content in terms of the following: molarity, molality, % w/w and mole fraction.

Molarity 5.9% w/v = 5.9 g in 100 ml solution = 59 g in one litre

$$\blacktriangleright \text{Molarity} = \frac{59}{118.0} = 0.5000 \text{ M}$$

Molality The solution contains 59 g per litre. Density 0.820 g/ml. Hence 59 g succinic acid in 1000 x 0.820 = 820 g solution
59 g succinic acid associated with (820-59) = 761 g ethanol

$$\text{Hence } \frac{59}{761} \times 1000 \text{ g associated with 1000 g ethanol}$$

$$\blacktriangleright \text{Molality} = \frac{59}{761} \times \frac{1000}{118} = 0.6570 \text{ m}$$

% w/w There are 59 g in 820 g solution hence

$$\frac{59}{820} \times 100 \text{ g in 100 g solution} = 7.195 \% \text{ w/w}$$

Mole fraction

There are 59 g succinic acid associated with 761 g ethanol - hence 59/118 moles succinic acid and 761/46 moles ethanol.

$$\text{Mole fraction} = \frac{59/118}{59/118 + 761/46} = 0.02933$$

Self-Assessment (Answers)

When calculating molarity, first work out the number of grams in 1000cm³ of the solvent. Then use the following equation, (No. of moles = mass (g) / RMM (g))

- Molarity = number of moles contained in one litre of the system.
1.0783g in 250mls, therefore in 1ml = $1.0783 / 250 = 0.004313\text{g}$,
therefore in 1000mls = $0.004313 \times 1000 = 4.3132\text{g}$
moles = mass / RMM = $4.3132 / 106 = 0.04069\text{M}$ (to 4 significant figures)
%w/v = number of grams in 100cm³ (ml) of the system, 1.0783g in 250mls,
therefore grams in 100mls = **0.431g = 0.431% w/v**
- NaCl → 0.18% w/v = 0.18g in 100mls → therefore in 30 litres,
→ $0.18\text{g} \times (30\,000/100) = \mathbf{54.0\text{g}}$
Glucose → 4.0% w/v = 4g in 100mls → therefore in 30 litres,
→ $4\text{g} \times (30\,000/100) = \mathbf{1200\text{g} = 1.2\text{kg}}$
Formula: NaCl 54g, Glucose 1200g, Water for Injection to 30 litres
 - How many bottles of product would this yield – $30\,000 / 500$
= **60 bottles (59 taking into account waste)**
 - Calculate the molarity of each solute component in the injection.
(NaCl, RMM = 58.44; Glucose RMM = 198.2)
NaCl = 0.18g in 100mls → 1.8g in 1000mls, Moles = mass / RMM
= $(1.8/58.44) = \mathbf{0.03080\text{ moles in }1000\text{cm}^3 = 0.0308\text{M}}$
Glucose = 4g in 100mls → 40g in 1000mls, Moles = mass / RMM
= $(40/198.2) = \mathbf{0.2018\text{ moles in }1000\text{cm}^3 = 0.2018\text{M}}$
Molecular mass of glucose is 180. Calculation needs to be adjusted.
- Molarity = number of moles in one litre of the system**
→ 0.47g in 500mls → 0.94g in 1000mls, Moles = Mass/RMM = $0.94/60.05$
= $0.01565\text{ moles in }1000\text{cm}^3 = \mathbf{0.01565\text{M}}$

% w/w = grams in 100g of the total system ($492\text{g} + 0.47\text{g} = 492.47\text{g}$) → 0.47g
in 492.47g → $0.47 \times (100/492.47) = \mathbf{0.0954\% w/w}$
% w/v = gms/100mls → 0.47g in 500mls → $0.47 \times (100/500) = \mathbf{0.094\% w/v}$
- %w/v: grams in 100 ml of total system
 - 0.12g in 100ml → **0.3g in 250ml**
 - 0.3g in 250ml → 1.2 g in 1000ml → moles = mass / RMM
→ moles = $1.2/158$ → **Molarity = $7.595 \times 10^{-3}\text{M}$.**
- $1 / 25000$ → **0.004% w/v**
- Normal saline: 0.9% w/v NaCl

→ 4.5g in 500ml (purified water to 500ml)
→ moles = $9 / 58.44 = \mathbf{0.1540\text{M}}$
- 150g Calamine (solute) + 850g Paraffin (solvent)
= 1000g solution (Total system)

→ 150g solute in 1000g total system.
→ **15g solute in 100g total system (15%w/w)**