then removed and replaced with photosensitizer solutions of various concentrations. In biofilm cultures the highest percentage kill achieved was 99.99% for isolate 3-6087B, using a TBO concentration of 5 mg mL^{-1}and a 30-min incubation time, and the lowest was 90.55% for isolate PAO1. This study demonstrates that antibiotic-resistant clinical *P. aeruginosa* isolates are susceptible to photodynamic inactivation when grown in either planktonic or biofilm cultures. Unlike conventional antibiotics, the type of culture has no significantly detrimental effect on the efficacy of PACT. We are currently investigating the influence of mucus on the efficacy of PACT of *P. aeruginosa* and the efficient pulmonary delivery of both photosensitizers and light.

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Photodynamic inactivation of *Candida albicans* with Toluidine Blue O released from a mucoadhesive patch

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Mucocutaneous oropharyngeal candidiasis, known informally as oral thrush, is predominantly caused by *Candida albicans* strains. The overall incidence of oral candidiasis in adults has increased dramatically with the spread of HIV/AIDS. The condition occurs in up to 84% of HIV-infected patients and is considered to be an independent predictor of immunodeficiency in patients with AIDS (Teichert 2002). Conventional treatments for oral candidiasis have been shown to assume a fungistatic effect rather than a fungicidal mechanism, a factor to which much of the inadequacy of current antifungal agents has been assigned. Resistance to such agents has also increased noticeably in recent years. Recent evidence indicates that photodynamic antimicrobial chemotherapy (PACT) may be useful for infections caused by antibiotic-resistant bacteria and those in multispecies biofilms. In addition, several studies have shown PACT to have significant antifungal action. In PACT, a combination of a sensitizing drug and visible light causes the selective destruction of microbial cells via singlet oxygen production. Importantly, as singlet oxygen is a non-specific oxidizing agent and is only present during illumination, development of resistance to this treatment is unlikely. As a result of increasing antibiotic resistance, PACT has recently come to the fore as a potential alternative antimicrobial therapy. However, due to the rapid development of the field, drug delivery research in this area is virtually non-existent (Donnelly et al 2005a). We have previously described a bioadhesive patch containing 5-aminolevulinic acid for PACT of onychomycosis pathogens, including *C. albicans* (Donnelly et al 2005b). In this study we have adapted this patch for PACT of *C. albicans* infections in the oral cavity. The primary objective of this study was to determine the susceptibility of clinical *C. albicans* isolates growing planktonically and in biofilm to photodynamic inactivation using a combination of toluidine blue O (TBO) and visible light (635 nm, 100 J cm^{-2}). The secondary objective was to determine whether the adapted patch could release sufficient amounts of TBO to allow photodynamic inactivation. Incubation of *C. albicans* (1×10^7 cfu mL^{-1}) with either 2 mg mL^{-1} or 5 mg mL^{-1} for 30 min, followed by 10 min irradiation, allowed greater than 6 $\log_{10}$ reductions in numbers of viable organisms of the planktonic cells. Incubation of *C. albicans* biofilms, grown overnight on PVC discs, for 3 h with 5 mg mL^{-1} TBO followed by 10 min irradiation again allowed greater than 6 $\log_{10}$ reductions in numbers of viable organisms. Patches containing 10 mg cm^{-2} TBO adhered strongly (mean force of removal = 1.1 N cm^{-2}, TA-XT2 Texture Analyser, Stable Microsystems, Haslemere, UK) to excised porcine cheek tissue, obtained from a local abattoir. Concentrations of TBO achieved on the receiver compartment side of a Cuprophan dialysis membrane, used to mimic diffusion through biofilms, were an order of magnitude lower than the phototoxic concentrations after 3 h release. However, when the release surface of the patch was exposed directly to the release medium, TBO concentrations of approximately 10 mg mL^{-1}were achieved in the receiver compartment after 3 h. Consequently, with suitable modifications, the patch may be suitable for delivery of TBO to the oral cavity for PACT of planktonic and biofilm cells of *C. albicans* causing oral candidosis.

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Antimicrobial properties of surface-active agents by flow calorimetry

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Surface-active reagents (surfactants) have wide and varied applications in today's modern society; from soaps to immunosorbents they form a multi billion dollar industry with some surprisingly subtle uses. One such application of surfactants is as soaps or detergents for the removal of dirt and grease. With the ever-increasing rise of bacterial resistance and increase in public awareness, the antimicrobial aspect of cleansing products must be considered and indeed this has spawned a whole new range of antibacterial products available for the general public to buy. Biological calorimetry offers a technique to study the growth and, moreover, death of microbiological cultures in a unique fashion, distinctly different from traditional microbiological analysis. Heat energy is evolved as microorganisms grow and respire, which can be detected and converted via thermocouples, into power (Watts); the resulting data from this technique is in the form of a power-time graph. A Thermal Activity Monitor (Jarfalla, Sweden) capable of detection in the nano-watt range was employed in flow-through mode to monitor the heat evolution of microbial cultures in a simple glucose buffered medium at 37°C. Isothermal Calorimetric analysis yields real-time data from which the dynamic response of microorganisms can be observed and their thermo-kinetic response quantified. This also has the advantage that experimental time can be reduced from a minimum of 24 h using traditional microbiological techniques to ca. 3 h calorimetrically. The results (Table 1) show that calorimetry offers an excellent technique for quantitatively assessing the antimicrobial potential of surfactants to a high degree of accuracy over a short period of time. *Saccharomyces cerevisiae* has been used as a model target organism for studying the effect of surfactants. *S. cerevisiae* was chosen for its ability to easily respire on glucose media with minimal nutrient requirement and a well-defined protocol (Beezer et al 1976) for freezing/thawing with good recovery. Calorimetry also offers an opportunity to study the effects of surfactants on polymicrobial cultures with ease or for microorganisms trapped within complex matrices. Furthermore antagonistic/synergistic actions of a combination of two or more surfactants can be easily assessed, again not easily accomplished with traditional techniques. Results from this quantitative analytical approach can be used to design and optimise the antimicrobial efficiency of formulations (e.g., surgical hand washes) in which an antimicrobial cationic surfactant is usually supported by a non-ionic surfactant.

Table 1 SDS addition after 20 min into *Saccharomyces cerevisiae* respiring on glucose buffered medium

SDS concn (mM)	Integrated power 0–2 h (μW)	Rate of kill (μW s^{-1})
0	831992	—
0.032	831856	0.00188
0.064	832052	-4.3×10^{-7}
1	620369	−0.03700
4	379234	−0.11495
8	379854	−0.12586

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Poster Session 3 – Pharmacy Education

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Design of a web-based tutorial for acid-base equilibrium theory

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Most drugs are either weak acids or weak bases and the ionisation state is dependent upon the pH of their environment. In solutions of these drugs, an equilibrium exists between the undissociated and the ionised form and extent of ionisation will affect solubility, partitioning, and ultimately drug absorption. The ionisation constant allows comparison of the strengths of weak acid and bases and this is an aspect of the MPharm course that students find challen-

ging. Computer-based learning (CBL) is well established and its benefits are widely reported. With recent studies showing the Web to be a useful medium for learning and assessment (Yazon et al 2002), the aim of this study was to produce a web-based tutorial for undergraduate MPharm students. For the aim to be fulfilled, the following objectives were set: to identify undergraduate MPharm students' weaknesses in their understanding of the acid-base equilibrium course; to identify students' attitudes towards web-based learning aimed at pharmaceutics; to design a web-based tutorial on acid-base equilibrium; and to assess whether students benefited from the web-based tutorial. The student learning experience was measured through questionnaire analysis. Questionnaires were given to students before (n = 86) and after the tutorial (n = 58) to assess student attitudes towards the tutorial as a supplement to a lecture course. Students generally had a positive attitude towards CAL/web-based tutorials and indicated that the tutorial would be a good supplement to the current lectures (89.5%). The aspects of the acid-base equilibrium course that the students found most difficult to understand were the Bronsted-Lowry theory (75.8%) and performing calculations based on acid-base theory (82.6%). The content of the tutorial was determined by the students' responses and concentrated, in particular, on the areas that students were finding difficult to understand, interpret and apply. Increase in performance or effectiveness using CBL is strongly influenced by the design of the interface in the computer-based materials (Evans et al 2004). If the potential of computer-based delivery is to be realised, usability and interactivity of the interface between the student and the courseware has to be considered and should not be used simply as an extension of the chalkboard, putting lecture notes directly on the web. The tutorial therefore contained theory, written by an undergraduate student to address the needs of the student cohort. The theory was then required to be applied to solve calculation-based self-assessment questions. It was designed for use on WebCT, an interface familiar to the students and piloted to a small group to identify any navigational and design issues. Students accessed the web-tutorial with minimum help and instruction thus it would be suitable for self study. Students responded that the tutorial did help their understanding of the subject area (77.6%) and addressed material that was difficult to understand from a lecture course (81.0%). Although it was felt that the tutorial addressed similar learning needs as the lecture course (75.9%), it was thought that the tutorial was an effective supplement to the lecture course (82.8%).

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Evans, C. et al (2004) *Computers and Education* **43**: 49–61

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Design a web-based learning pH-partition package

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The dominating factors that affect absorption of weak acids and bases are pH at the absorption site and the lipid solubility of the unionised species. Student examination performance and course review questionnaires have highlighted this as an area that could benefit from additional support supplementary to the lecture course. A computer-based learning (CBL) package may be used to address this need. Many online courses, however, consist merely of a series of textual notes and pictures with little navigational information or choice. A recent study by Evans et al (2004) highlighted errors in usability of computer-bases learning systems and included: not structuring material to more than one level; not "chunking" information; not providing sufficient navigational information; providing either too little or too much navigational choice; and not providing interactions and self-assessment questions. Therefore, a Computer Aided Learning (CAL) package was created to support the lecture series and the needs of the students. In this endeavour two focus groups (n = 8) were conducted, the former to develop the CAL package and the latter to evaluate it. The initial focus group used a theme plan with questions concerning CAL and the pH-partition hypothesis to explore the views and ideas of the students that had recently completed the lecture course. Discussions within the focus group were recorded and the results showed that students wanted a bright, interactive and relevant learning aid to complement the lectures. They wanted to be able to work at their own pace and to be able to test their understanding throughout. The package was created using Microsoft PowerPoint. It was designed to incorporate animation, hyperlinks and to be interactive. An evaluation focus group and semi-structured interviews were used to determine whether the package met the needs of the students. Key elements identified by the focus group as desirable in the package were the use of bright, animated graphics and summary pages. The benefits of being able to work at one's own pace and to assess knowledge through questions built into the package, identified by the initial focus group as important criteria, were also viewed as being successfully addressed by the package. The degree of success of CAL packages will depend on how closely they fit with the needs of the students, the course and the lecturer. The students believed the package to be excellent, with colour, animation and self-assessment questions that met the identified needs.

Evans, C. et al (2004) *Computers and Education* **43**: 49–61

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Differentiating inquisitive and acquisitive learning: a comparative study at the Portsmouth and Brighton schools of pharmacy

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Educational research has highlighted the relative benefits of providing students with complete and partial sets of notes, indicating that students are potentially inconsistent or even inexperienced note-takers (Kiewra et al 1988). It was noted that reviewing a complete set of notes for a sufficient amount of time resulted in a better test performance than reviewing personal notes alone. However, the best test performances were achieved when a combination of personal notes and provided handouts were used. This was attributed to the importance of personal cues generated during the note taking process. These personal cues are more likely to be recalled by the student than those suggested by the lecturer. "Skeletal" notes are based on complete notes, but are deliberately incomplete. They contain the structure and the detail of the complete notes, but also allow the student to incorporate personal cues and hence maximise the encoding function. It was the aim of this study to assess staff and student attitudes to different resource provision at the Portsmouth and Brighton Schools of Pharmacy, and to ultimately determine whether the nature and type of resource provision could affect academic performance. Staff and student attitudes were assessed via a questionnaire based on that piloted previously (Ingram et al 2004). The questionnaire was developed after the method of McLennan & Isaacs (2002), which assessed the role of handouts and course delivery in veterinary science lectures at the University of Queensland. The final questionnaire was developed after a pilot scale study, and analysis by focus groups in both institutions. Results indicated that students and staff differ comprehensively in their opinions regarding the supply, usage and nature of handouts, with lecturers preferring to make use of partial handouts when they see a need. Students, on the other hand, show a preference for as many detailed handouts as possible. Staff and students did share the same generalised view that handouts encourage learning. However, students as a whole believe that handouts do not discourage further study in a subject, and also do not discourage attendance to lectures. Demographic factors that were shown to have an effect on responses were language (particularly where English was not the first language), year of study, choice of pre-registration placement, gender, marital status, age and the number of children.

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Invited Abstracts

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Predicting drug absorption and disposition: transporter, solubility and elimination interplay

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The Biopharmaceutics Classification System (BCS) was developed to allow prediction of in vivo pharmacokinetic performance of drug products from measurements of permeability (determined as the extent of oral absorption) and solubility (determined for the highest dose strength in 250 ml of water over the pH range 1–6.8). Although the BCS is useful for characterizing drugs in Class 1 (high permeability; high solubility) for which drug dosage form dissolution alone may be amenable for waiver of in vivo bioequivalence studies, there is little predictability concerning drugs in Classes 2 (high permeability; low solubility), 3 (low permeability; high solubility) and 4 (low permeability; low solubility). Early this year (Benete et al 2005), we suggested that a modified version of such a classification system, designated the Biopharmaceutics Drug Disposition Classification System (BDDCS), may be