Research Links Throughout the Bioscience Curriculum: Effective Learning?

Introducing undergraduate students to scientific reports

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ABSTRACT

- Account of a Level One activity to introduce undergraduates to reading and writing of scientific reports

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INTRODUCTION

Why is this taught?

- Research papers are the principal means of communication within the science community
- Skills necessary for critiquing reports do not arise routinely in other activities
- Final year projects are written in the style of scientific reports, but practical work does not necessarily develop those skills

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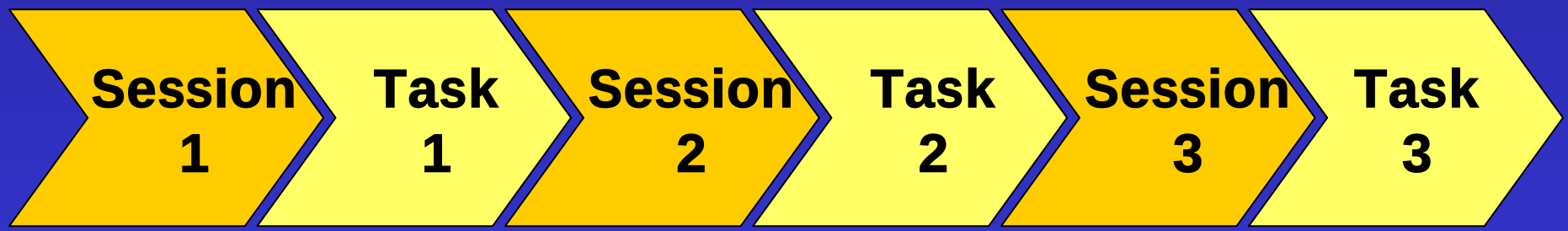
MATERIALS AND METHODS

- A series of classroom sessions and study activities carried out over a period of 2 months
- Part of a broader programme of Key Skills for Level One Medical Biochemists and Medical Genetics students (n = 70)



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MATERIALS AND METHODS

Session 1

- Buzzgroups discuss names and purpose of sections in a research paper, followed by tutor-led discussion

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MATERIALS AND METHODS

The main sections of a scientific paper can be summarised as follows:

Main sections of a scientific paper[1]

Section	*Intends to tell the reader*
Title	What the paper is about
Abstract	Short summary, which can also "stand alone"
Introduction	The problem, and what is known already
Materials and Methods	What you did
Results	What you found
Discussion	How you interpret the results
Conclusions	Possible implications
Acknowledgements	Who contributed to the work and how
References	How to find the papers referred to
Appendix	Supplementary material

Malmfors *et al* (2000)

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MATERIALS AND METHODS

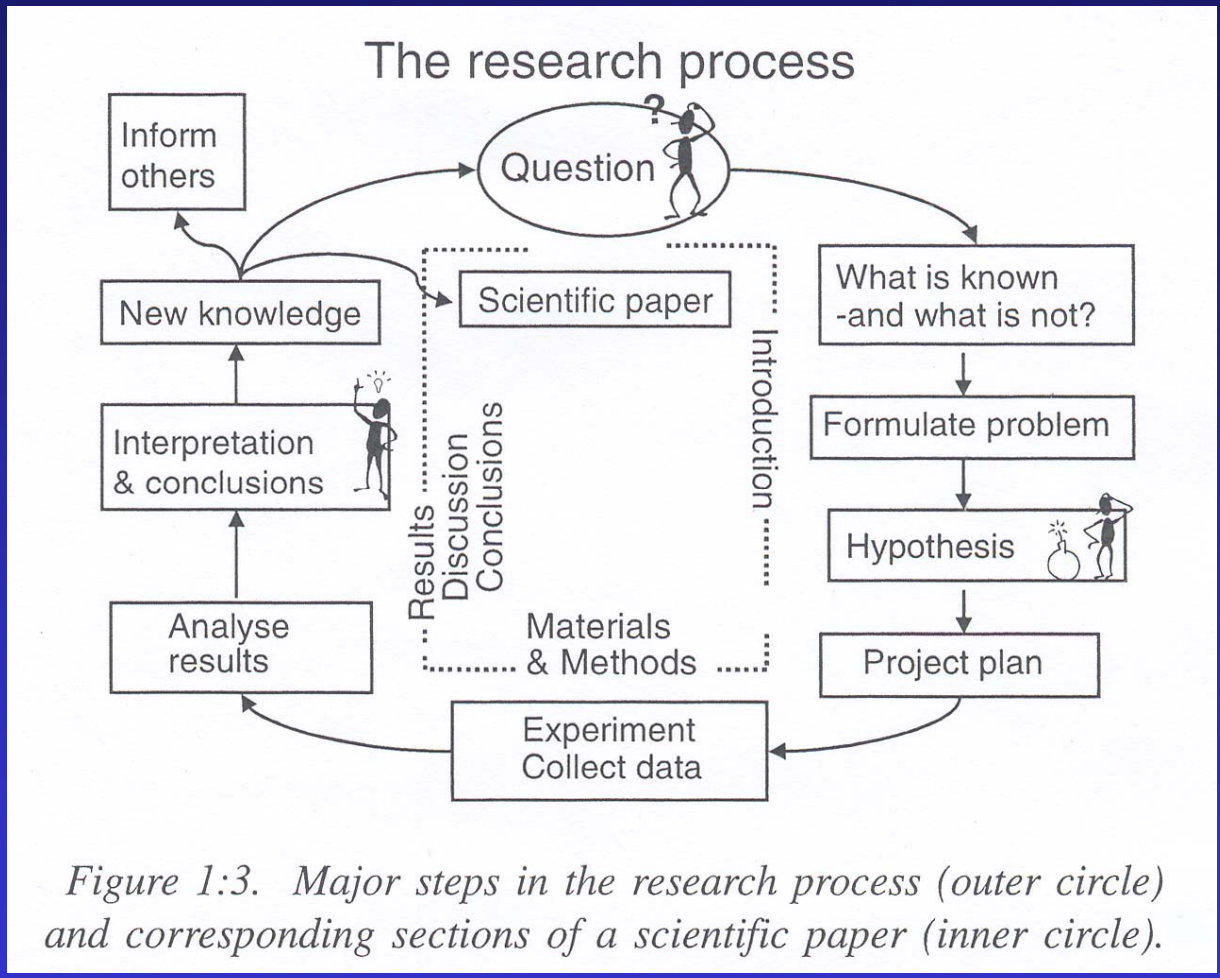

Figure 1:3. Major steps in the research process (outer circle) and corresponding sections of a scientific paper (inner circle).

Malmfors *et al* (2000)

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MATERIALS AND METHODS

Session 1

- Buzzgroups discuss names and purpose of sections in a research paper, followed by tutor-led discussion
- Students consider strengths and weaknesses of three versions of an Abstract (Kirkman)
- Set Task 1

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MATERIALS AND METHODS

Task 1

- Students answer series of questions to guide them through research article
- Culminates in writing an Abstract for paper
- Formative assessment

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MATERIALS AND METHODS

Task 1

- Choosing an appropriate paper
- Contemporary papers frequently jargon-rich and impenetrable
- "*There is no form of prose more difficult to understand and more tedious to read than the average scientific paper*" Francis Crick
- Short-listed potential articles from recommended reading in textbook

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MATERIALS AND METHODS

Proc. Nat. Acad. Sci. USA
Vol. 69, No. 9, pp. 2509–2512, September 1972

The Gradient-Sensing Mechanism in Bacterial Chemotaxis

(temporal gradient apparatus/stopped-flow/*S. typhimurium*/motility tracks/memory)

ROBERT M. MACNAB AND D. E. KOSHLAND, JR.

Department of Biochemistry, University of California, Berkeley, Calif. 94720

Contributed by D. E. Koshland, Jr., June 30, 1972

ABSTRACT **A "temporal gradient apparatus" has been developed that allows the motility of bacteria to be studied after they have been subjected to a sudden change from one uniform concentration of attractant to another. A sudden decrease elicits the tumbling response observed with spatial gradients; it was found, however, that a sudden increase also elicits a response, namely supercoordinated swimming. This demonstrates that chemotaxis is achieved by modulation of the incidence of tumbling both above and below its steady-state value. The initial responses gradually revert to the steady-state motility pattern characteristic of a uniform distribution of attractant. The apparent detection of a spatial gradient by the bacteria therefore involves an actual detection of a temporal gradient experienced as a result of movement through space. Potential models for the chemotactic response based on some "memory" mechanism are discussed.**

The phenomenon of chemotaxis occurs widely in biological systems. Its presence in bacteria was detected by Pfeffer (1) in 1881, and has been clarified further in recent years, in particular by the recent studies of Adler and his coworkers (2, 3). In many ways bacterial chemotaxis appears analogous to sensory reception in higher species as in (*a*) the specificity of the response to attractants (2, 4), (*b*) the indication that the receptor molecules are located in the outer membrane (3, 5), and (*c*) the sensitivity of the response to ratios of concentrations rather than to differences (1, 6).‡ However, bacterial chemotaxis poses a special problem: how can such a small organism detect the concentration differences necessary to

The difficulties of an instantaneous spatial comparison are removed if one postulates a mechanism for comparison of concentrations over a time interval (7). Since there are indications that time-dependent processes may be present in phototactic organisms (8), and are present in higher neural processes (9), it seemed worthwhile to test the chemotactic system for the ability to make temporal comparisons. The difficulty was to devise an experimental method that isolated the time dependence from ambiguities of spatial sensing.

We accomplished this by developing a "temporal gradient apparatus," analogous to the stopped-flow apparatus of chemical kinetics. In this apparatus (Fig. 1), the bacteria initially present in a uniform attractant concentration (C_i) are plunged by a rapid mixing device into a final uniform concentration (C_f). They are then observed by microscopic and photomicrographic techniques. Since the bacteria are observed only after mixing is complete, they will respond as if they are in a uniform environment if they utilize instantaneous spatial sensing, whereas they will respond as if they are in a gradient if they utilize temporal gradient sensing, provided the mixing time is short compared to their time-dependent response.

MATERIALS AND METHODS

Salmonella typhimurium, strain LT2-S2, was taken from a stationary culture in nutrient broth and grown overnight at 30° with agitation in Vogel-Bonner citrate medium (10), with 1% *w/v* glycerol as an additional carbon source.

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MATERIALS AND METHODS

The Gradient-Sensing Mechanism in Bacterial Chemotaxis

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MATERIALS AND METHODS

Session 2

- Begins with interactive review of previous task
- Introduction to next activity, writing-up an experiment on lactate dehydrogenase (LDH)
- 2a – the problem is outlined
  2b – the data is distributed and the exptl strategy discussed
  2c – a first draft is brought to a further discussion on data handling

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Task 2

- Students write-up report using provided data as though it is their own experiment
- Several stages (as described), to distinguish between assessment of writing skills and understanding
- Formative assessment

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Session 3

- Students have 10 minute 1-2-1 tutorial with tutor/marker to discuss improvements in their report writing
- Plenary session: introduction to, and discussion of, second experiment (on genetic basis of colour blindness)

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MATERIALS AND METHODS

Task 3

- Students write-up a report of second experiment using provided data
- Summative assessment (33% of module)

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RESULTS AND DISCUSSION

What have we done well?

- Series of activities generally receive good feedback from the students
- Personalised advice in 1-2-1 session particularly popular
- Opportunity to practice an activity before summative assessment

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RESULTS AND DISCUSSION

What have we done *less* well?

- Some students still seek *the* answer as directly as possible and don't recognise value in discussing alternative strategies to same problem
- We have not adequately developed this activity in the Year 2 curriculum

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- Tim Harrison (Biochemistry)
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