The two papers Jacquin mentioned in his 14 February lecture – Ellington and Szostak in *Nature*, and Tuerk and Gold in *Science*, dated four weeks apart in August 1990(!) – make for interesting side-by-side reading. They independently describe the same method (SELEX) but with different motivations and styles of presentation; presumably this is due in part to the house style requirements at *Science* and *Nature*, but the many textual differences also reflect the authors' divergent purposes in writing the papers in the first place.

I'll focus here on the construction of the two papers themselves – specifically on the framing material (title, abstract, intro, discussion), which is less tightly specified than the Methods and Results material, and consequently reveals its **persuasive strategies** more readily. Note: I do not discuss the technical differences between the procedures described in the two papers! The significance of the differences is well outside my expertise, such as it is. If I've misrepresented the technical content, please please let me know.

Persuasive strategies?

Surely you don't think the *sole* purpose of a scientific paper is to give a recipe for reproducing an experiment in the form of a chain of deductive logic, finish with an affectless **QED**, and be done with things?! Were that the case, this exercise wouldn't be necessary; or at least it'd be a lot shorter.

The importance of a good title

Check it: the Tuerk paper names the SELEX procedure in the title, then specifies its application (same strategy as in the Abstract). In other words, 'here is a novel procedure and here is what we developed it for.' Meanwhile the Szostak paper's title reveals something of its disciplinary context and specifies

the *problem* it approaches without indicating method. Both are valid strategies, but you should look to your instructors (read: editors/referees/gurus) to see if they want anything specific.

Again, this is partly a matter of house style, partly an indication of the authors' intent to *frame* their work within an ongoing professional discourse.

Abstract and intro

Here are the two abstracts in full.

Szostak:

> Subpopulations of RNA molecules that bind specifically to a variety of organic dyes have been isolated from a population of random sequence RNA molecules. Roughly one in 10^10 random sequence RNA molecules folds in such a way as to create a specific binding site for small ligands.

Tuerk:

> High-affinity nucleic acid ligands for a protein were isolated by a procedure that depends on alternate cycles of ligand selection from pools of variant sequences and amplification of the bound species. Multiple rounds exponentially enrich the population for the highest affinity species that can be clonally isolated and characterized. In particular one eight-base region of an RNA that interacts with the T4 DNA polymerase was chosen and randomized. Two different sequences were selected by this procedure from the calculated pool of 65,536 species. One is the wild-type sequence found in the bacteriophage mRNA; one is varied from wild type at four positions. The binding constants of these two RNA's to T4 DNA polymerase are equivalent. These protocols with minimal modification can yield high-affinity ligands for any protein that binds nucleic acids as part of its function; high-affinity ligands could conceivably be developed for any target molecule.

Density and salesmanship

The much pithier Szostak abstract doesn't describe the experiment; it summarizes the procedure in one sentence, and gives one key result. Meanwhile the Tuerk abstract gives a schematic of SELEX itself – in a savvy bit of branding, the clever acronym is used in the paper's title – and only then explains how the researchers used/developed it; crucially the abstract reveals the flashiest

takeaway from the Discussion. (Note the slight hedge, 'conceivably,' in the final sentence.)

These cultural matters…matter.

Verb tense

Szostak's first sentence describes the *work* in past tense, then the finding of interest in present tense (i.e. it'll stay true when the work is forgotten). The Tuerk paper take the *exact same* approach to verb tenses. That's a very useful reading cue, and if you internalize those verb tense conventions then you'll be able to pick up on such errors before the draft leaves your hands.

Conclusions and context

Both research groups come out of Molecular Biology departments – remember when this work was done – but their motivations are quite different, and their papers are consequently framed in different terms.

Szostak: pointing toward a broad research program

The Szostak paper comes out of work on the origins of organic life (from the lab's website: 'We hope that our explorations of the chemistry and physics behind the emergence of Darwinian evolution will lead to explanations for some of the universal properties of modern cells, as well as explanations of how modern cells arose from their simpler ancestors'), so the Discussion section points to implications for that research area:

> Although it is difficult to extrapolate from substrate binding to catalytic function, the multiplicity of solutions seen for a given chemical problem (ligand binding) suggests that complex catalysts such as the hypothesized primordial RNA replicase might also be accessible in even limited searches of sequence space.

SELEX is framed by Szostak and his team as a tool for helping generate and test models of the prebiotic Earth, and the findings are expressed in evolutionary language ('As the isolates that bear these conserved regions are

otherwise entirely different, they must have arisen independently'). The title, abstract, introduction, and discussion all point toward the applicability of SELEX to the particular problems the Szostak lab was/is interested in.

Tuerk: exploring a novel laboratory method

The Tuerk paper, on the other hand, is all about developing a novel laboratory method *as such*. The structure serves the purpose. The paper's final two sections cover '**The roots of SELEX**' and '**Applications**' – 'how we thought it up' and 'now that we've got it, what new domains can we approach,' respectively. From the penultimate section:

> The philosophy of studying a pool of sequences completely randomized at various positions was developed in our laboratory (25) in order to understand what relation the information content of target sequences had to binding energy in a nucleic acid-protein interaction (26). By cloning with oligonucleotides that were randomized at some nucleotide positions and screening individual transformants, sequence-specific contributions to translational initiation in *E. coli* were studied (25). Subsequently, Schneider and Stormo extended this approach in the study of transcriptional initiation by T7 RNA polymerase (27). The cloning, screening, and sequencing were laborious and time-consuming tasks, however. In addition, the screens often depend on phenotypes that sum a number of intermediate processes and possible in vivo variables in these and other such studies (28–30). SELEX bypasses these caveats, although cloning is still essential to interpretation.

One implicit function of this paragraph is to establish the class of problems SELEX is meant to address, and establish its effectiveness in *comparative* terms – recognizing and extending the ongoing discussion and development of sci/tech knowledge (the 'scientific discourse') while arguing the novelty and importance of their own approach.

N.B. Pointing out that your research is novel isn't (just) hubris, it's a vital step in the community-oriented task of contextualizing your work, both in science history and in the set of current practices and understandings.

Tuerk's final section, **Applications**, walks the reader through several problem domains in which SELEX might be profitably used. Crucially, the third-last paragraph ('By extension, any partitioning agent…') specifically refers to Szostak's coauthor Ellington's work on 'primordial life-forms'; i.e. Tuerk's paper notes SELEX's applicability to the other group's research, but needn't

speculate further on that score, because the problem itself isn't of paramount importance.

'It's not called The Wheel…it's called The Carousel.'

The final paragraph is…hmm:

> Finally, SELEX may be just the beginning of evolution in a test tube…SELEX, therefore, heralds a new era in novel molecular design unrestrained by the rules that govern organismic survival and replication. SELEX could thus provide unpredictable and unimaginable molecular configurations of nucleic acids and proteins with any number of targeted functions.

The technical term for that species of writing is 'advertising copy,' as seen on AMC's popular historical drama *Mad Men*.

In terms of rhetorical effectiveness – the 'fitness function' of a scientific paper, to borrow a phrase – we might cheekily point out, again, that the 'product name' in the title of the Tuerk paper is still in use, like *Xerox* for *photocopy*.

A question for you, the Student, regarding citations

Why does the Szostak paper include only nine citations, when the Tuerk paper needs *thirty-six?*

Closing

In the context of a BE lab class, you should *of course* be spending more time on these papers' technical considerations than on their rhetorical strategies. But as science practitioners, one of your major activities in future will be reading and interpreting *reports* of others' research – in other words, *textual study* – and entering into dialogue with those researchers and their work. Technical communication is a science skill. Being able to move easily between conceptual material and written rhetorical expression is a science skill *and* a writing skill.

So there you have it, for today.