Scientific Writing

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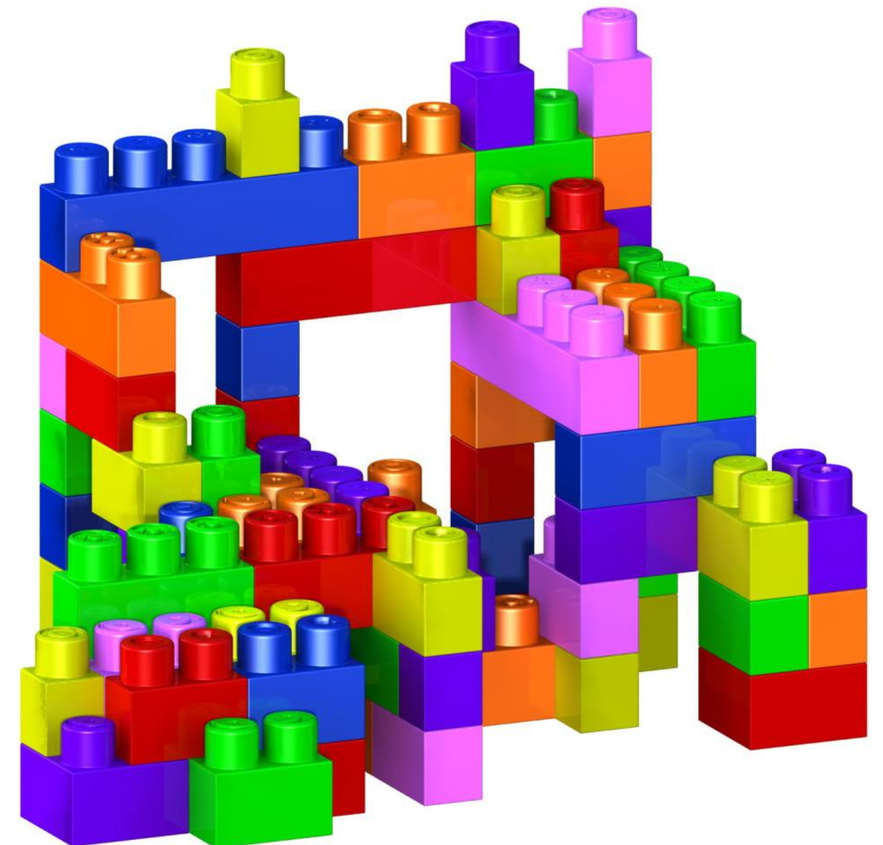
Why Scientific writing

- Scientists write to communicate their research results and findings with other scientists or experts. In this way, information is shared in a systematic manner, so that researchers can build upon the work of others.

oral or poster presentations on scientific conferences

science blogs, or data warehouses

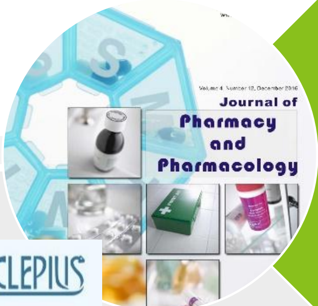
written reports/papers



Ways of communication

oral or poster presentations on scientific conferences

science blogs, or data warehouses

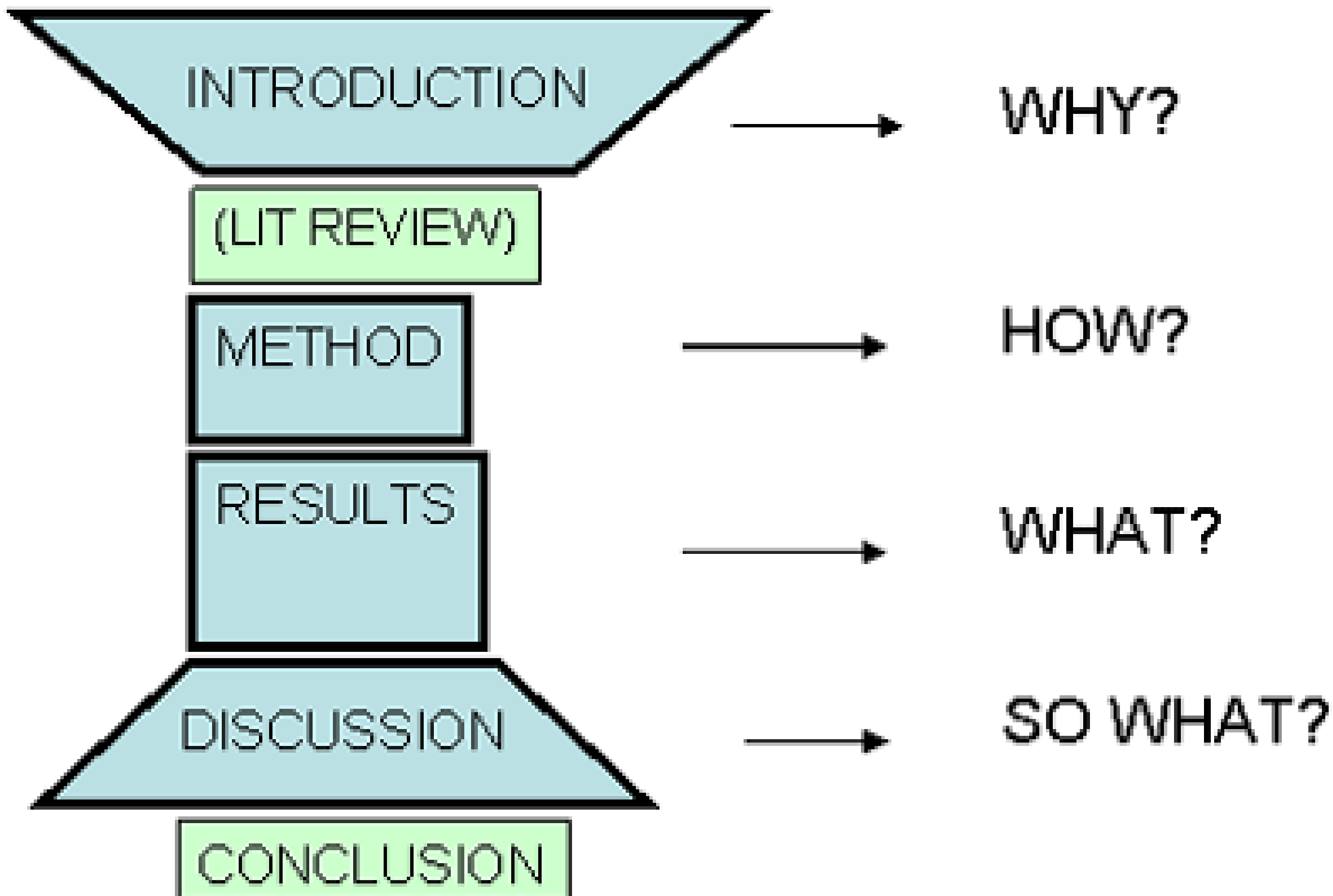


written reports/papers

ASCLEPIUS

Writing according to the IMRAD structure

- IMRAD is an acronym for introduction, methods, results, and discussion



Ethics in science

"Misconduct in science" is defined as fabrication, falsification of plagiarism or other practices that significantly deviate from those commonly accepted within the scientific community for proposing, conducting or reporting research. It does not include honest error or honest differences in interpretations or judgement of data.

Cronological order for writing a manuscript

- How should I start writing my manuscript, what comes first?
  - Introduction;
  - Material and Methods;
  - Results;
  - Title?

Active poll

How should I

Introduction
0%

Material and Methods
0%

Results
0%

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Cronological order for writing a manuscript

- Results
- Introduction
- Methods
- Discussion
- Summary
- Acknowledgements
- Reference list is created during

the writing.

Results

- Prepare all Figures and tables
- Make a logical connection between data tables and Figures
- Do not repite the same data in Figures & Tables
- Write the figures legend/Table head
  - The figure + legend must be self-explaining
- What is the "story"?
  - Try to tell your story together with the figures. Which of the figures are the best for demonstrating your results to readers?
  - Explain the results you obtain and what you did further to obtain the next result

Results

temperatures which produced rod-shaped cells (5–20°C). At this temperature, phages caused an approximately 82% of cell density reduction compared to control samples (Table 1). Cell density reduction (80%) of phage infection of elongated cells, grown at 30°C, was not significantly different ($P > 0.05$) from cells infected at 25°C (Table 1). Phage replication inside cells with reduced specific growth rate (5 and 10°C) (Table 1), led to low numbers of progeny phages produced (Fig. 1e).

One-step growth experiments performed at room temperature (RT) showed that the latent and rise periods were not influenced by cell morphology; however, the burst size varied considerably resulting, after 60 min, in approximately 58 (rod) and 150 (elongated) progeny phages per infected cells (Fig. 2a). Furthermore, adsorption assays, also performed at RT, showed a slightly faster adsorption of phages to elongated cells (Fig. 2b). The adsorption rates for rod and elongated cells, calculated according to Barry and Walter [2], were of 3.97×10^{-10} and 4.21×10^{-10} ml min^{-1} for a period of 4 min, respectively.

The *P. fluorescens* OMP and LPS profiles remained similar regardless of cell morphology (Fig. 2c, d).

Describe data

Statisticall analysis of the data

Exlplain what you did further

Tables

•Each Table must have a title which *alone* gives a clear idea of its content

•Explanations that are *necessary for the reader to understand the results* in the table (without looking into M&M section) are written behind the title or (in some journals) as foot notes

•The table must be *self-explanatory*

•Avoid repetitions in column and line headings, e.g. units

•You <u>must</u> display the variability / variance / significance of the figures in the table

Tables

Table 1 Influence of temperature and rotational agitation speed on *P. fluorescens* PF7A cell length, specific growth rate, cell number at an OD_{600} of 1, and cell density decrease (%) after phage infection using a MOI of 0.15

T (°C), Speed (rpm)	Cell length[a] (μm) (±SD) [min (μm)–max (μm)][b]	μ (h^{-1}) (±SD)	Log (CFU ml^{-1})	OD_{600} decrease (%) (±SD)
5, 160	2.14 (0.84) [1.6–3.6]	0.025 (0.001)	9.85 (0.03)	67.80 (3.08)
10, 160	2.28 (0.87) [1.7–3.7]	0.047 (0.002)	9.89 (0.02)	69.33 (2.75)
15, 160	2.25 (0.90) [1.7–3.8]	0.070 (0.004)	9.85 (0.04)	61.54 (4.05)
20, 160	2.54 (0.43) [2.3–3.3]	0.087 (0.004)	9.86 (0.05)	73.08 (3.75)
25, 160	2.70 (0.45) [2.4–3.4]	0.122 (0.003)	9.88 (0.04)	82.37 (1.94)
30,160	14.80 (7.30) [4.2–23.8]	0.084 (0.003)	8.77 (0.12)	79.75 (6.75)
30, 0	2.04 (0.78) [1.5–3.3]	0.048 (0.004)	9.88 (0.04)	27.04 (4.50)
30, 160	14.80 (7.30) [4.2–23.8]	0.084 (0.003)	8.77 (0.12)	79.75 (6.75)
30, 200	20.7 (7.12) [11.3–29.2]	0.127 (0.002)	7.58 (0.04)	84.15 (2.38)

SD standard deviations

[a] Minimum and maximum size from measurements of 5–10 cells

[b] Minimum and Maximum cell length observed

Title: self-explicative detailed description

Tables

Table 2. Influence of different *Salmonella* Typhimurium LT2 physiological states (planktonic/biofilm) on the combinatorial effect of Lys68 and outer membrane permeabilizers.

S. Tyhpimurium LT2	Planktonic		Biofilm
	Exponential phase	Stationary phase	
Lys68 + Water	0.11±0.14	0.14±0.07	0.15±0.11
PBS + Citric acid	0.10±0.11	0.08±0.11	0.09±0.19
PBS + Malic acid	0.08±0.20	0.19±0.18	0.15±0.25
Lys68 + Citric acid	**5.01±0.37**	**1.45±0.15**	**1.26±0.10**
Lys68 + Malic acid	**3.23±0.33**	0.65±0.28	**1.01±0.13**

In the planktonic and stationary assay, 50 μL cells resuspended in 10 mM HEPES/NaOH (pH 7.2) to a final 10^8 CFU/ml were incubated with 25 μL Lys68 (2 μM final concentration) together with 25 μL of citric and malic acid (2 mM and 5 mM final concentrations, respectively) for 2 h. In biofilms assay, cells were washed twice with 200 μL of 10 mM HEPES/NaOH (pH 7.2). Cells were then incubated with 100 μL of Hepes together with 50 μL Lys68 (2 μM final concentration) and 50 μL of citric and malic acid (2 mM and 5 mM final concentrations, respectively) for 2 h. For both experiments, cells incubated with water (instead of citric/malic acid) or PBS (instead of Lys68) were used as negative controls. After incubation CFUs were counted. Averages ± standard deviations are given for n = 4 repeats. Indicated in bold are significant log reduction units observed (≥1 log).

doi:10.1371/journal.pone.0108376.t002

- Explanations that are *necessary for the reader to understand the results* in the table (without looking into M&M section) are written bellow the title or (in some journals) as foot notes

Figures

- Each figure must have a name and a figure legend
- The Figure with name & legend must be *self-explanatory*
- Different symbols easy to distinguish from each other and logical, related items with related symbols,
- Choose the size so large that it reflects the variability of your data.
- Carefull with data presentation (bar for SD, logaritmic scale...)

Figures

Standard deviations

Logaritmic scale

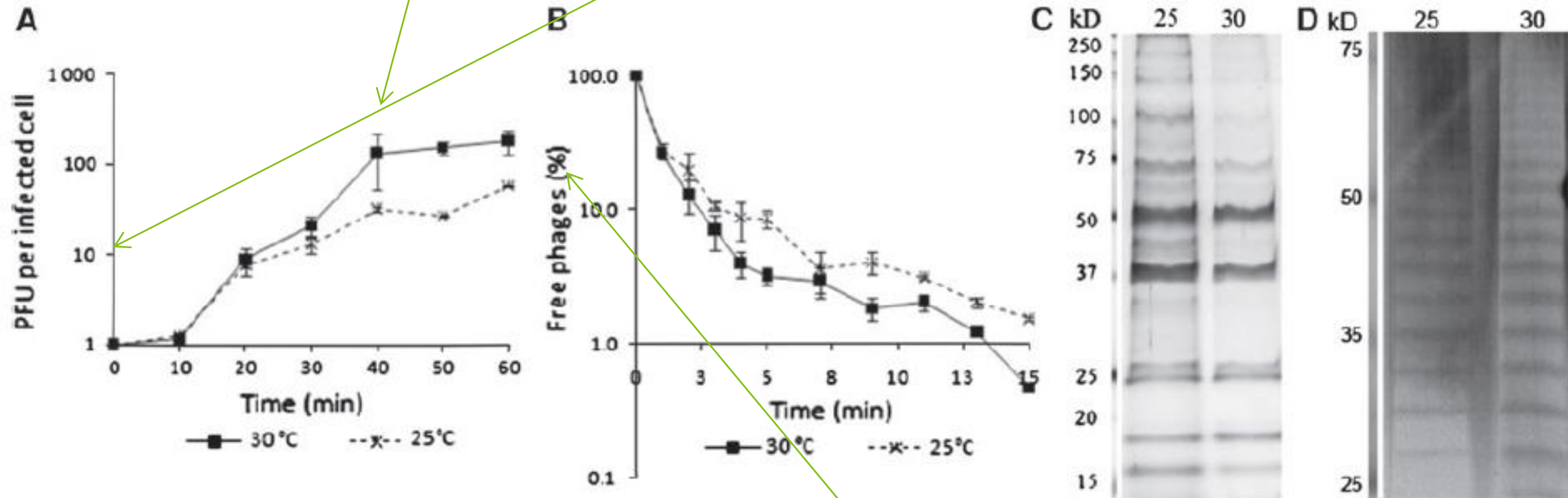

Fig. 2 Phage ϕIBB-PF7A **a** one-step and **b** adsorption experiments to *P. fluorescens* grown at 25 and 30°C where *error bars* indicate standard deviations of three independent experiments, **c** the outer membrane protein profiles and **d** LPS of cells grown at 25 and 30°C, respectively. Precision Plus Protein All Blue standard (Bio-Rad) and Protometrics (National Diagnostics) were the protein standards used in the SDS-PAGE and LPS gels, respectively

Units

Figure legend detailed

Figures

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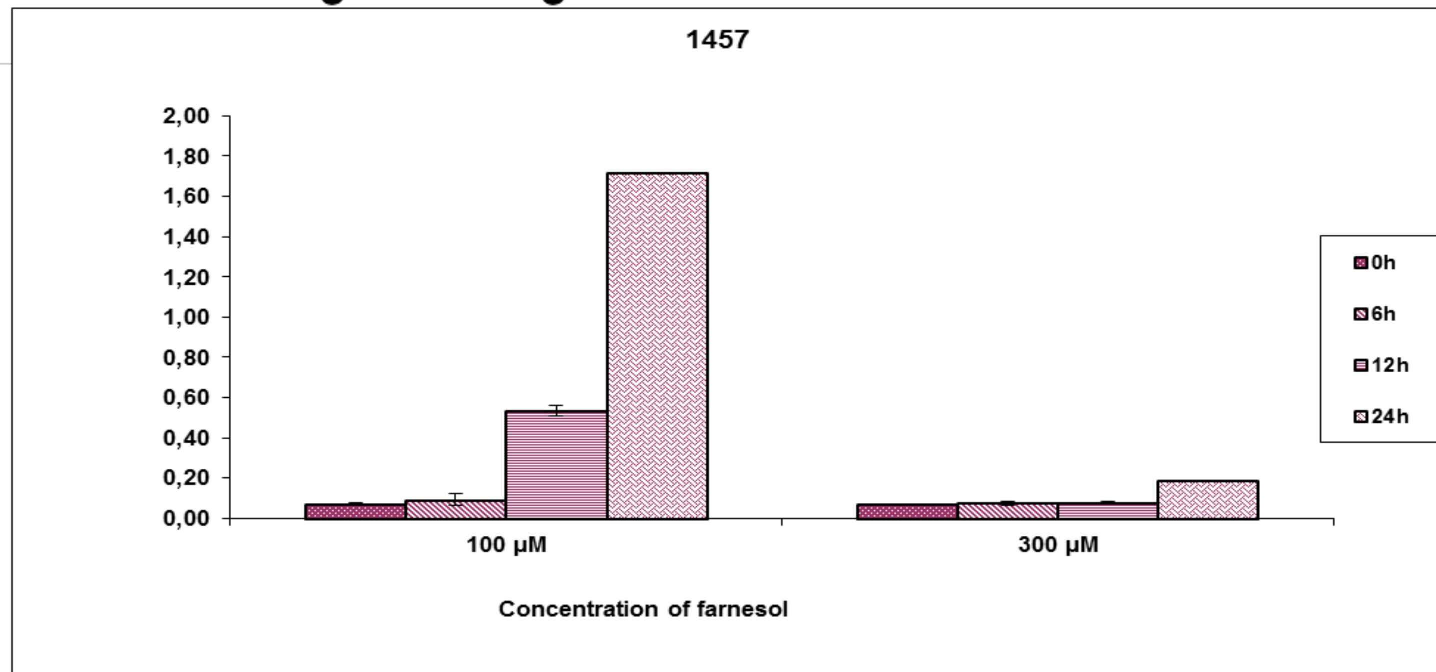


Figure 1: PAE expressed as XTT OD of planktonic *S. epidermidis* cells (Strain 1457) after 6, 12 and 24h in medium without farnesol.

Introduction

should include 4 parts:

1. A few sentences introduction into the area of research
2. Description of the state of art: a well documened state-of-the art with recent findings
3. Explain the gap of knowledge what is still needed to know in the area.
4. Describe the aims of the work to fill the gap you explained. You may add at the end one sentence on your most exciting result, or give a hint on it. This you may do with the aim of saying: dear reader, if you read my story, this is what you will get…(optional)

Introduction

Introduction

A bacterial genus presents typically one or a limited subset of different morphologies within the forms rods, variations of rods, or cocci. Cells can change their shape in response to adverse environments (for example, nutrient limitation) or during the course of pathogenesis which might improve their survival chances. It is suggested that the variability of shapes is greatly due to bacterial defense mechanisms against adverse conditions and predation. Bacterial morphology can aid bacteria against predation by allowing them: (i) to escape by being too small or too fast, (ii) to resist ingestion by becoming too large or too long, and (iii) to become inaccessible by growing in aggregates or biofilms [29]. Moreover, cell morphology can also have a role in optimizing cell attachment to surfaces, passive dispersal, active motility, and internal or external differentiation [28].

Bacteriophages (phages) are bacterial viruses discovered nearly 100 years ago. Since then, a vast amount of research has been carried out with different phage-host systems and it is commonly accepted that the effectiveness of bacteriophages in lysing their hosts depends greatly on the target bacterium but also on external factors which can highly influence phage growth parameters.

In a recent work, biofilms of *Pseudomonas fluorescens*, a psychrotrophic bacterium, were observed to acquire rod and elongated shapes depending on the conditions used [21] which were both infected by phage ϕIBB-PF7A. However, the influence of infection of these different morphologies on progeny phage production remained unclear. Thus, this study aims at understanding the impact of cell morphology on the level of outer membrane proteins (OMP) and lipopolysaccharides (LPS) (possible phage receptors), and evaluating the influence of *P. fluorescens* cell morphology on phage adsorption and production.

1- Introduction to the topic

2- State-of-the-art

3- Gap of knowladge

4- Aim of the work

Materials and Methods

- Take your Figs /Tabs one by one, and explain the methods you used to get the results *that you showed in the Results section.*
- Explain shortly the principle of the method, and how it was done. If you used a published method as such, you only give the principle and the reference. It must be *as recent as possible* and a *publicaly available* reference. If you modified the method, you explain how.
- Biological Materials:
  - Originis of samples and microbes/clones etc used (from whom, from where),
  - Strain codes of all strains, relevant collection codes,
  - Accession numbers of the sequences you used and you deposited,
  - How samples were stored, pre-treated, preserved,

- Reagents and equipment: Indicate manufacturers (name, city) of instruments, reagents and kits you used.

- When explaining a protocol, you do this in order of sequence: you tell first what was done first, then the following step etc. Like a cooking book: if the reader wants to repeat your expt, he can put your text on his lab bench and execute the steps in the order you listed them.

- Compile items into tables as much as possible: eg. list of strains and their origins, list of sampling sites and their geographic locations…

Materials and Methods

Biological materials

Culture collection reference

Materials and methods

Organisms

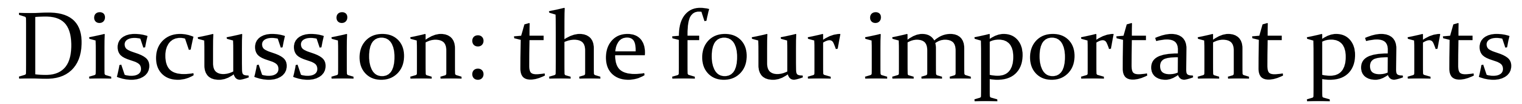
A total of six clinical isolates of *C. glabrata*, originally recovered from the oral cavity (strains D1 and AE2), vagina (strains 534784 and 585626) and urinary tract (strains 562123 and 513100) were used in this study. A reference strain of *C. glabrata* from the American Type Culture Collection (ATCC 2001) was also included. Oral isolates were obtained from the biofilm group of the Centre of Biological Engineering, Minho University (Braga, Portugal). Strains isolated from urinary and vaginal infections were kindly provided from the culture collection of the Hospital of São Marcos (Braga, Portugal). An oral isolate of *C. albicans* (strain 324LA/94) from the culture collection of Cardiff Dental

Reconstituted human oral epithelium infection

To investigate *in vitro* single- and mixed species infection of oral mucosa by *C. glabrata* and *C. albicans* strains, a reconstituted human oral epithelium (RHOE) (human keratinocytes derived from a squamous carcinoma of the buccal mucosa, cell line TR 146, SkinEthic Laboratories, Nice, France) model was used. RHOE tissue inserts (0.5 cm^2) were placed in 24-well tissue culture plates with MCDB 153-defined medium containing 5 μg/ml insulin, 1.5 mM $CaCl_2$, 25 μl/ml gentamicin, and 0.4 μg/ml hydrocortisone, according to the manufacturer's instructions. For single species infection, 1 ml of standardized suspensions (2×10^6 cells/ml) of *C. glabrata* or *C. albicans* was placed directly onto the RHOE tissue inserts. For mixed species infection, 500 μl of *C. glabrata* (2×10^6 cells/ml) was combined with 500 μl of *C. albicans* (2×10^6 cells/ml) suspension and this preparation placed onto the RHOE tissue inserts. Control samples were inoculated with 1 ml of medium

Methods

Reference of material and equipment



Discussion: the four important parts

- 1. ***Does your paper contain novelty*? (= results different from what has been published before). When yes, start the Discussion with it!** In order to know whether you have news or not, you must follow the literature actively throughout your work – otherwise you may end up in (by accident) executing experimental work similar to that published before. It is too late if you start reading the literature just when you want to write the discussion!

- 2. ***Combine your results with literature data***, can you reach more conclusions (added value) than just based on your *own* data? Do your results support somebody's else's, or do you contradict somebody's results? Do your data make some earlier theories or general opinions questionable?

- ***3.Present a theory to explain your results: why*** they were as they were. If your resultys contradict somebody's elses, explain why this is so (Are his methods inadequate? *If somebody published results similar to yours, you must say it.*

- ***4. So what?*** What can your results be used for / can they be applied to develop something? Are your results useful? For what? How do your results advance science?

Discussion

species is generally the most virulent (19, 27).

Interestingly, mixed species infection revealed (Table 1 and Fig. 3B) that *C. albicans* promoted the invasiveness of *C. glabrata*. In fact, all six *C. glabrata* strains classified as 'non-invaders' in single infection studies were found to penetrate the oral epithelium in the presence of *C. albicans*. It is known that *C. albicans* hyphal formation is a critical determinant in invasive pathogenesis especially in comparison with non-*Candida albicans Candida* species, and it has been shown that *C. albicans* with mutations in genes involved in promoting hyphal development were less invasive than wild type strains (20).

The exact mechanism of how *C. albicans* might promote *C. glabrata* penetration of the oral epithelium remains unclear. Damage to the integrity of the epithelial surface caused by the growing tips of the *C. albicans* hyphae (Fig. 4A,B) seems to provide access to lower epithelial layers for *C. glabrata* yeast. In fact, *C. glabrata* cells were observed in close proximity to *C. albicans* hyphae and transported in this adhered form to deeper tissue layers (Fig 4C, arrows). In this context, Ez-Azizi et al. (29) showed the efficient adherence of *C. albicans* to a pre-formed *C. glabrata* biofilm in a catheter model, suggesting the co-aggregation of these two species *in vivo*.

- ***2. Combine your results with literature data***,
- ***3.Present a theory to explain your results: why*** they were as they
- ***4. So what?*** What can your results be used for / can they be applied to develop something?

The increased LDH activity (Fig. 2) reported after mixed infection with *C. albicans* and *C. glabrata* supports a finding of enhanced pathogenicity (7). Of additional concern is that strains of *C. glabrata* often have higher resistance to azoles antifungal agents compared with many other *Candida* species, including *C. albicans* (5, 6, 30). In such instances, mixed infection would not only exhibit enhanced pathogenicity (7), but could also be more problematic to treat. Many diagnostic laboratories are limited in the identification of mixed *Candida* infection, particularly when non-differential primary isolation agars such as Sabouraud dextrose agar are used. The importance of recognizing the occurrence of such mixed infection is however highlighted by the results of this study and represents an area that should be considered by both diagnostic laboratories and clinicians alike.

Summary

Abstract This study aims at assessing the influence of *Pseudomonas fluorescence* cell morphology on the effectiveness and production of the lytic bacteriophage ϕIBB-PF7A. *P. fluorescens* were cultured as rods or as elongated cells by varying the temperature and rotary agitation conditions. Cells presented rod shape when grown at temperatures up to 25°C and also at 30°C under static conditions, and elongated morphology only at 30°C when cultures were grown under agitation. Elongated cells were 0.4 up to 27.9 µm longer than rod cells. Rod-shaped hosts were best infected by phages at 25°C which resulted in an 82% cell density reduction. Phage infection of elongated cells was successful, and the cell density reductions achieved was statistically similar ($P > 0.05$) to those obtained at the optimum growth temperature of *P. fluorescens*. Phage burst size varied with the cell growth conditions and was approximately 58 and 153 PFU per infected rod and elongated cells, grown at 160 rpm, at 25°C (the optimal temperature) and 30°C, respectively. Phage adsorption was faster to elongated cells, most likely due to the longer length of the host. The surface composition of rod and elongated cells is similar in terms of outer membrane proteins and lipopolysaccharide profiles. The results of this study suggest that the change of rod cells to an elongated morphology does not prevent cells from being attacked by phages and also does not impair the phage infection.

- Scope of the work
- Aim of the work
- What you did to accomplish the aim
- Results (major results with values)
- Conclusion

Summary

BACKGROUND: *Candida albicans* is regarded as the leading of candidosis. However, *Candida glabrata* has emerged as an important pathogen of oral mucosa, occurring both singly or in mixed species infections, often with *C. albicans*. Compared with *C. albicans*, little is known about the role of *C. glabrata* in oral infection. The aim of this study was to examine single and mixed species infection of oral epithelium involving *C. glabrata* and establish its ability to invade and damage tissue.

METHODS: A reconstituted human oral epithelium (RHOE) was infected only with *C. glabrata*, or simultaneously with *C. glabrata* and *C. albicans*. The ability of both species to invade the tissue was examined using species specific peptide nucleic acid (PNA) probe hybridization and confocal laser scanning microscopy. Epithelial damage was assessed by measuring lactate dehydrogenase (LDH) activity.

RESULTS: *Candida glabrata* strains were able to colonize the RHOE, in a strain dependent manner. *Candida glabrata* single infection after 12 h, generally revealed no invasion of the RHOE, which contrasted with extensive tissue invasion demonstrated by *C. albicans*. Mixed infection showed that *C. albicans* enhanced the invasiveness of *C. glabrata*, and led to increased LDH release by the RHOE, which paralleled the observed histological damage.

CONCLUSIONS: The results obtained demonstrating enhanced invasion and increased tissue damage caused by mixed *C. glabrata* and *C. albicans* infections have important clinical significance and highlight the need to identify *Candida* species involved in oral candidosis.

J Oral Pathol Med (2011) **40**: 421–427

- Scope of the work
- Aim of the work
- What you did to accomplish the aim
- Results (major results with values)
- Conclusion

Title

- Title The title of a paper or report reflects the content of the report and is informative and short (approximately 15 words at maximum). It should also be appealing. Omit any redundant phrases, such as “a study of..” or “a report of...”.

Ex: “ “Assessment of soil erosion in Africa using remote sensing”,

Informative: it informs the reader about

1) The subject (assessment of soil erosion),
2) the location (Africa), and
3) the research method (remote sensing).

Exercise

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- Please select the most appropriate title

1. Development and Application of a Genetically Engineered Bacteriophage Carrying CRISPR-Cas Components Designed to Specifically Target and Disrupt the Horizontal Transfer of Multiple Antibiotic Resistance Plasmids
2. CRISPR-Cas–Armed Bacteriophage Suppresses Horizontal Transfer of Antibiotic Resistance Genes in Escherichia coli
3. Designer Phages Against Resistance
4. A Study of How Gene Editing in Phages Can Stop Resistance from Spreading in Bacteria
5. Supercharged Viruses That Fight Back

Exercise

- Please select the most appropriate title

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1. Development and Application of a Genetically Engineered Bacteriophage Carrying CRISPR-Cas Components Designed to Specifically Target and Disrupt the Horizontal Transfer of Multiple Antibiotic Resistance Plasmids TOO long
2. CRISPR-Cas–Armed Bacteriophage Suppresses Horizontal Transfer of Antibiotic Resistance Genes in Escherichia coli Best one!
3. Designer Phages Against Resistance (Too Vague)
4. A Study of How Gene Editing in Phages Can Stop Resistance from Spreading in Bacteria Unspecific
5. Supercharged Viruses That Fight Back (informal, not scientific).

Table 1: Highlights of common dos and don'ts when writing scientific manuscripts

Item	Dos	Don'ts
Title	Use accurate, interesting, and catchy titles. Example: "Can scientists and policymakers work together?"	Do not use titles that are too long, such as: "A multi-sectoral mixed model study to examine the facilitators and barriers in the collaboration of scientists and policymakers in joint efforts using qualitative and quantitative methods".
Abstract	Use the abstract to attract readers and summarize your story line.	Do not include content that is not found in the article.
Introduction (Why?)		
Objectives	Carefully state your objective, as everything should follow logically from the objective.	Do not leave out the objective or just tie it in loosely to the rest of the article.
Methods (How?)		
Appropriateness	Ensure and explain how the research method addresses the research objectives. Describe the methods in sufficient detail so other people can repeat the study.	Do not use a cross-sectional study to examine causal associations because it cannot. Do not state: "our study used conventional methods" without giving a reference.

Table 1: Highlights of common dos and don'ts when writing scientific manuscripts (continued)

Item	Dos	Don'ts
Results (What?)		
Sequencing	Order the sequence of information so that the Results section addresses the objective in a logical way.	Do not present results in a random fashion or include results that are irrelevant.
Other information	Include only results of your study in the Results section.	The results of other studies belong either in the introduction (to provide context) or the discussion (to compare with your results).
Use of tables and figures	Tables and figures should highlight key study findings. Text in the Results section should complement tables and figures; for example, if a table shows "relative risk=8.5, *P*=0.02", the text might read "a strong, statistically significant association was found."	Do not simply repeat data from tables and figures in the text of the Results section; for example, "the relative risk was 8.5 and the *P*-value was 0.02" is repetitive of the information already provided in the table, and provides no additional information for the readers.

		for the readers.
Discussion and conclusion (So What?)		
Main findings	The first sentence of the Discussion section should address your research objective and highlight the key findings of your study.	Do not simply summarize the results a second time without interpretation.
Unexpected results	If results contradict expectation, look for possible sources of bias, such as selection of subjects, methods of data collection and confounding factors.	Do not delete results simply because they contradict expectation. These may be the most important results of your study.
Contribution to knowledge	Describe the new knowledge provided by this study.	Do not just say “our study confirmed the results of previous studies”.
Strengths and limitations	Discuss strengths and limitations of the study in a few paragraphs.	Do not overstate the limitations but do not hide them either.
Implications	Describe how the study may inform current practice. Suggest future research directions.	Do not just say “our study has made important contributions to science”. Do not just say “this study indicates that future studies are needed”.

can we use AI no write a scientific paper?

Yes — AI can definitely help **write** a scientific paper, but with some important caveats.

Here's how it's usually used responsibly:

✅ **Brainstorming & outlining**

- Generating possible research questions or hypotheses
- Suggesting structures for introduction, methods, results, and discussion

✅ **Drafting & editing**

- Helping write clear explanations of methods or background
- Polishing language for clarity, grammar, and conciseness
- Summarizing references or related work (but you should always check the sources yourself)

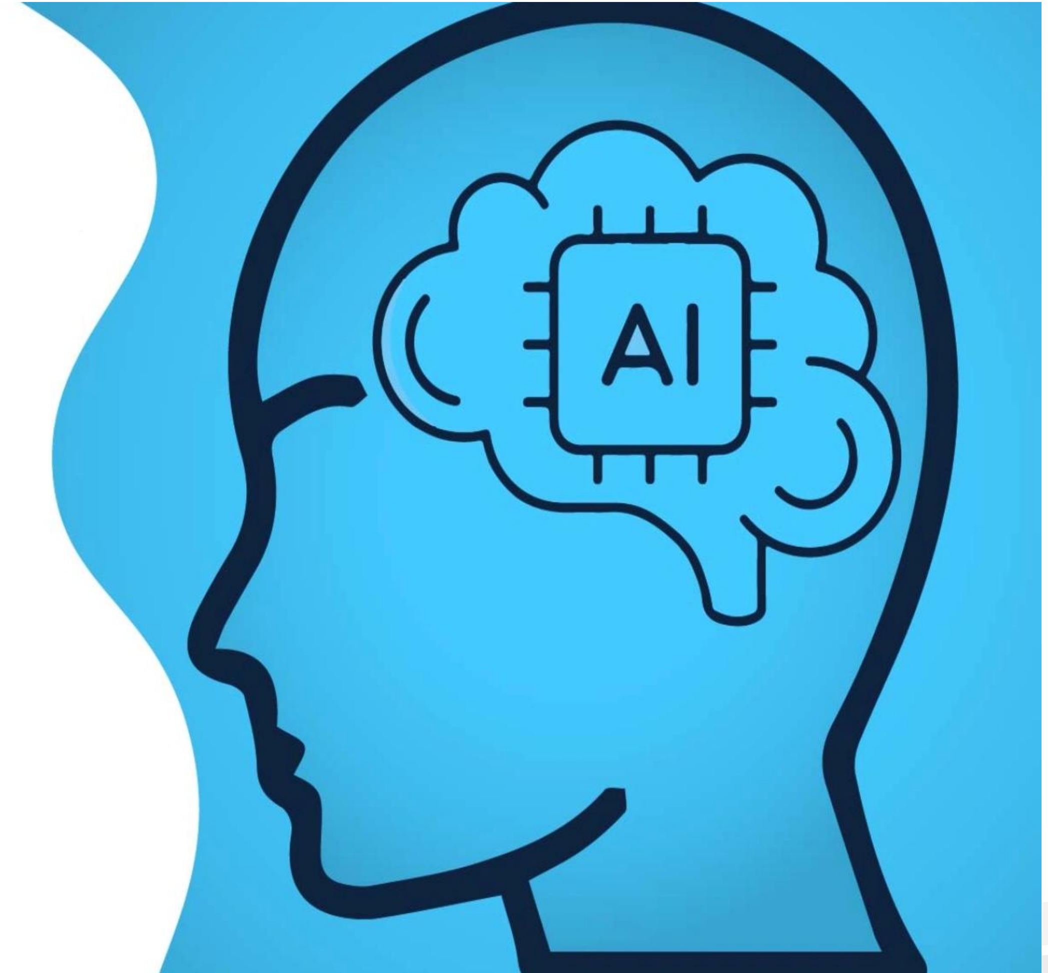
✅ **Data analysis & visualization** (with specialized AI tools)

- Running statistical analyses or coding assistance
- Producing clear graphs, tables, or figures

⚠️ **But here's what to watch out for:**

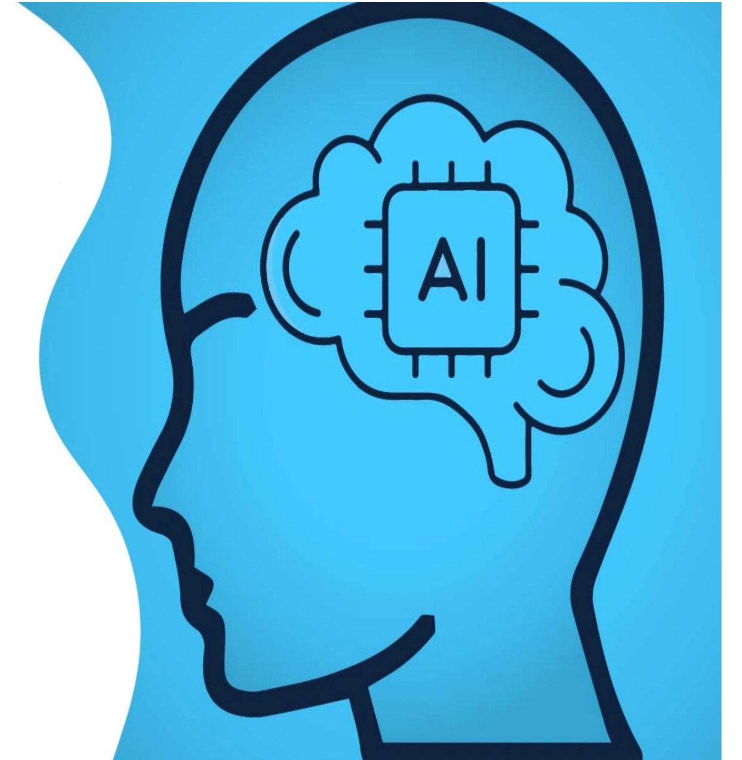
- **Factual accuracy:** AI may produce incorrect or "hallucinated" references, data, or citations. These must always be verified.
- **Originality:** Journals require original work; AI should assist, not replace, your reasoning and contributions.
- **Ethics:** Many publishers (e.g., Elsevier, Springer, Nature journals) allow AI-assisted writing *if disclosed*. They usually don't allow listing AI as an author.
- **Critical thinking:** AI can't replace your scientific insight — interpretation of results and argumentation must be yours.

👉 A good practice: Think of AI as a **very advanced assistant** — it helps with the writing, but you remain the researcher and author responsible for accuracy, originality, and ethics.



Best practices in using AI

- Always verify sources & citations
- Disclose AI use if required by journals
- Use AI as an assistant, not a substitute
- Keep critical thinking and interpretation your own



good luck!

With your writing!