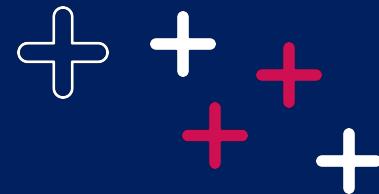


# Modeling biological systems

## A4 Santé-BIOTECH 1ST SEMESTER



# ABOUT THIS COURS

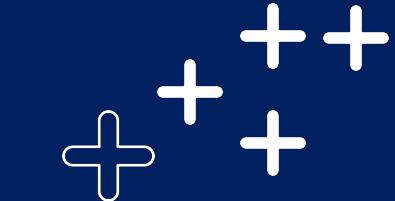
**Professor : Enzo Fabiani**

Mail : [enzo.fabiani@ext.devinci.fr](mailto:enzo.fabiani@ext.devinci.fr)

**A4 Health-BioTech - 1st semester**

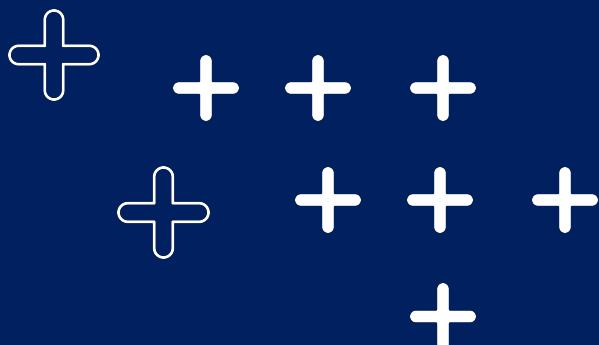
**39h : 18h Lecture + 21h small projects (divided in 2 groups)**

**Graded throughout the semester (Continuous Assessment)**



Modeling Biological Systems

# SYLLABUS

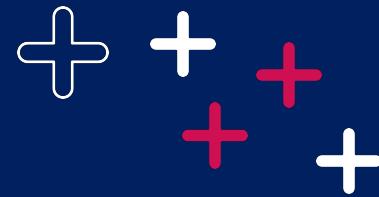


- **Introduction to Modeling (mathematical approach)**
- **Introduction to R programming and application with Swirl**
- **Writing Scientific Results and Presenting**
- **Modeling biological systems**
  - Discrete and Continuous time models (deterministic and stochastic)
  - Ordinary Differential Equations (ODE)
  - Euler's methods and more
  - Lotka-Volterra (predator-pray)
  - Monte Carlo Methods
  - Markov chains
- **Application to cancer modeling (active matter approach)**

# 1

## Introduction to Modeling

# DEFINITIONS



**A model** is a description of a system

**A system** is any collection of interrelated objects

**An object** is some elemental unit upon which observations can be made, but whose internal structure either does not exist or is ignored

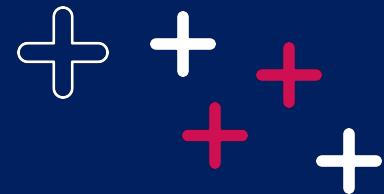


**Systems** are anything humans wish to discuss

**Models** are one tool that facilitates the discussion



# TYPES OF MODELS



## Conceptual/ Verbal

Description in a natural language



## Physical

A real, physical mock-up of a real system or object



## Diagrammatic

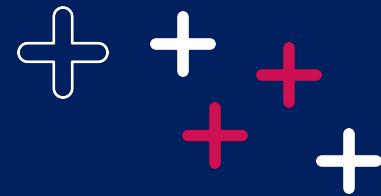
Graphical representations of the objects and relations



$$fx$$

## Formal

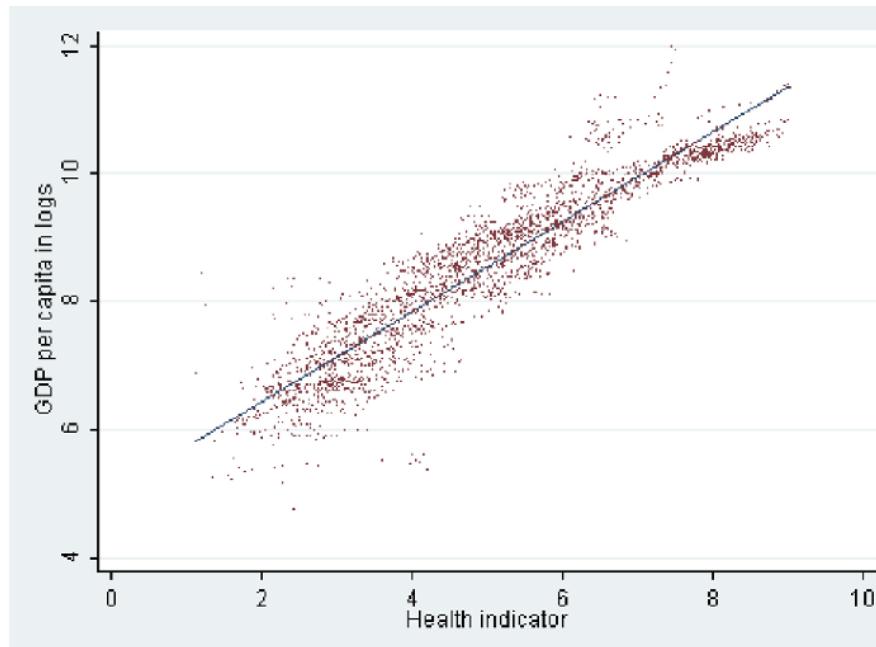
Mathematical representation with equations



# FIXED OR THROUGH TIME

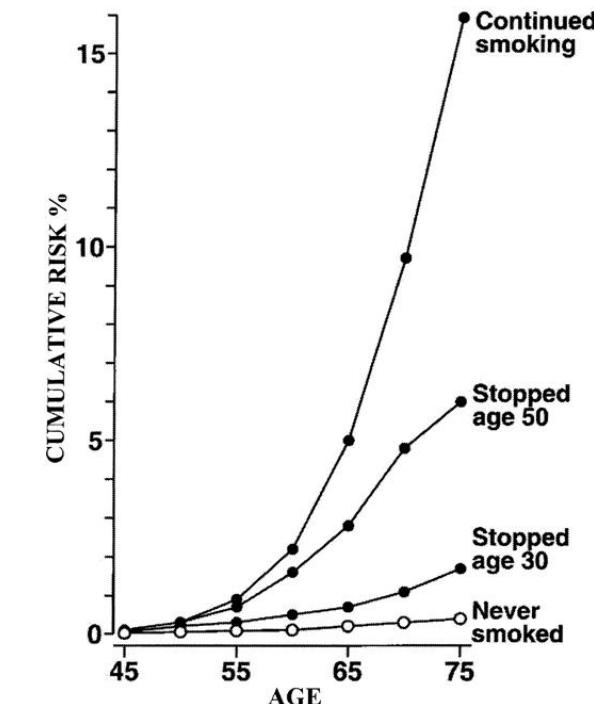
## « Frozen »

Elements of the system are correlated, how ?

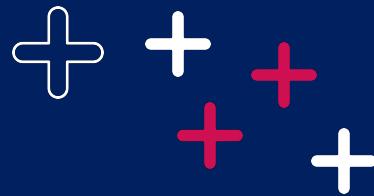


## Dynamic

Time is a key element of our problem



# INTRODUCTION TO MODELING DYNAMIC SYSTEMS



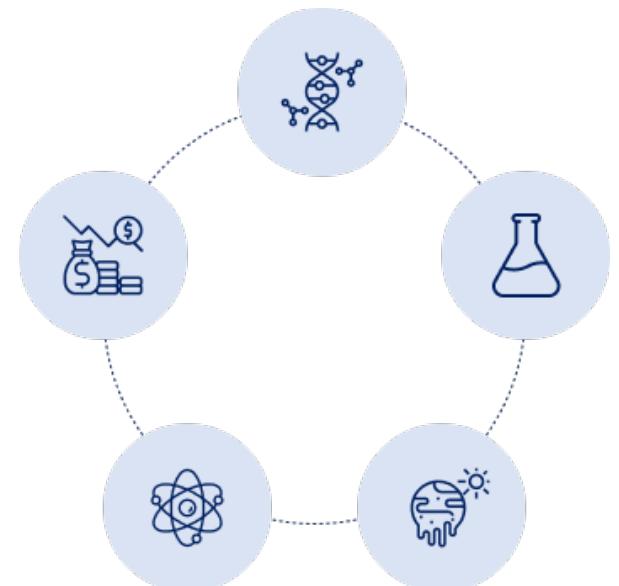
**Dynamic systems** are systems where one or several variables change through time according to certain rules

Examples in Biology

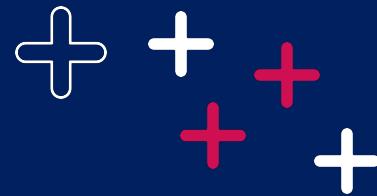
- *Ecological models for how the size of a population changes through time*
- *Epidemiological models for how the prevalence of a disease within a host population changes through time*
- *Evolutionary models for how the frequency of a gene changes through time*

But not only

- *Physics (e.g., change in the numbers of different types of atoms during nuclear fusion)*
- *Chemistry (change in number of molecules during chemical reactions)*
- *Climate science (e.g., change in temperature through time)*
- *Economics (change in stock prices)*
- *Linguistics (change in word use through time)*



# TYPES OF MODELS



1

## Predictive models

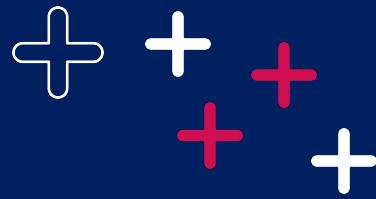
- Models can be used to make concrete, quantitative predictions about the future
- Predictive models require much more information about the system on which predictions are made

2

## “Proof of concept” models

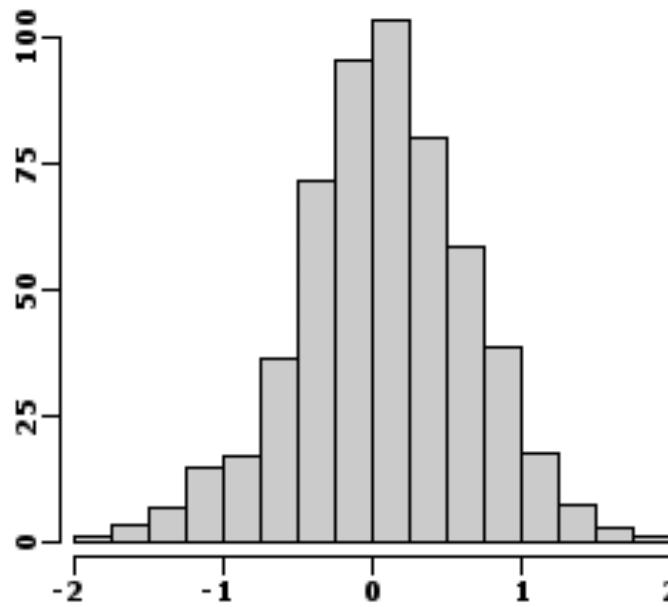
- General understanding
- Proofs that some hypotheses explain a given behavior (theoretical or not)
- Do not include a complete proof that the natural phenomenon
- Not purely predictive in general but may aim at quantitative predictions

# TYPES OF MODELS



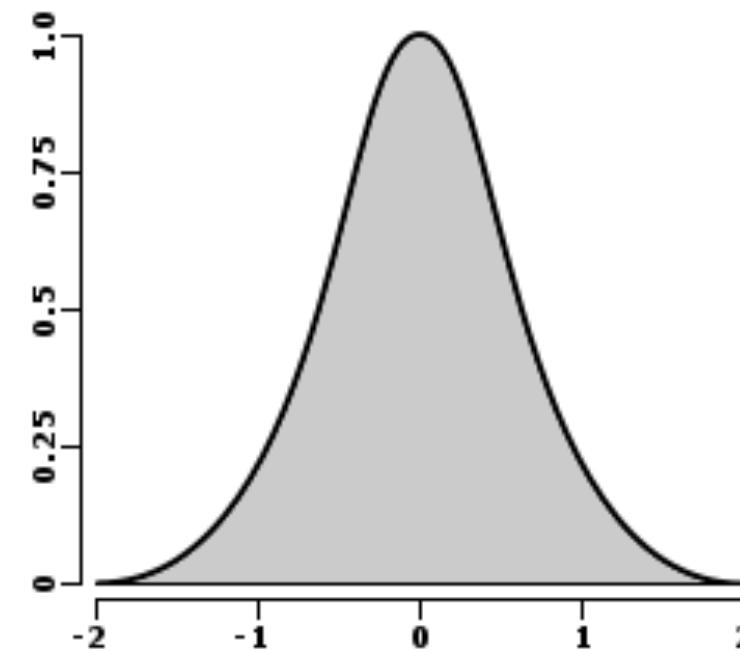
## Discrete

Time proceeds in a step-wise manner



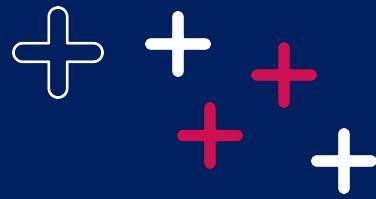
## Continuous

Assume that time is a real number



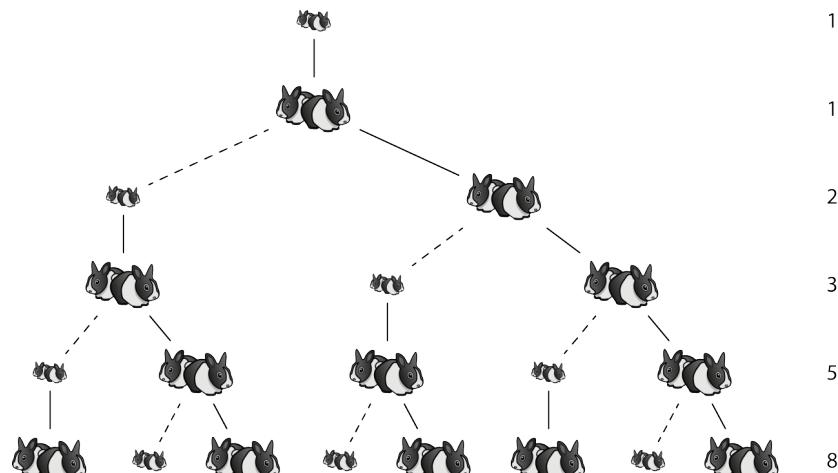
# INTRODUCTION TO MODELING

# TYPES OF MODELS



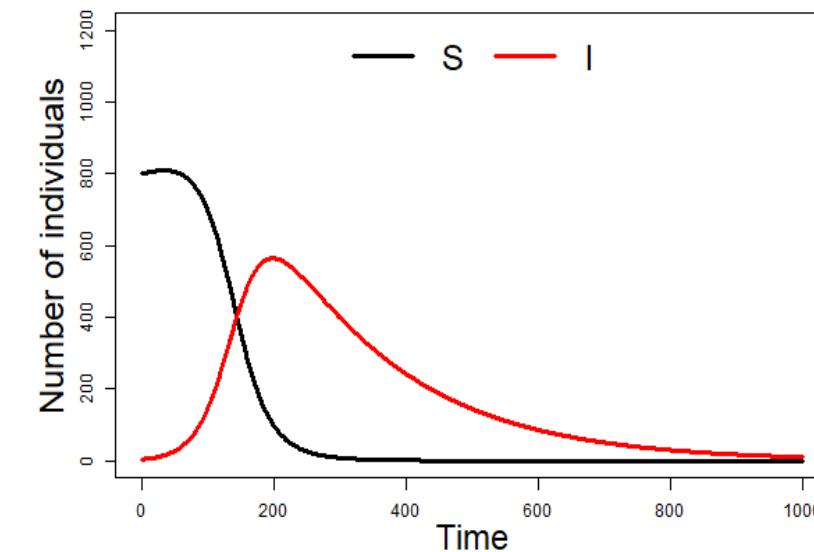
## Discrete

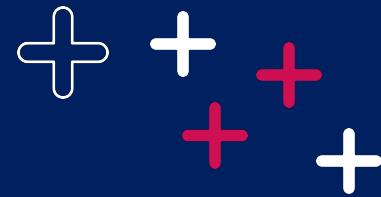
Time proceeds in a step-wise manner



## Continuous

Assume that time is a real number

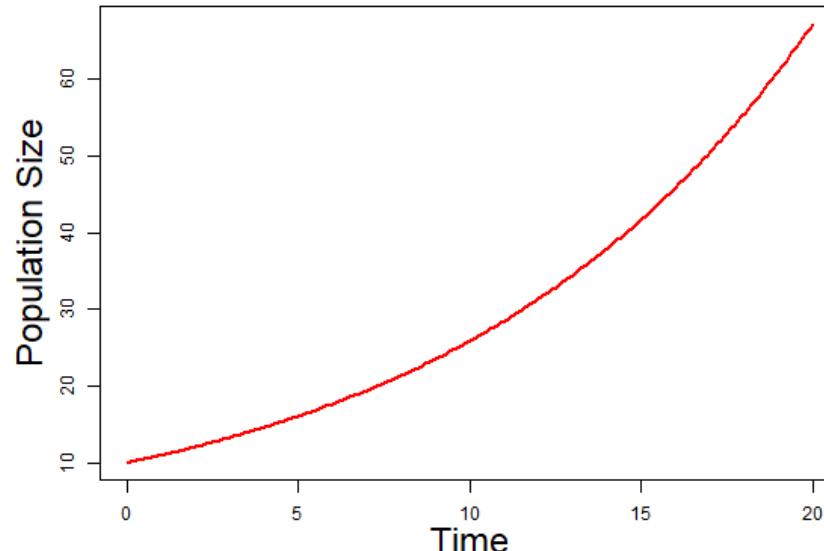




# TYPES OF MODELS

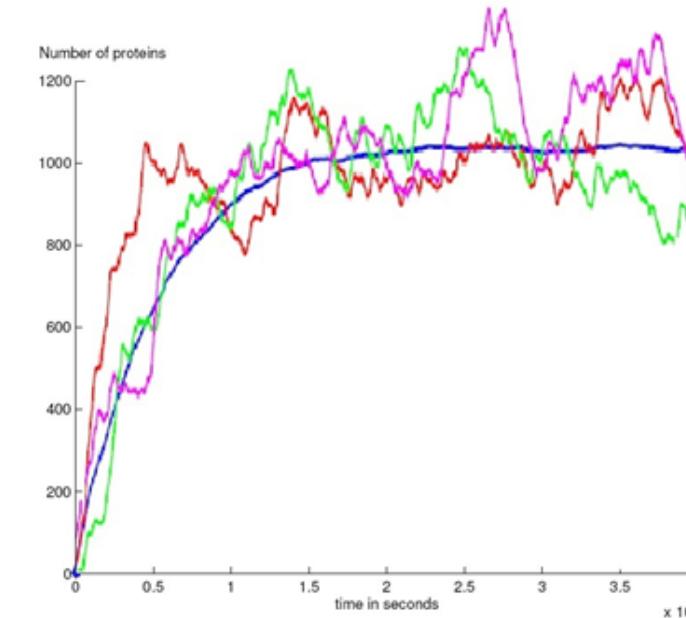
## Deterministic

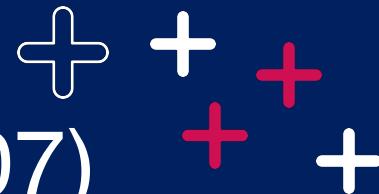
- Once all parameters and initial conditions are set, the variables change in a mechanical, "predestined" manner
- Multiple iterations of the model produce exactly the same outcome**



## Stochastic

- Some variables are random numbers
- Each iteration of the model may therefore produce a different outcome**





# BUILDING A MODEL (OTTO AND DAY, 2007)

1

## Formulate the question

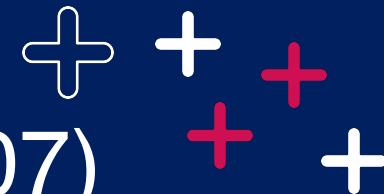
- In any research project, the first step is to state clearly your **goal**
- You will build your model depending on the system and the problem you are trying to solve

2

## Determine the model ingredients

- The most fundamental ingredient of your model are your **variables**
- A system can become complex, what part can you get rid of, and what part you cannot?
- Think about the **range of values** that are biologically plausible for your variable(s)
- Choose how time should be represented in your model (**discrete or continuous**)
- Will your model be **deterministic or stochastic?**
- Determine which **parameters** your model should include
- Add complexity, step by step

# BUILDING A MODEL (OTTO AND DAY, 2007)



3

## Describe the model qualitatively

- Draw diagrams or flow charts to provide a visual aid
- Make sure you have sufficient clarity about how the model should work

4

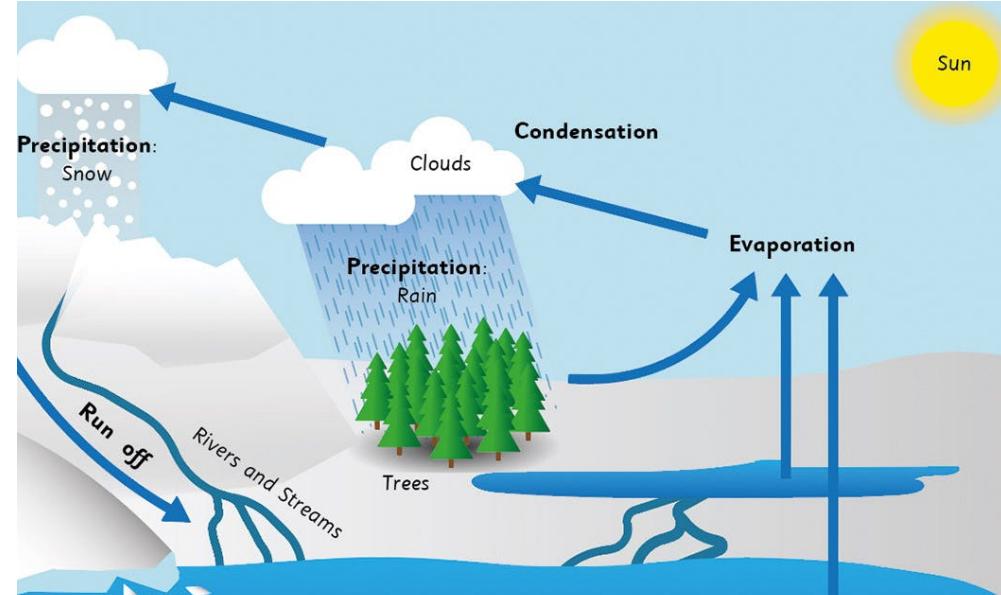
## Analytical analysis (theory)

- Write down the equations or the rules governing your system (must define your dynamical model)
- Might be recursive equations, differentials ...
- See what is done in this field or bring new perspectives

5

## Numerical analysis

- Implement the model in a programming language
- Simulate how the variables change through time



$$P + I = ET + Inf + R + \Delta S$$

Where:

The incoming water balance components:

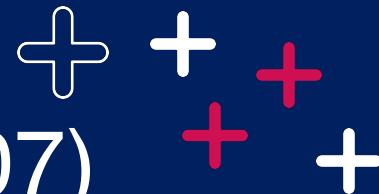
**P** - precipitation (including snow)  
**I** - irrigation

The outgoing water balance components are:

**ET** - Evapotranspiration  
**Inf** - Infiltration of water  
**R** - Surface runoff (natural) or surface drainage (artificial)

$\Delta S$  is the change of water storage

# BUILDING A MODEL (OTTO AND DAY, 2007)



6

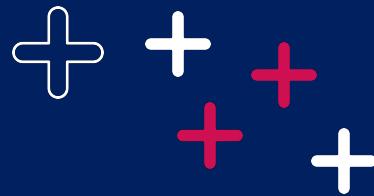
## Checks and balances

- Initial analyses may reveal mistakes in the model, or identify undesirable features of your model

7

## Relate the results back to the question

- Now that your model works and you obtained a good understanding of its behavior, you can relate the results to reality
- What does your model tell you about how the biological system that you studied should behave?

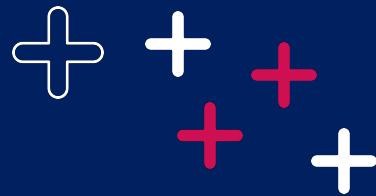


## A publication on mathematical modeling for living organisms

Maël Montévil. *A Primer on Mathematical Modeling in the Study of Organisms and Their Parts.* Bizzarri M. Methods in Molecular Biology

« Mathematical modeling is a very powerful tool to understand natural phenomena. Such a tool carries its own assumptions and should always be used critically. [...] we highlight the key ingredients and steps of modeling and focus on their biological interpretation. [...] we discuss the role of theoretical principles in writing models. We also highlight the meaning and interpretation of equations [...] to facilitate the interaction between biologists and mathematical modelers. »

# COMPUTING APPLICATION



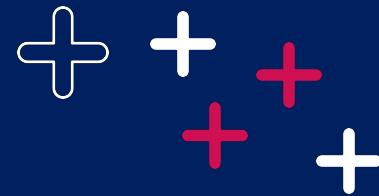
**Please for next time**

- Download R and Rstudio (IDE)
  - Who has used this language before?
  - Who prefers to use Python ?
- Download the Swirl library

2

# WRITING SCIENTIFIC RESULTS

## SCIENTIFIC PUBLISHING



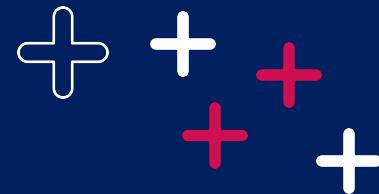
# GENERALITIES

## How to chose the journal ?

- Domain of study
- Argument
- Impact factor
- Rapidity of reviewing
- Sometimes: language, and by extension, target public

## How to evaluate the validity of a published article ?

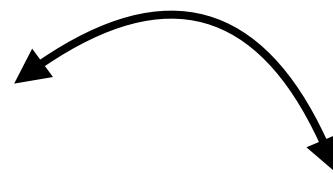
- Peer reviewing
- Impact factor and references used

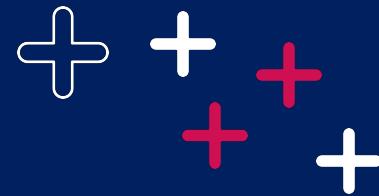


# GENERALITIES

## Classic procedure

- Choose your journal
- Log into the journal page
- Follow their « Author instructions »
- Write the article and send it to the co-authors
- Submit to the journal (long)
- Wait
- Receive the reviews (minor or major)
- Point-by-point response to the referees/reviewers : can loop



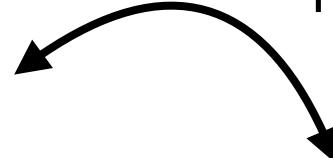


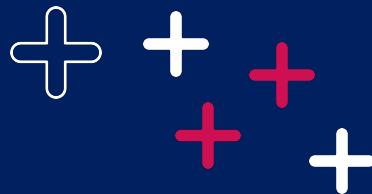
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Process can be long





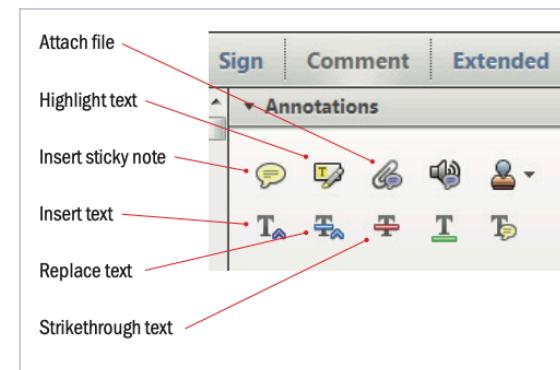
# REMARKS

- Reviewers ask for data, so it is recommended to keep them accessible easily and quick
- Graphs can be modified many times during the publishing process : automation of how graphics are generated is therefore recommended
- There is a convention in reviewing and correcting articles

Please follow these instructions to mark changes or add notes to your proof. You can use Adobe Acrobat Reader (download the most recent version from <https://get.adobe.com>) or an open source PDF annotator.

For Adobe Reader, the tools you need to use are contained in **Annotations** in the **Comment** toolbar. You can also right-click on the text for several options. The most useful tools have been highlighted here. If you cannot make the desired change with the tools, please insert a sticky note describing the correction.

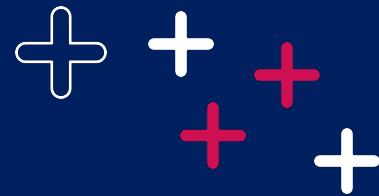
Please ensure all changes are visible via the 'Comments List' in the annotated PDF so that your corrections are not missed.



**Do not attempt to directly edit the PDF file as changes will not be visible.**

## PRESENTING SCIENTIFIC RESULTS

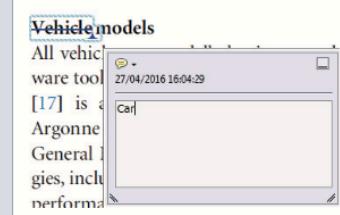
## PEER REVIEWING



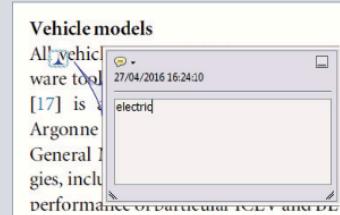
- Example :

**Replacing text**

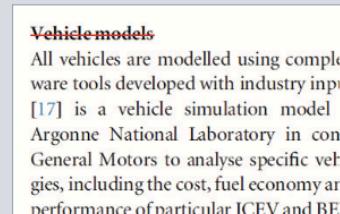
To replace text, highlight what you want to change then press the replace text icon, or right-click and press 'Add Note to Replace Text', then insert your text in the pop up box. Highlight the text and right click to style in bold, italic, superscript or subscript.

**Inserting text**

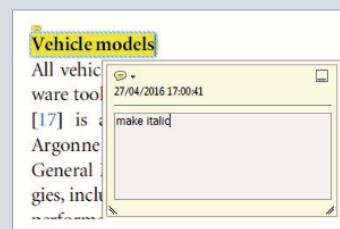
Place your cursor where you want to insert text, then press the insert text icon, or right-click and press 'Insert Text at Cursor', then insert your text in the pop up box. Highlight the text and right click to style in bold, italic, superscript or subscript.

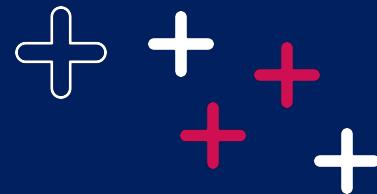
**Deleting text**

To delete text, highlight what you want to remove then press the strikethrough icon, or right-click and press 'Strikethrough Text'.

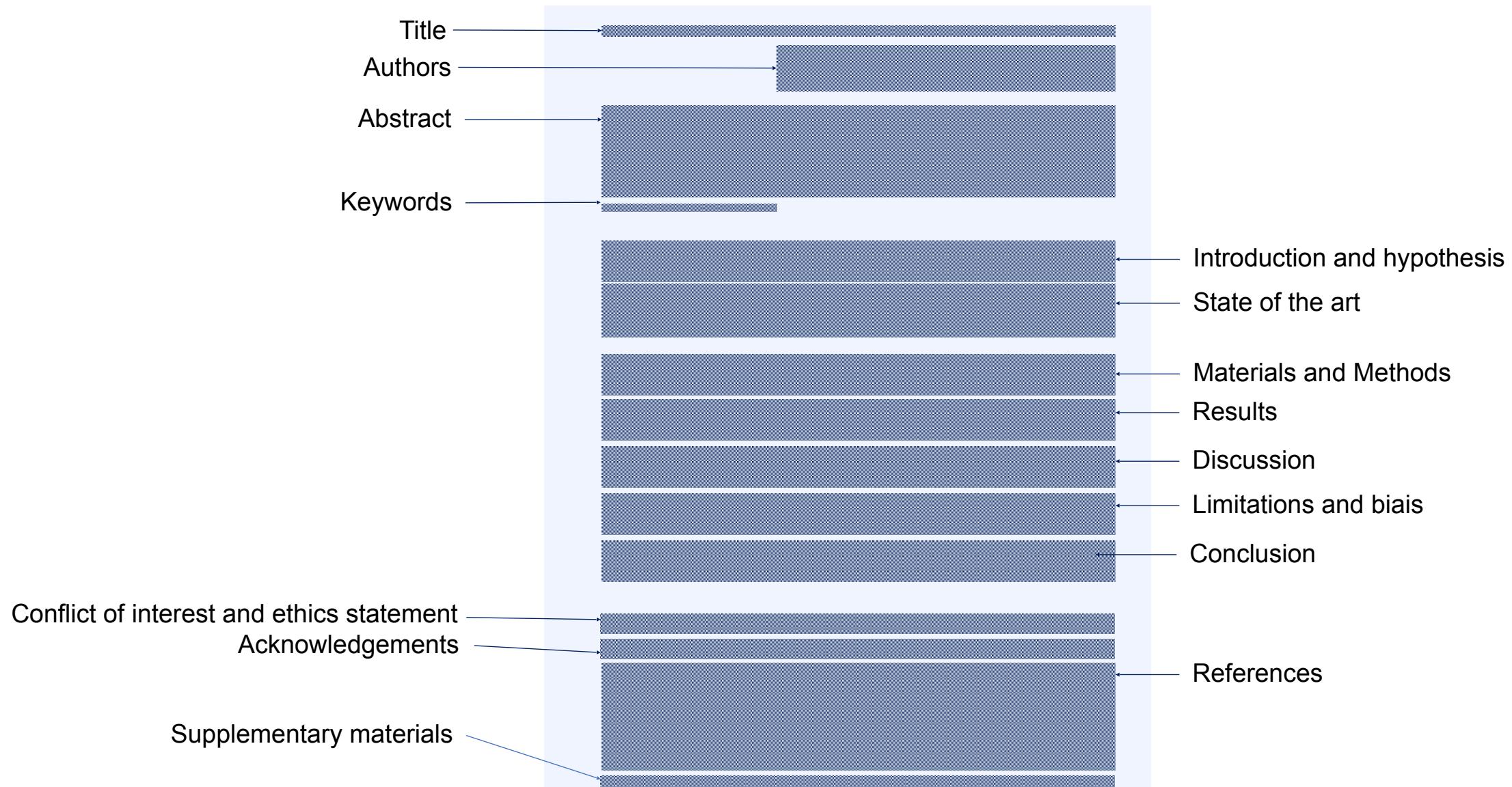
**Highlighting text**

To highlight text, with the cursor highlight the selected text then press the highlight text icon, or right-click and press 'Highlight text'. If you double click on this highlighted text you can add a comment.

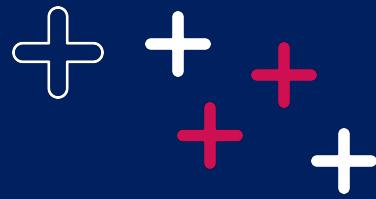




# STANDARD STRUCTURE OF AN ARTICLE



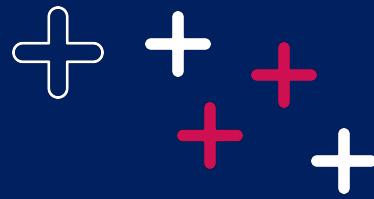
# TITLE



- Has to be extremely accurate
- Can be really specific

Let's brainstorm with an abstract !

# TITLE

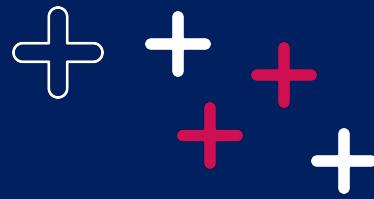


- Has to be extremely accurate
- Can be really specific

## Abstract

Experimental studies of cell motility in culture have shown that under adequate conditions these living organisms possess the ability to organize themselves into complex structures. Such structures may exhibit a synergy that greatly increases their survival rate and facilitate growth or spreading to different tissues. These properties are even more significant for cancer cells and related pathologies. Theoretical studies supported by experimental evidence have also shown that adhesion plays a significant role in cellular organization. Here we show that the directional persistence observed in polarized displacements permits the formation of stable cell aggregates in the absence of adhesion, even in low-density regimes. We introduce a discrete stochastic model for the dispersal of polarized cells with exclusion and derive the hydrodynamic limit. We demonstrate that the persistence coupled with the cell-cell exclusion hinders the cellular motility around other cells, leading to a non-linear diffusion which facilitates their capture into larger aggregates.

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Experimental studies of cell motility in culture have shown that under adequate conditions these living organisms possess the ability to organize themselves into complex structures. Such structures may exhibit a synergy that greatly increases their survival rate and facilitate growth or spreading to different tissues. These properties are even more significant for cancer cells and related pathologies. Theoretical studies supported by experimental evidence have also shown that adhesion plays a significant role in cellular organization. Here we show that the directional persistence observed in polarized displacements permits the formation of stable cell aggregates in the absence of adhesion, even in low-density regimes. We introduce a discrete stochastic model for the dispersal of polarized cells with exclusion and derive the hydrodynamic limit. We demonstrate that the persistence coupled with the cell-cell exclusion hinders the cellular motility around other cells, leading to a non-linear diffusion which facilitates their capture into larger aggregates.

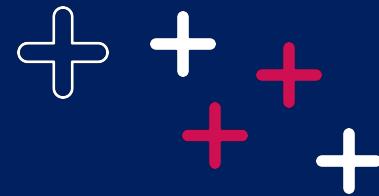
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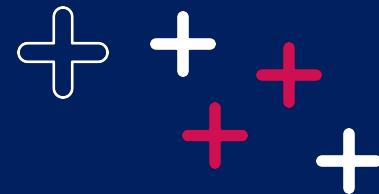


# TITLE

- Has to be extremely accurate
- Can be really specific

The title given at the end of the day:

**Dispersal and organization of polarized cells: non-linear diffusion and cluster formation without adhesion**



# AUTHORS

- Affiliations of each authors must be mentioned
- Sometimes there is an order in writing names
- Contribution in the project

**Young-Ju Kang<sup>1,†</sup>, In Cheul Jeung<sup>2,†</sup>, Arum Park<sup>1,3</sup>, Young-Jun Park<sup>1,3</sup>, Haiyoung Jung<sup>1,3</sup>, Tae-Don Kim<sup>1,3</sup>, Hee Gu Lee<sup>4</sup>, Inpyo Choi<sup>1,3</sup> and Suk Ran Yoon<sup>1,3,\*</sup>**

<sup>1</sup>Immunotherapy Research Center, Korea Research Institute of Bioscience and Biotechnology, Yuseong-gu, Daejeon 305-806, Republic of Korea

<sup>2</sup>Department of Obstetrics and Gynecology, College of Medicine, The Catholic University of Korea, Jung-gu, Daejeon 301-723, Republic of Korea

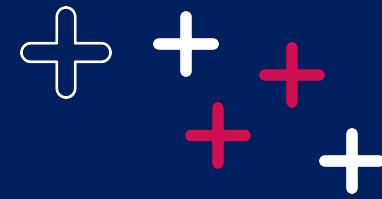
<sup>3</sup>Department of Functional Genomics, University of Science & Technology, Yuseong-gu, Daejeon 305-350, Republic of Korea <sup>4</sup>Medical Genomics Research Center, Korea Research Institute of Bioscience and Biotechnology, Yuseong-gu, Daejeon 305-806, Republic of Korea

\*Correspondence address. E-mail: sryoon@kribb.re.kr

## Authors' roles

Y.-J.K. performed all experiments, analyzed the data and wrote the manuscript. I.C.J. conducted clinical evaluations and collected samples. A.P. assisted with sample preparation and flow cytometry analysis. Y.-J.P., T.-D.K., H.J., H.G.L. and I.C. provided helpful discussion and critical analysis of data. S.R.Y. supervised the overall project, analyzed the data and wrote the manuscript.

# ABSTRACT



- Probably the most important part
- **Usually the only part most people will read**
- Present all the major information of the paper :
  - Problematic
  - Hypothesis
  - Results
  - Conclusion
- Written in the language of the article, and in English if the language is different (rare)
- In this case : really detailed and explicit

**STUDY QUESTION:** Is the decreased natural killer (NK) cell cytolytic activity in the peritoneal fluid (PF) of endometriosis patients due to primary cytokine activity?

**SUMMARY ANSWER:** An increased level of interleukin-6 (IL-6) in the PF of patients with endometriosis suppresses NK cell cytolytic activity by down-regulating cytolytic granule components, such as granzyme B and perforin, through the modulation of Src homology region 2-containing protein tyrosine phosphatase-2 (SHP-2) expression.

**WHAT IS ALREADY KNOWN:** Endometriosis is known to be related to a defect in NK cell cytolytic activity. Additionally, the levels of inflammatory cytokines are elevated in the PF of women with endometriosis.

**STUDY DESIGN, SIZE, DURATION:** The effects of PF on the differentiation and functional activity of NK cells were investigated in patients with or without endometriosis, and cytokines that reduce NK cell cytolytic activity in endometriosis patients were examined. The study included women who underwent laparoscopic examination for the diagnosis of endometriosis from August 2012 to July 2013 (33 women with, and 15 women without, endometriosis).

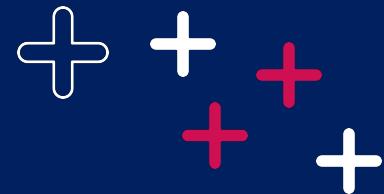
**PARTICIPANTS/MATERIALS, SETTING, METHODS:** Women of reproductive age (20–40 years old) who underwent laparoscopic examination for endometriosis were included. Cytokines present in the PF were identified by enzyme-linked immunosorbent assay. The cytolytic activity of NK cells in the PF was also analyzed using a calcein-acetoxy methyl ester (AM) release assay.

**MAIN RESULTS AND THE ROLE OF CHANCE:** PF from patients with endometriosis suppressed the differentiation and cytotoxicity of NK cells compared with PF from controls ( $P < 0.05$ ). Increased levels of IL-6 were also found in the PF of patients with endometriosis ( $P < 0.01$ ), and IL-6 levels were negatively correlated with the cytolytic activity of NK cells ( $r_s = -0.558$ ,  $P = 0.03$ ). Furthermore, IL-6 reduced the cytolytic activity of NK cells, concomitantly with the down-regulation of granzyme B and perforin ( $P < 0.05$ ), by modulating SHP-2. Importantly, the addition of anti-IL-6 to the PF of endometriosis patients restored the activity of NK cells ( $P < 0.01$ ), suggesting that IL-6 plays a crucial role in the reduction of NK cell activity in the PF of patients with endometriosis.

**LIMITATIONS, REASONS FOR CAUTION:** PF contains various inflammatory cytokines in addition to IL-6 and so it is possible that other cytokines may affect the differentiation and activity of NK cells.

**WIDER IMPLICATIONS OF THE FINDINGS:** Our results imply that the suppression of IL-6 using an anti-IL-6 antibody or soluble IL-6 receptor could rescue the impairment of NK cell activity in patients with endometriosis.

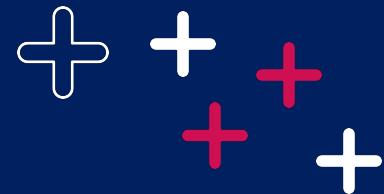
# ABSTRACT



- In general : in one single block and subparts are implicit

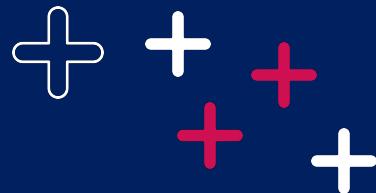
**Abstract :** Experimental studies of cell motility in culture have shown that under adequate conditions, these living organisms possess the ability to organize themselves into complex structures. Such structures may exhibit a synergy that greatly increases their survival rate and facilitates growth or spreading to different tissues. These properties are even more significant for cancer cells and related pathologies. Theoretical studies supported by experimental evidence have also shown that adhesion plays a significant role in cellular organization. Here, we show that the directional persistence observed in polarized displacements permits the formation of stable cell aggregates in the absence of adhesion, even in low-density regimes. We introduce a discrete stochastic model for the dispersal of polarized cells with exclusion and derive the hydrodynamic limit. We demonstrate that the persistence coupled with the cell–cell exclusion hinders the cellular motility around other cells, leading to a non-linear diffusion which facilitates their capture into larger aggregates.

# KEYWORDS



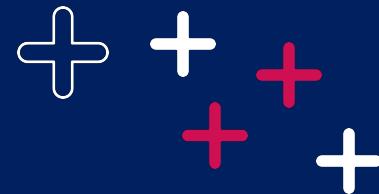
- Helps find relevant articles
- Useful when you look for a publication on a specific subject
- Useful to make sure your work will be found

**Key words:** IL-6 / natural killer cell / cytotoxicity / endometriosis / SHP-2



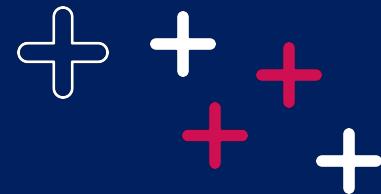
# INTRODUCTION AND HYPOTHESIS

- Present the context of your research
- Present your population or the problematic you're working on
- The problem should lead to the idea of a better solution : your hypothesis



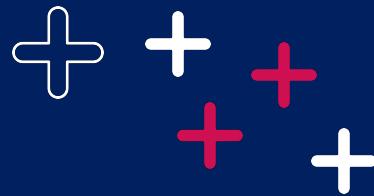
# STATE OF THE ART

- Describe the existing literature on your subject : why it relates to what is in the article and why previous works did not answer your problematic
- This part is needed to prove you've done enough research to understand the issue and the current limitations, and basically to make sure you're not reinventing the wheel
- It sometimes take a previous work to go further (of author's research group or other research groups)



# MATERIALS AND METHODS

- Material (medical device, computer specification like #cores/CPU/GPU, ...)
- Method : your experiment, your protocol, your software, your equations ...
- Data : either existing or created during the study, with specifications as well, ...
- Statistical tests, metrics used, number of participants
- ...



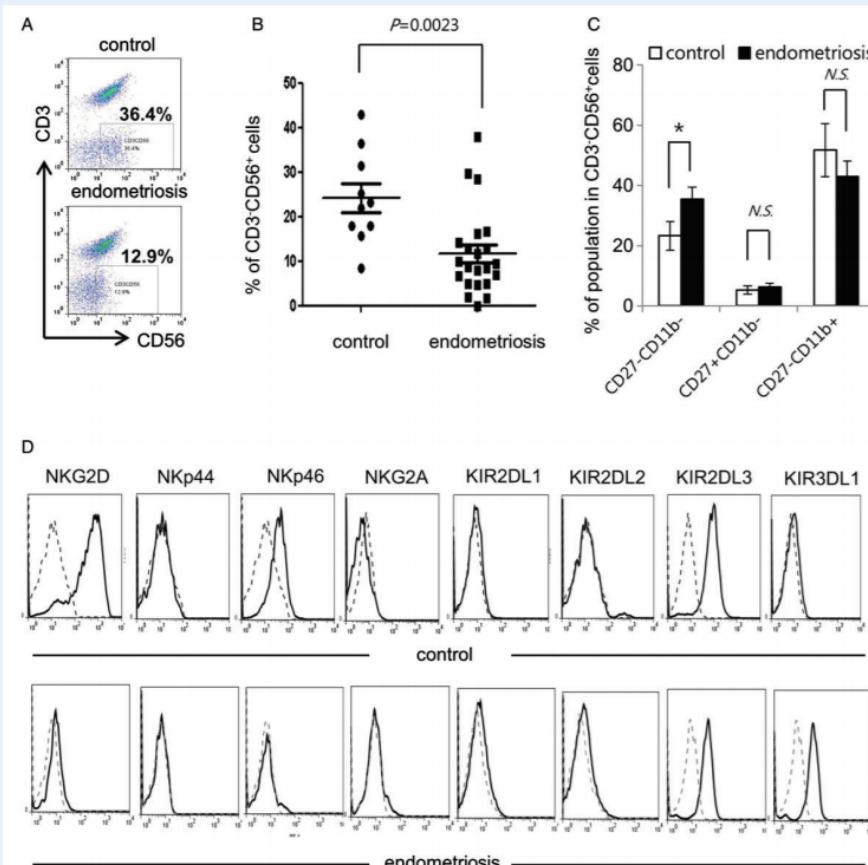
# RESULTS

- Give the result of all your experiment. Any protocol you described earlier, any questionnaire or measure, will appear in this section
- You will give a detailed explanation about the results in the next part, this section is mostly here to state them, in a clear manner.
- Any kind of visual is appreciated (graphs, tables, ...) but are of 2 types : figures and tables

## PRESENTING SCIENTIFIC RESULTS

## RESULTS

Example :



**Table I** Lineage distribution in the peritoneal fluid of patients with endometriosis and controls.

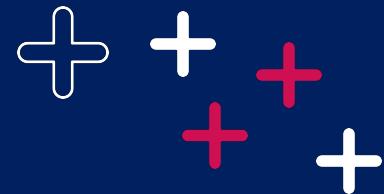
	Phenotype	Control (%)	Endometriosis (%)
T cells	CD3	27.25 ( $\pm$ 5.56)	27.25 ( $\pm$ 5.56)
T cells	CD4	54.75 ( $\pm$ 6.95)	55.7 ( $\pm$ 5.51)
T cells	CD8	18.73 ( $\pm$ 5.24)	15.06 ( $\pm$ 2.62)
B cells	CD19	2.79 ( $\pm$ 1.72)	1.67 ( $\pm$ 0.37)
Macrophage	CD16	25.3 ( $\pm$ 5.06)	34.01 ( $\pm$ 4.88)
Macrophage	CD11b	54.68 ( $\pm$ 7.73)	67.02 ( $\pm$ 2.14)
Monocyte	CD14	31.72 ( $\pm$ 6.78)	40.00 ( $\pm$ 4.27)
Neutrophils	CD15	0.30 ( $\pm$ 0.06)**	1.69 ( $\pm$ 0.39)**
NK cells	CD3 <sup>-</sup> CD56 <sup>+</sup>	24.07 ( $\pm$ 3.26)**	13.91 ( $\pm$ 2.56)**
DCs	CD14 <sup>+</sup> CD11c <sup>+</sup>	31.65 ( $\pm$ 6.14)	38.65 ( $\pm$ 4.63)

Data are presented as the mean  $\pm$  SEM (control:  $n = 10$ , endometriosis:  $n = 23$ ).

P-values were calculated using a two-tailed unpaired Mann–Whitney U-test.

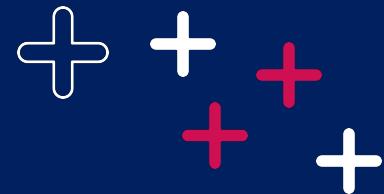
\*\*Significant difference between groups,  $P < 0.01$ .

# DISCUSSION



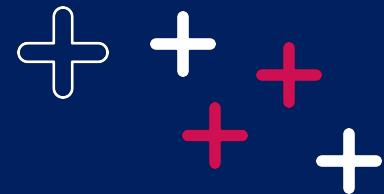
- Analyze your results : what kind of information can you extract
- Limit your analysis
- Link your results to your problematic and your hypothesis
- Compare your results with the literature (= state of the art)

# LIMITATIONS AND BIAS

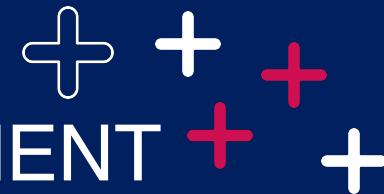


- « Tricks » that you used to obtain your results
- Potential bias in your results (« side effects »)
- Ideas to improve your results / Next step (already on track in general !)

# CONCLUSION



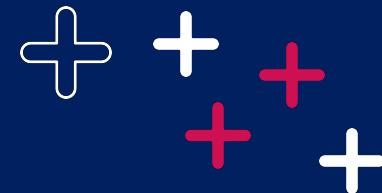
- Reminder of the major results
- Link the result with your hypothesis and your problematic
- Use the limitation section to propose future hypothesis and new research orientation
- **Usually the last part people read** (sometimes the only part ...), so use it to put the main results in evidence



# CONFLICTS OF INTEREST AND ETHICS STATEMENT

- Author's other affiliation, for example : also working in a private company
- Fundings/Grants for the project (« who paid? » correlation)
- Ethics committee

**STUDY FUNDING/COMPETING INTEREST(s):** This work was supported by the KRIBB Creative Research Program (KCS3051312); the STP project (DTM0111221) of the Ministry of Knowledge & Economy and the Basic Science Research Program (RBM0271312) of the National Research Foundation of Korea (NRF) from the Ministry of Education, Science & Technology. There are no conflicts of interest.



# ACKNOWLEDGEMENTS AND FUNDING

- Source of funding
- Labs or company affiliated
- Provider of data
- Every big entity that made this research possible

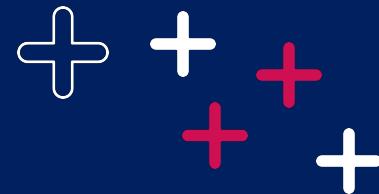
## Acknowledgements

We thank Hyang Ran Yoon (Medical Genomics Research Center, KRIBB) for technical assistance with confocal microscope.

## Funding

This work was supported by the KRIBB Creative Research Program (KCS3051312), the STP project (DTM01111221) of the Ministry of Knowledge & Economy and the Basic Science Research Program (RBM0271312) of the National Research Foundation of Korea (NRF) from the Ministry of Education, Science & Technology.

# REFERENCES



- Present in your entire article
- Bibliography at the end
- Style depending on the field (different styles : APA, Chicago, NLM etc ...)
- 

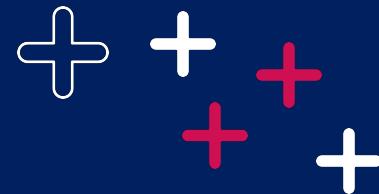
In text, depending on the style :

- Lorem ipsum<sup>1</sup>
- Lorem ipsum [1]
- Lorem ipsum (*Allan et al, 2010*)

At the end :

## References

- Allan DS, Rybalov B, Awong G, Zuniga-Pflucker JC, Kopcow HD, Carlyle JR, Strominger JL. TGF-beta affects development and differentiation of human natural killer cell subsets. *Eur J Immunol* 2010;40:2289–2295.
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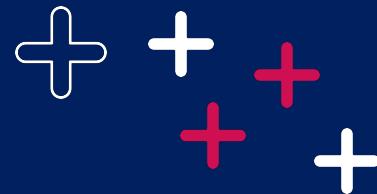


# SUPPLEMENTARY MATERIALS

- Detailed graphs
- Datasets associated
- ... Any information potentially useful for the reader to understand, reproduce or follow your work

## Supplementary data

Supplementary data are available at <http://humrep.oxfordjournals.org/>.

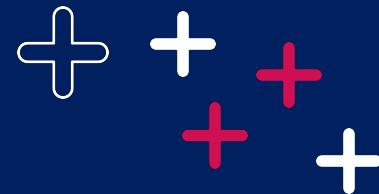


# FINDING AND USING SCIENTIFIC ARTICLES

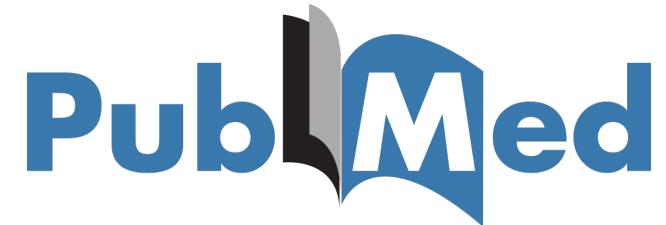
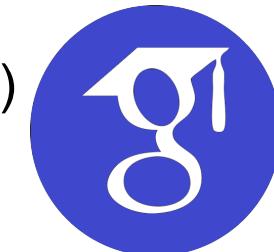
- To solve complex issues, you will need to search thoroughly throughout the literature
- You will present all the sources of your findings in a bibliography
- Bibliographies can include :
  - Scientific article
  - Books
  - Patents
  - ...
- Bibliography tools :
  - EndNote
  - Zotero
  - JabRef,
  - ...



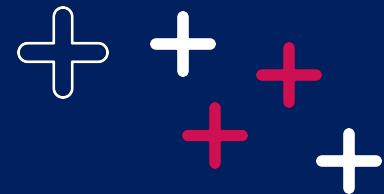
# FINDING AND USING SCIENTIFIC ARTICLES



- Search engines
  - Mendeley
  - Google Scholar
  - PubMed
  - HAL (French and free)
  - ArXiv (careful because it is pre-publication!)
  - ...
- Keywords :
  - As stated before, they help you find an article on a specific subject of interest

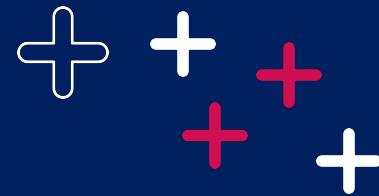


# FINDING AND USING SCIENTIFIC ARTICLES



## Identifiers

- Online publication :
  - DOI or Digital Object Identifier (<https://doi.org/10.XXXX/XXXX...>)
  - PMID (XXXXXX)
  - ...
- Books :
  - ISBN (X-XXXX-XXXX-X or XXX-X-XXXX-XXXX-X)
- Magazines :
  - ISSN (XXXX-XXXX)



# Exercises

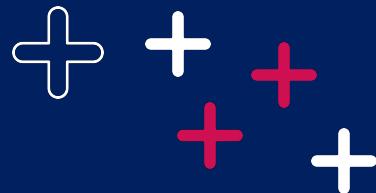
## Comment participer ?



-  1 Connectez-vous sur [www.wooclap.com/SCIENPUB](http://www.wooclap.com/SCIENPUB)
  -  2 Vous pouvez participer
- 
-  1 Pas encore connecté ? Envoyez @SCIENPUB au 06 44 60 96 62
  -  2 Vous pouvez participer

# 3

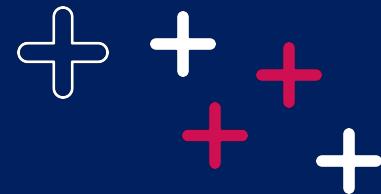
## PRESENTING SCIENTIFIC RESULTS CONFERENCES



# ADVICES FOR YOUR PRESENTATIONS

## Generalities / Timing

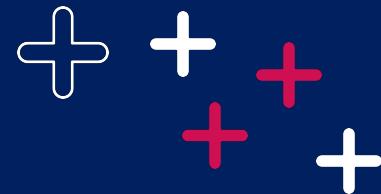
- Adapt your content
- Be **synthetic** : only show details if it is **relevant**
- **1 min / 1 slide** is a good ratio in general



# ADVICES FOR YOUR PRESENTATIONS

## Slides I : Make the presentation understandable to everyone

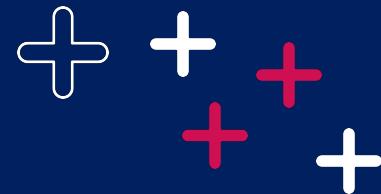
- Put an intro / **context**
- Clearly explain the problem to be solved
- Do not use specific vocabulary (or define acronyms before etc...)
- Conclude by **summarizing** the essential points
- Open up (perspectives) by explaining what could be done to improve the study/  
to go further



# ADVICES FOR YOUR PRESENTATIONS

## Slides II : do not be boring for the audience

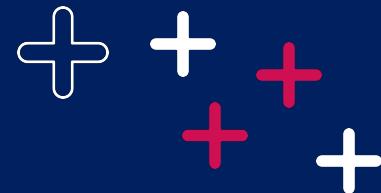
- Pay attention to the aesthetics of the slides (choice of background / font)
- Use visual elements (graphs/illustrations etc.) but **explain** them
- Make logical transitions between the slides (connect them to the oral presentation)
- A **little bit of humor** can make the presentation more dynamic



# ADVICES FOR YOUR PRESENTATIONS

## Slides III : do not distract the audience

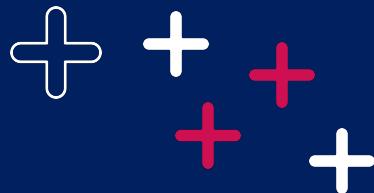
- Not too much text/information per slide: otherwise the audience reads and doesn't listen anymore
- Not too many illustrations or jokes: it doesn't look serious
- Consistency in font size / alignment of elements



# ADVICES FOR YOUR PRESENTATIONS

## Presenter (you)

- Do not read sheets of paper (look poorly prepared and disconnect you from the audience)
- Do not read the slides (but use them to make your speech)
- Don't be fidgety but don't be too rigid
- Speak articulately and slowly: silence can be used to pace the presentation
- Look frequently at your audience : eye contact when possible is useful
- If you feel stressed: use the "I am in control, I will adapt" manner or the "pedagogic" approach
- Do not endure your presentation



# Finding and using scientific literature

**Please for next time**

- Bring a list of diseases that you are interested in
- Learn and try to remember every part of the structure of a scientific article