

FRIA CALL 2025

FRIA 1ères bourses [FRIA-B1] / FRIA (1st grants) [FRIA-B1]

Application ID : 40038435

Host institution: Université de Liège

Participants:

PROPS Charles-Henri [Applicant]

DUMOULIN Mireille (ULiège) [Promoter]

Titre de la proposition :

Développement de nano-anticorps (VHHs) contre les facteurs de virulence de Pseudomonas aeruginosa

Proposal title:

Development of Nano-Antibodies (VHHs) against Pseudomonas aeruginosa Virulence Factors

Eligibility

Degree giving access to the grant

Graduation date (or expected graduation date) of your master degree or equivalent	10/09/2024
Level of your master degree or equivalent	Master 120
Field of your master degree or equivalent	Biomedical and Pharmaceutical Sciences
Country where the degree was or will be awarded	Belgium
Are you a doctor or a veterinary doctor?	No

Number of childbirths/adoptions

Please indicate the number of childbirths (including 0)	0
Number of adoptions (including 0)	0

Researcher's identification

Researcher's profile

Last name	Props
------------------	-------

First name	Charles-Henri
Other given name(s)	-
Date of birth	04/12/2001
Gender	Male
Nationality	Belgium

Phone number(s)

Professional phone number	-
Mobile professional phone number	0499870728
Private phone number	-
Private cellular phone number	0499870728

Your diplomas

Diplomas:

Date of award	Diploma	Institution
10/09/2024	Master 120 Sciences Master's degree in biochemistry and molecular and cellular biology, with an in-depth focus Mention : Distinction Thesis : Sélection et caractérisation de Nanobodies® dirigés contre TFIP11 et LasB Promoter : Mireille Dumoulin	Université de Liège (Belgique)
04/07/2022	Bachelor's degree Sciences Bachelor in Biological Sciences Mention : Distinction	Université de Liège (Belgique)

ORCID ID number

If you have an identification number on the ORCID platform, you can indicate your ID number.	-
---	---

Position(s)

Career:

Position	Institution / Company	Position starting date	Position end date
Assistant Full time	Université de Liège	07/10/2024	06/10/2025

Type of Grant

Information on the type of the requested grant

Number of previous applications submitted for this instrument (including 0)	0
Type of grant for which you are applying	1st grant 1st year

Have you already worked on your PhD thesis, on this topic precisely ?

Have you already worked on your PhD thesis, on this topic precisely ? If yes, indicate the number of months on a full-time equivalent basis. If not, indicate 0. <i>Note: if your thesis is an extension of your master's dissertation, please do not take into account the research period of your master's dissertation e.g. if you have worked during 18 months at 50%, please indicate 9</i>	0
I certify that by October 1st, I won't have worked or I will have worked full time for less than a year on the PhD project that I am submitting	Yes

Thesis already started:

No data

Start date of the grant

If you expect your grant to begin after 1st October of the year of the call, please indicate the date foreseen	07/10/2025
If you would like your fellowship to start at a date later than October 1st, please provide a justification in the box <i>e.g. ongoing contract or grant until xxx</i>	
Contrat (d'assistant "technicien de l'enseignement" pour l'Université de Liège) en cours jusqu'au 6 octobre	

Framework

Host institution

Host institution where the research programme will be pursued	Université de Liège
Graduate school	Other

If you have selected "Other", please justify

L'école doctorale est la suivante: Biochimie, Biologie moléculaire et cellulaire, Bioinformatique et modélisation

Promoter

Informations

Dumoulin Mireille
 mdumoulin@uliege.be
 Université de Liège

Co-promoter

Does your proposal include a co-promoter?

The co-promoter has to be at the postdoctoral level and belong to one of the institutions listed in Appendix 1 (of the rules and regulations)

No

No data

Joint supervision

Do you plan to prepare your Ph.D. under joint supervision?

Scientific collaboration with co-graduation during full doctoral studies within both universities based on the same research work. This leads to a double degree obtained within both universities involved.

No

No data

Miscellaneous

Artificial intelligence

Did you use generative Artificial Intelligence (AI) tools and/or other AI-assisted technologies in the preparation of this application? This statement does not apply to syntax and spell checking.

No

Project description

Research project : general information

Main language of the proposal English

During the interview, in which language do you wish to defend your project?	French
Title of the project in French	Développement de nano-anticorps (VHHs) contre les facteurs de virulence de <i>Pseudomonas aeruginosa</i>
Title of the project in English	Development of Nano-Antibodies (VHHs) against <i>Pseudomonas aeruginosa</i> Virulence Factors
Shortened title or acronym of the proposal	Antivirulence factors VHHs
Abstract of the project in French	
<p><i>Pseudomonas aeruginosa</i> est un pathogène opportuniste à Gram négatif responsable d'infections sévères. Sa forte capacité à développer une résistance aux antibiotiques, reconnue par l'Organisation mondiale de la santé comme une menace prioritaire, rend la thérapie antibiotique classique de plus en plus inefficace. Il est donc urgent de développer des stratégies thérapeutiques alternatives. Une approche prometteuse, la thérapie anti-virulence, cible les facteurs de virulence bactériens responsables des dommages tissulaires, de l'évasion immunitaire ou de la formation de biofilm, réduisant ainsi la pathogénicité sans tuer directement les bactéries. Cette approche minimise donc la pression sélective favorisant l'apparition de résistances et préserve le microbiote bénéfique. L'objectif de ce projet est de développer des nano-anticorps pour inhiber spécifiquement deux enzymes lipolytiques extracellulaires majeures de <i>Pseudomonas aeruginosa</i>, la lipase A (LipA) et l'estérase A (EstA), qui jouent un rôle clé dans la pathogénèse de <i>P. aeruginosa</i>, et d'évaluer leur efficacité thérapeutique dans un modèle de larves de <i>Galleria mellonella</i>.</p>	
Abstract of the project in English	
<p><i>Pseudomonas aeruginosa</i> is a Gram-negative opportunistic pathogen responsible for severe infections. Its high propensity to develop antibiotic resistance, recognized by the World Health Organization as a priority threat, makes conventional antibiotic therapy increasingly ineffective. Therefore, there is an urgent need to develop alternative therapeutic strategies. One promising approach, anti-virulence therapy, targets bacterial virulence factors that mediate tissues damage, immune evasion, or biofilm formation, thereby reducing pathogenicity without directly killing the bacteria. This approach therefore minimizes selective pressure for resistance and preserves the beneficial microbiome. The aim of this project is to develop nano-antibodies, to specifically inhibit two major extracellular lipolytic enzymes of <i>Pseudomonas aeruginosa</i>, Lipase A (LipA) and Esterase A (EstA), which play key roles in the pathogenesis of <i>P. aeruginosa</i>, and to investigate their therapeutic efficiency in <i>Galleria mellonella</i> larvae model.</p>	
Does your research project encompass an interdisciplinary approach?	Yes
Did you submit a funding application to the F.R.S.-FNRS via the same instrument in the past ?	No

Uploaded file : Research project:

Project proposal
Charles-Henri Props FRIA_B1_partie_scientifique B.pdf (21/08/2025 - 622.374 kB)

Jury

LS1 - Molecular biology, biochemistry, structural biology, molecular biophysics, synthetic and chemical biology, drug design, innovative methods and modelling • LS1 - jury 1

Descriptors

- LS1 - Molecular biology, biochemistry, structural biology, molecular biophysics, synthetic and chemical biology, drug design, innovative methods and modelling LS1_2 - Biochemistry (Relevancy: High)
- LS1 - Molecular biology, biochemistry, structural biology, molecular biophysics, synthetic and chemical biology, drug design, innovative methods and modelling LS1_4 - Protein biology (Relevancy: Low)
- LS6 - The immune system, related disorders and their mechanisms, biology of infectious agents and infection, biological basis of prevention and treatment of infectious diseases, innovative immunological tools and approaches, including therapies LS6_6 - Infectious diseases (Relevancy: Medium)
- LS6 - The immune system, related disorders and their mechanisms, biology of infectious agents and infection, biological basis of prevention and treatment of infectious diseases, innovative immunological tools and approaches, including therapies LS6_8 - Biological basis of prevention and treatment of infection (Relevancy: High)
- LS6 - The immune system, related disorders and their mechanisms, biology of infectious agents and infection, biological basis of prevention and treatment of infectious diseases, innovative immunological tools and approaches, including therapies LS6_9 - Antimicrobials, antimicrobial resistance (Relevancy: Medium)
- LS6 - The immune system, related disorders and their mechanisms, biology of infectious agents and infection, biological basis of prevention and treatment of infectious diseases, innovative immunological tools and approaches, including therapies LS6_11 - Innovative immunological tools and approaches, including therapies (Relevancy: Medium)

If you chose only one descriptor relevant to your subject area selection, please justify it

-

Optional: in case you are conducting a sustainable development-oriented research project, you can select a descriptor listed in the drop down menu below

-

Unrestricted keywords

-

Ethical aspects

Does your research involve experiments or samples on human being/material ?	Yes
Does your research involve the use of experimental animals ?	Yes
Does your research involve ethical issues related to Human Sciences ?	No

If you answered "Yes" to at least one of the three previous questions, please comment on the ethical aspects of your research program.

Des expériences seront réalisées sur des échantillons d'exsudat de plaies qui seront fournis par l'équipe du Dr Alexander Nyström à l'Université de Fribourg (Département de Dermatologie, Allemagne). Ces échantillons biologiques sont prélevés en tant que matériel résiduel issu d'interventions médicales ; par conséquent, aucune autorisation éthique spécifique n'est requise.
L'immunisation d'un lama et d'un alpaga sera réalisée par la société CER-Groupe, qui possède toutes les autorisations éthiques nécessaires

Other information

Scientific seniority

Scientific seniority <i>Effective duration (in years) of research and development activities carried out from the date the diploma (master) which gives access to the requested funding was awarded.</i>	0
--	---

Cursus details

Uploaded file : Cursus details:

Cursus details
detail_cursus.pdf (13/08/2025 - 214.188 kB)

Ranking

Uploaded file : Ranking:

Ranking
classement_doctorantPROPS.pdf (19/08/2025 - 217.225 kB)

Scientific awards and honours

No data

Periods of inactivity

Over the last 5 years, have you been professionally inactive for more than 2 months?	No
--	----

Publications

Do you have any publications ?	No
--------------------------------	----

Master thesis

Master thesis:

Master thesis
Mémoire Charles-Henri Props 2024.pdf (27/08/2024 - 2244.2 kB)

Research stays completed (mobility)

Please indicate your research stays of more than 30 days **completed** outside your main host institution

Previous research stays:

From	To	Information about the research stay
03/10/2023	22/12/2023	IHU Méditerranée Infection Aix

		Marseille Université UMR MEPHI Marseille (France) étudiant stagiaire Erasmus
--	--	--

Planned research stays (mobility)

Please indicate your research stays of more than 30 days **that you plan to do** outside your main host institution

Planned research stays:

No data

Additional courses

Additional courses:

No data

Additional scientific activities

Additional scientific activities

Encadrement de travaux pratiques en tant qu'étudiant pour le cours de biochimie (BIOC0204) lors de l'année académique 2023-2024.
Assistant technicien de l'enseignement pour le département des Sciences de la Vie (Université de Liège) du 7 octobre 2024 au 6 octobre 2025. J'étais en charge de l'encadrement des séances de travaux pratiques pour plusieurs cours, tant au premier qu'au second quadrimestre de l'année 2024-2025, ainsi qu'au début du quadrimestre de l'année 2025-2026. De plus, j'ai assuré deux séances d'aide à l'étude pour le cours de biologie cellulaire (BIOL0006).

Academic Referees

Academic Reference persons:

Informations
Galleni Moreno mgalleni@uliege.be
Legrand Sylvie S.Legrand@uliege.be

Justification for the prospects of industrial or agronomic applications

Does your doctoral work have short, mid, or long-term of industrial or agronomic applications prospects?	Long-term
Description and justification of the prospects (If there are no prospects, please indicate "Not applicable")	
Les VHHs inhibiteurs de LipA et EstA pourraient constituer une base pour le développement de thérapies innovantes	

Domains and themes considered a priority and identified as such by the Walloon Government

Select one or more themes	• Santé - Biopharmacie
---------------------------	------------------------

Referees external to the academic world

Non academic Reference persons:

No data

Appendices

Appendices

Please upload the required appendices **in PDF format**

Appendices can be uploaded into your form until the validation date of your form. If some documents listed hereunder are not in your possession by the date of validation of your application, they may be uploaded on your e-space page until 30/09/2025 at the latest. After the validation deadline for the applicant, the F.R.S.-FNRS will send you an e-mail including all practical information related to your application (documents to upload etc.).

Certificate of achievement or Diploma

Uploaded file : Copy of the degree:

Certificate of achievement or Diploma
diplôme master.pdf (14/08/2025 - 593.128 kB)

PhD access certificate

Uploaded file : PhD access certificate:

No data

Certificate of registration for the specialization

Certificate of registration for the specialization:

No data

Annexe : Parcours académique par année d'études (Etudes supérieures)***Academic record per year of study (higher education studies)***

Complétez le tableau suivant par année d'études en commençant par la première année académique (incluant les années non réussies ou abandonnées).

Please complete the table below detailing your academic record per year, starting with the first year of study, including failed and aborted years of study.

Année académique <i>Academic Year</i>	Intitulé de l'année d'études <i>Course Title for each year of study</i>	Nombre de crédits acquis¹ <i>Credits obtained¹</i>	Résultats obtenus même en cas d'échec <i>Results or class obtained, including failure</i>	Date de proclamation <i>Graduation Date</i>	Institution + pays <i>Institution</i> +country
2016-2017	Ex. : 1 ^{ère} année Bachelier Histoire / Bachelier Histoire (Bloc annuel 1) ...	Ex. : 45/60	Ex. : Ajourné, Bien, Distinction, Sans Mention, 76%, 13/20,...	30/06/2019	Ex. Université de Bologne (Italie)
2019-2020	1 ^{ère} année Bachelier Biologie	60/60	13/20	10/09/2020	Université de Liège (Belgique)
2020-2021	2 ^{ème} année Bachelier Biologie	60/60	14,21/20	08/09/2021	Université de Liège (Belgique)
2021-2022	3 ^{ème} année Bachelier Biologie	60/60	14,5/20 (Distinction)	04/07/2022	Université de Liège (Belgique)
2022-2023	1 ^{ère} année Master Biochimie, biologie moléculaire et cellulaire	60/60	15,25/20	03/07/2023	Université de Liège (Belgique)
2023-2024	2 ^{ème} année Master Biochimie, biologie moléculaire et cellulaire	60/60	15,13/20 (Distinction)	10/09/2024	Université de Liège (Belgique)

¹ par rapport au nombre de crédits théoriques (si applicable) / based on the number of ECTS credits required (if applicable)

Full name of the applicant	Charles-Henri Props
e-space reference	40038435

SCIENTIFIC SECTION OF THE PROPOSAL

MAIN LANGUAGE CHOSEN = ENGLISH

This part includes the following elements:

1. Description of the research project
2. Comments on changes made in the research project in case of resubmission (optional)
3. Activities report on the first year of doctorate (**ONLY** for 1st grant - **2nd year**)*
4. Potential interdisciplinary approach of the research project (optional)
5. Description of the work environment
6. Summary of the master's thesis or equivalent
7. Additionnal comments (optional)
8. Ph.D. work calendar per month

*** “1st grant - 2nd year” applicants have already worked on a full-time basis for one year full time equivalent on the Ph.D. project submitted to the FRIA.**

The applicant must fill in the sections below and convert the file into an unprotected PDF before appending it to the online application form.

The F.R.S.-FNRS insists on **strict compliance with the instructions given for each part of the proposal** (scientific section relevant to the instrument selected, number of pages allowed for the documents to be enclosed with the application form...) and stresses again the sovereign consideration of the juries in case the file would exceed the applicable page limit.

1. DESCRIPTION OF THE RESEARCH PROJECT

The written project must be made up of 4 parts (max. 4 pages) according to the structure below, accompanied by a reference bibliography (max. 1 page besides the 4 pages dedicated to the project) listed by order of appearance within the text.

Graphs and tables may be added (max. 2 pages).

[Enter text here. Format: Arial 12, single space]

1.1 Goals of the research

Pseudomonas aeruginosa is a Gram-negative opportunistic pathogen responsible for severe infections. Its high propensity to develop antibiotic resistance, recognized by the World Health Organization as a priority threat, makes conventional antibiotic therapy increasingly ineffective. Therefore, there is an urgent need to develop alternative therapeutic strategies. One promising approach, anti-virulence therapy, targets bacterial virulence factors that mediate tissues damage, immune evasion, or biofilm formation, thereby reducing pathogenicity without directly killing the bacteria. This approach therefore minimizes selective pressure for resistance and preserves the beneficial microbiome. **The aim of this project is to develop nano-antibodies, to specifically inhibit two major extracellular lipolytic enzymes of *Pseudomonas aeruginosa*, Lipase A (LipA) and Esterase A (EstA), which play key roles in the pathogenesis of *P. aeruginosa*, and to investigate their therapeutic efficiency in *Galleria mellonella* larvae model.**

1.2 State of the art

Pseudomonas aeruginosa is a Gram-negative, opportunistic pathogen and a leading cause of nosocomial infections including pneumonia and urinary tract infections in hospitalized patients with other underlying conditions ¹. Moreover, chronic *P. aeruginosa* infections are common in the lungs of patients with cystic fibrosis or chronic obstructive pulmonary disease (COPD) and are associated with high morbidity and mortality in this population ². *P. aeruginosa* is also associated with colonisation of burns and wounds, and the formation of abscesses ³. Globally, this bacterium was associated with more than 300,000 deaths in 2019 ⁴. The World Health Organization (WHO) lists *P. aeruginosa* among priority pathogens due to its high capacity to develop antibiotic resistance ⁵. **Since its antibiotic resistance is outpacing the development of new antibiotics, new therapeutic alternatives are urgently needed to combat it.** *P. aeruginosa* produces a wide variety of virulence factors, which are all involved in the initiation and/or establishment of infectious processes including the formation of biofilms ⁶. These factors include not only proteins such as toxins, proteases, lipases, and phospholipases, but also non-protein compounds such as rhamnolipids ^{7–9}. **Neutralizing virulence factors, a strategy referred to as the anti-virulence approach, is gaining growing interest to combat infectious diseases** ^{7,9–12}. By neutralizing virulence factors, this approach aims to reduce bacterial virulence and infectivity without directly killing of the bacteria. There is, therefore, less selective pressure on the bacterial survival, making it less likely to induce drug resistance ¹¹. In addition, it is pathogen-specific and does not, therefore, affect the beneficial microbiome ¹³. Some virulence factors primarily damage the host, while others protect the bacterium, such as those involved in biofilm formation or immune evasion. Targeting these protective factors can weaken bacterial defenses and enhance antibiotic susceptibility ¹⁴. **Moreover, synergistic effects have been observed when multiple virulence factors are targeted simultaneously** ^{14,15}. As a result, anti-virulence drugs are being developed not only as stand-alone prophylactic or therapeutic agents targeting one or more virulence factors, but also for combinatorial use with conventional antibiotics. Anti-virulence molecules in clinics are targeting toxins from *Bacillus anthracis* and *Clostridium botulinum* ¹³. As far as *P. aeruginosa* is concerned, there are several small molecules and monoclonal antibodies targeting extracellular virulence factors (e.g., type III secretion system, molecules involved in biofilm formation or structure such as DNABII proteins) in clinical trials ¹² and many are in preclinical stages targeting a wide range of virulence factors ¹¹. The group of M. Dumoulin has recently developed a nano-antibody (VHH) specifically and efficiently inhibiting elastase B (LasB) (K_i ~ 10 nM range), the major protease secreted by *P. aeruginosa* (Figure 1, Annexes). **The aim of this project is to develop nano-antibodies to neutralize two major lipolytic extracellular enzymes of *P. aeruginosa*, Lipase A (LipA) and esterase A (EstA), with the goal of creating a multitargeted therapeutic strategy in combination with the anti-LasB VHH.** Although these enzymes are recognized as major virulence factors, there is only a limited number of studies exploring the generation of specific inhibitory molecules against them, **highlighting the novelty and potential impact of this approach.**

Lipase A (LipA, 30 kDa), is secreted via the type II secretion pathway and is involved in the transcriptional regulation of the *pvdS* gene, and thus in the production of the sigma factor PvdS, which controls and regulates the expression of several other determinant virulence factors in *P. aeruginosa*, including the siderophore pyoverdine, the protease PrpL, the exotoxin A and the toxins ExoS and ExoT ^{16,17}. Consequently, LipA affects key processes required for the full virulence of *P. aeruginosa* ¹⁸ (Figure 2, Annexes).

Esterase A (EstA, 66 kDa), is made of two structural domains: a C-terminal β -barrel domain anchoring the protein to the outer membrane and an extracellular N-ter catalytic domain ¹⁹. EstA is required to produce rhamnolipids which play a multifactorial role in *P. aeruginosa* infection including uptake of hydrophobic substrates, biofilm formation, inhibition of phagocytosis, bacterium mobility (swimming, twitching, swarming) and host cell hemolysis ²⁰. It is required for full virulence in a rat model of chronic pulmonary infection ²¹ (Figure 2, Annexes).

VHHs also referred to as Nanobodies® or Nano-antibodies are single-domain antibody fragments derived from heavy-chain-only antibodies produced by camelids ²². Despite their small size, the

affinity of VHHs for their target is comparable to that of classical antibodies. Because of their small size, VHHs display a series of remarkable properties including high stability and solubility, easy production in *Escherichia coli*, easy modification by genetic engineering to adapt their properties to the needs of a given application, high tissue penetration, and an ability to target, via a long CDR3 (Complementary Determining Region 3), cryptic epitopes generally inaccessible to conventional antibodies such as enzymes active sites^{23,24}. Several enzymes inhibitory VHHs have been described in the literature (e.g., against hen lysozyme²⁵ and or the matrix metalloproteinase 2²⁶). Antibodies and antibody fragments, including VHHs, present the advantages of high affinity and target specificity and thereby fewer adverse events compared to small molecule drugs²⁷. Finally, it is important to underline that three VHHs have been approved for clinical use and more than twenty are in clinical trials²⁸. **All these properties, make VHHs molecules of choice to inhibit LipA and EstA.**

1.3 Research project

The aim of this project is to develop nano-antibodies to neutralize two major lipolytic extracellular enzymes of *P. aeruginosa*, Lipase A (LipA) and Esterase A (EstA) with the goal of creating a multitargeted therapeutic strategy in combination with the anti-LasB VHH already available.

The work can be divided into 3 work packages:

1.3.1. Selection of anti-LipA and anti-EstA VHHs (WP1).

Production of LipA and EstA: LipA and the catalytic domain of EstA will be produced and subsequently purified following established protocols^{19,29,30}. The gene coding for each enzyme, optimized for *E. coli* codon usage, and cloned into pET20b will be ordered from Gencust. The enzymes will be produced in the periplasm of *E. coli* BL21 DE3 in the presence of a C-terminal Histidine tag. They will be purified from the periplasmic extract by an immobilized metal affinity chromatography (IMAC), followed by a size-exclusion chromatography. Quality controls will be performed to confirm their proper folding and integrity including mass spectrometry analysis, SEC-MALS, circular dichroism spectra and determination of specific activities following hydrolysis of specific substrates (i.e., p-nitrophenyl caproate (p-NPC) for EstA²⁰ and p-nitrophenyl palmitate (p-NPP) for LipA³¹).

Immunisation: One alpaca and one llama will be immunized with the two enzymes. The immunizations (6 injections at weekly intervals, 100 µg/injection with Gerbu adjuvant) will be outsourced at CER (Aye, Belgium).

Creation of the immune libraries: After the last injection, about 80 mL of blood from the immunized animals will be collected and total RNAs will be isolated from this blood and used to create the two phage libraries containing the genes coding for the VHHs using established protocols³².

Selection of VHHs: VHHs specific for LipA and EstA will be selected by phage display using original protocols developed in our laboratory to select enzyme inhibitory VHHs against other enzymes. The two pannings will be carried out in parallel using the Kingfisher equipment available at the AlpaNano platform. Usually, 3 rounds of selection are enough to enrich the library with VHHs directed against the antigen of interest. For each panning campaign, about 400 clones, selected randomly (200 for the 2nd and 200 for the 3rd round of panning), will be screened by ELISA using the robotic platform for high-throughput microplate mutagenesis and purification of CIP (Robotein®, <http://www.robotein.ulg.ac.be/equipment>), to confirm their specificity for their respective antigens.

Selection of inhibitory VHHs: The inhibitory activity of the positive clones will be screened using a high-throughput protocol using the Ellipse robot (ASM) for automated enzyme activity measurements available at CIP using the periplasmic extracts. The activity will be monitored by following the hydrolysis of specific substrates. In the very unlikely case that this procedure does

not allow the selection of inhibitory VHHs, all the clones selected during rounds 2 and 3 of panning will be submitted to Next Generation Sequencing (NGS) in order to identify the families of VHHs present in low amounts and therefore difficult to isolate using the standard screening procedure. If necessary, new panning campaigns with alternative set-ups will be carried out.

1.3.2. *In vitro* characterization of the selected anti-LipA and anti-EstA VHHs (WP2)

Production of the VHHs: All the inhibitory VHHs will be produced in *E. coli* in larger amounts and purified according to established protocols ²⁴.

***In vitro* characterization:** The affinity of the VHHs for their respective antigen will be measured using the Octet technology available at the Robotein® platform. For each antigen, competition experiments will be carried out to determine if the VHHs of different families bind to the same or different epitopes on the surface of their respective antigen. The inhibition constants for the hydrolysis of p-NPC for EstA ²⁰ and p-NPP for LipA ³¹ will be determined from enzymatic experiments carried out at different ratios of VHHs. The mechanism of inhibition will be determined by measuring the rate of hydrolysis of p-NPC for EstA and p-NPP for LipA at different concentrations of both the substrate and VHH.

The thermodynamic stability of the VHHs will be determined by analyzing the equilibrium transition curves induced by different denaturing agents (heat and urea) and measured by intrinsic fluorescence and circular dichroism in the far UV. Stability towards forced oxidation and deamidation will be also monitored to investigate the developability of the VHHs ²⁴. The stability of the VHHs in the supernatant of culture of *P. aeruginosa* and in wounds exudates from patients infected with *P. aeruginosa* will be investigated by Western Blot (WB).

From the results of all these experiments, for each targeted enzyme, the inhibitory VHH exhibiting the optimal properties will be selected for the rest of the project. In order to better understand the mechanism of inhibition, the X-ray structure of the VHH-target complexes will be determined (Collaboration with F. Kerff, CIP, ULiege). If no crystal can be obtained, other approach such as HDX-MS or cryo-electron microscopy will be envisioned.

1.3.3. Therapeutic efficacy studies (WP3)

Studies on *P. aeruginosa* cultures:

Inhibition of enzymatic activity of LipA and EstA. *P. aeruginosa* PAO1 will be cultured in conditions enhancing the production of virulence factors ³³. The inhibitory LipA activity of the VHHs will be investigated using the supernatant of culture at different time points during growth using p-NPP as substrate. Cell extracts will be used to monitor the inhibition of EstA using p-NPC as substrate ²⁰.

Inhibition of biofilm formation (anti-EstA VHH). The formation of biofilm will be monitored using the crystal violet assay in a microplate at different time points ³⁴. The selected VHH will be added at different ratios at the start of the bacterial culture.

Inhibition of the production of rhamnolipids (anti-EstA VHH). The concentration of rhamnolipids will be quantified via the orcinol assay as described in ²⁰. It is a colorimetric test to determine the amount of hexose sugar and it will be carried out in the culture supernatant. A calibration curve will be prepared with rhamnose.

*Effects of the VHHs on the mobility of *P. aeruginosa* (anti-EstA VHH).* The effects of the inhibitory VHHs on the different type of mobility will be carried out according to established protocols ³⁵ using agar-based assays in which the agar concentration varies depending on the mobility mode (swimming: ~0.3% agar, swarming: ~ 0.5 % agar + NH₄Cl and twitching: stab inoculation into ~1.5% agar).

Effects of the VHHs on the production of pyoverdine (anti-LipA VHH). Pyoverdine will be quantified using a fluorimetric assay, which measures its natural fluorescence (excitation at 400 nm, emission at 460 nm) in culture supernatants³⁶.

Effects of the VHHs on the transcription levels of the *pvdS* gene (anti-LipA VHH). The transcriptional level of the *pvdS* gene will be measured by qPCR as described in ¹⁸.

All the above assays will be carried out using various concentrations of VHHs. The effect of anti-LipA and anti-EstA VHHs will be investigated both alone and in combination.

Inhibition of enzymatic activity in biological samples: The ability of the VHHs to inhibit their respective enzyme will be investigated in wounds exudates from patients affected with *P. aeruginosa* using the same enzymatic assay as described above. The wound exudate samples will be provided by the group of Dr Alexander Nyström from the University of Freiburg (Department of Dermatology, Germany).

In vivo studies in *Galleria mellonella*: The efficacy of the anti-LipA and anti-EstA VHHs will be assessed in infection models of *G. mellonella* larvae. These experiments will be carried out in the laboratory of Dr Damien Thiry (University of Liège) ³⁷. This model displays a significant correlation with mouse model and is therefore considered as a powerful tool to investigate pathogenicity in the context of mammalian infections ³⁸. The model can be generated by injecting a bacterial suspension into the *G. mellonella* larvae. Groups of larvae will be infected with inocula of *P. aeruginosa* (25×10^1 CFU/mL to 2.5×10^3 CFU/mL). Different doses of VHHs will be delivered and larvae survival will be monitored over time. Moreover, after sacrificing the larvae, bacterial load and the amount of LipA and EstA will be quantified by enzymatic assays. The efficacy of the anti-LipA and anti-EstA will be investigated separately and in combination. The synergistic effect with anti-LasB VHH will also be investigated. The Spearman–Karber Method ³⁹ will be used to estimate the Lethal Dose causing 50% mortality (LD₅₀). cAb-BclI10, a VHH specific of the beta-lactamase BclI10, will be used as a negative control in these experiments.

1.4 Work plan (to be described for the whole duration of the project)

A Gantt diagram with the different WP is shown in [section 8](#) and the schematic representation of the workflow is given in [Figure 3 \(Annexes\)](#).

1.5 Bibliography

1. Jurado-Martín, I., Sainz-Mejías, M. & McClean, S. *Pseudomonas aeruginosa*: An Audacious Pathogen with an Adaptable Arsenal of Virulence Factors. *Int. J. Mol. Sci.* **22**, 3128 (2021).
2. Malhotra, S., Hayes, D. & Wozniak, D. J. Cystic Fibrosis and *Pseudomonas aeruginosa*: the Host-Microbe Interface. *Clin. Microbiol. Rev.* **32**, (2019).
3. Ruffin, M. & Brochiero, E. Repair Process Impairment by *Pseudomonas aeruginosa* in Epithelial Tissues: Major Features and Potential Therapeutic Avenues. *Front. Cell. Infect. Microbiol.* **9**, (2019).
4. Murray, C. J. L. *et al.* Global burden of bacterial antimicrobial resistance in 2019: a systematic analysis. *Lancet* **399**, 629–655 (2022).
5. Sati, H. *et al.* The WHO Bacterial Priority Pathogens List 2024: a prioritisation study to guide research, development, and public health strategies against antimicrobial resistance. *Lancet Infect. Dis.* **25**, 1033–1043 (2025).
6. Zhang, X. *et al.* A comprehensive review of the pathogenic mechanisms of *Pseudomonas aeruginosa*: synergistic effects of virulence factors, quorum sensing, and biofilm formation. *Front. Microbiol.* **16**, (2025).
7. Blasey, N., Rehrmann, D., Riebis, A. K. & Mühlen, S. Targeting bacterial pathogenesis by inhibiting virulence-associated Type III and Type IV secretion systems. *Front. Cell. Infect. Microbiol.* **12**, (2023).
8. Qin, S. *et al.* *Pseudomonas aeruginosa*: pathogenesis, virulence factors, antibiotic resistance, interaction with host, technology advances and emerging therapeutics. *Signal Transduct. Target. Ther.* **7**, 199 (2022).
9. Fleitas Martínez, O., Cardoso, M. H., Ribeiro, S. M. & Franco, O. L. Recent Advances in

- Anti-virulence Therapeutic Strategies With a Focus on Dismantling Bacterial Membrane Microdomains, Toxin Neutralization, Quorum-Sensing Interference and Biofilm Inhibition. *Front. Cell. Infect. Microbiol.* **9**, (2019).
10. Dehbanipour, R. & Ghalavand, Z. Anti-virulence therapeutic strategies against bacterial infections: recent advances. *Germs* **12**, 262–275 (2022).
 11. Liao, C., Huang, X., Wang, Q., Yao, D. & Lu, W. Virulence Factors of *Pseudomonas aeruginosa* and Antivirulence Strategies to Combat Its Drug Resistance. *Front. Cell. Infect. Microbiol.* **12**, (2022).
 12. Romanos, L. T., Kontogiannis, D. S., Tsiampali, C., Tzvetanova, I. D. & Falagas, M. E. Antibiotics and non-traditional antimicrobial agents for *Pseudomonas aeruginosa* in clinical phases 1, 2, and 3 trials. *Expert Opin. Investig. Drugs* **34**, 639–653 (2025).
 13. Lau, W. Y. V., Taylor, P. K., Brinkman, F. S. L. & Lee, A. H. Y. Pathogen-associated gene discovery workflows for novel antivirulence therapeutic development. *eBioMedicine* **88**, 104429 (2023).
 14. Rezzoagli, C., Archetti, M., Mignot, I., Baumgartner, M. & Kümmerli, R. Combining antibiotics with antivirulence compounds can have synergistic effects and reverse selection for antibiotic resistance in *Pseudomonas aeruginosa*. *PLOS Biol.* **18**, e3000805 (2020).
 15. Long, M. B. *et al.* A Bispecific Monoclonal Antibody Targeting Psl and PcrV Enhances Neutrophil-Mediated Killing of *Pseudomonas aeruginosa* in Patients with Bronchiectasis. *Am. J. Respir. Crit. Care Med.* **210**, 35–46 (2024).
 16. Cunliffe, H. E., Merriman, T. R. & Lamont, I. L. Cloning and characterization of pvdS, a gene required for pyoverdine synthesis in *Pseudomonas aeruginosa*: PvdS is probably an alternative sigma factor. *J. Bacteriol.* **177**, 2744–2750 (1995).
 17. Wilderman, P. J. *et al.* Characterization of an Endoprotease (PrpL) Encoded by a PvdS-Regulated Gene in *Pseudomonas aeruginosa*. *Infect. Immun.* **69**, 5385–5394 (2001).
 18. Funken, H. *et al.* The Lipase LipA (PA2862) but Not LipC (PA4813) from *Pseudomonas aeruginosa* Influences Regulation of Pyoverdine Production and Expression of the Sigma Factor PvdS. *J. Bacteriol.* **193**, 5858–5860 (2011).
 19. van den Berg, B. Crystal Structure of a Full-Length Autotransporter. *J. Mol. Biol.* **396**, 627–633 (2010).
 20. Wilhelm, S., Gdynia, A., Tielen, P., Rosenau, F. & Jaeger, K.-E. The Autotransporter Esterase EstA of *Pseudomonas aeruginosa* Is Required for Rhamnolipid Production, Cell Motility, and Biofilm Formation. *J. Bacteriol.* **189**, 6695–6703 (2007).
 21. Potvin, E. *et al.* In vivo functional genomics of *Pseudomonas aeruginosa* for high-throughput screening of new virulence factors and antibacterial targets. *Environ. Microbiol.* **5**, 1294–1308 (2003).
 22. Muyldermans, S. Nanobodies: Natural single-domain antibodies. *Annual Review of Biochemistry* at <https://doi.org/10.1146/annurev-biochem-063011-092449> (2013).
 23. Pain, C., Dumont, J. & Dumoulin, M. Camelid single-domain antibody fragments: Uses and prospects to investigate protein misfolding and aggregation, and to treat diseases associated with these phenomena. *Biochimie* at <https://doi.org/10.1016/j.biochi.2015.01.012> (2015).
 24. Redeghier, P. *et al.* Enzymatic, structural, and biophysical characterization of a single-domain antibody (VHH) selectively and tightly inhibiting neutrophil elastase and exhibiting favorable developability properties. *Protein Sci.* **33**, (2024).
 25. Desmyter, A. *et al.* Crystal structure of a camel single-domain VH antibody fragment in complex with lysozyme. *Nat. Struct. Mol. Biol.* **3**, 803–811 (1996).
 26. Marturano, A. *et al.* Development of anti-matrix metalloproteinase-2 (MMP-2) nanobodies as potential therapeutic and diagnostic tools. *Nanomedicine Nanotechnology, Biol. Med.* (2020) doi:10.1016/j.nano.2019.102103.
 27. Castelli, M. S., McGonigle, P. & Hornby, P. J. The pharmacology and therapeutic applications of monoclonal antibodies. *Pharmacol. Res. Perspect.* **7**, (2019).
 28. Alexander, E. & Leong, K. W. Discovery of nanobodies: a comprehensive review of their applications and potential over the past five years. *J. Nanobiotechnology* **22**, 661 (2024).

29. Kovacic, F. *et al.* A membrane-bound esterase PA2949 from *Pseudomonas aeruginosa* is expressed and purified from *Escherichia coli*. *FEBS Open Bio* **6**, 484–493 (2016).
30. Madan, B. & Mishra, P. Co-expression of the lipase and foldase of *Pseudomonas aeruginosa* to a functional lipase in *Escherichia coli*. *Appl. Microbiol. Biotechnol.* **85**, 597–604 (2010).
31. Winkler, U. K. & Stuckmann, M. Glycogen, hyaluronate, and some other polysaccharides greatly enhance the formation of exolipase by *Serratia marcescens*. *J. Bacteriol.* **138**, 663–670 (1979).
32. Pardon, E. *et al.* A general protocol for the generation of Nanobodies for structural biology. *Nat. Protoc.* (2014) doi:10.1038/nprot.2014.039.
33. Wolfmeier, H. *et al.* Targeting the *Pseudomonas aeruginosa* Virulence Factor Phospholipase C With Engineered Liposomes. *Front. Microbiol.* **13**, (2022).
34. Peeters, E., Nelis, H. J. & Coenye, T. Comparison of multiple methods for quantification of microbial biofilms grown in microtiter plates. *J. Microbiol. Methods* **72**, 157–165 (2008).
35. Arslan, E., Coşkun, M. K., Çobanoğlu, Ş., Aslan, M. H. & Yazıcı, A. Effects of four antibiotics on *Pseudomonas aeruginosa* motility, biofilm formation, and biofilm-specific antibiotic resistance genes expression. *Diagn. Microbiol. Infect. Dis.* **106**, 115931 (2023).
36. Höfte, M., Buysens, S., Koedam, N. & Cornelis, P. Zinc affects siderophore-mediated high affinity iron uptake systems in the rhizosphere *Pseudomonas aeruginosa* 7NSK2. *Biometals* **6**, (1993).
37. Antoine, C. *et al.* Efficacy assessment of PEV2 phage on *Galleria mellonella* larvae infected with a *Pseudomonas aeruginosa* dog otitis isolate. *Res. Vet. Sci.* **136**, 598–601 (2021).
38. Champion, O. L., Wagley, S. & Titball, R. W. *Galleria mellonella* as a model host for microbiological and toxin research. *Virulence* **7**, 840–845 (2016).
39. Hamilton, M. A., Russo, R. C. & Thurston, R. V. Trimmed Spearman-Kärber method for estimating median lethal concentrations in toxicity bioassays. *Environ. Sci. Technol.* **11**, 714–719 (1977).

1.6 Annexes

Inhibition curve of LasB by NbLasB

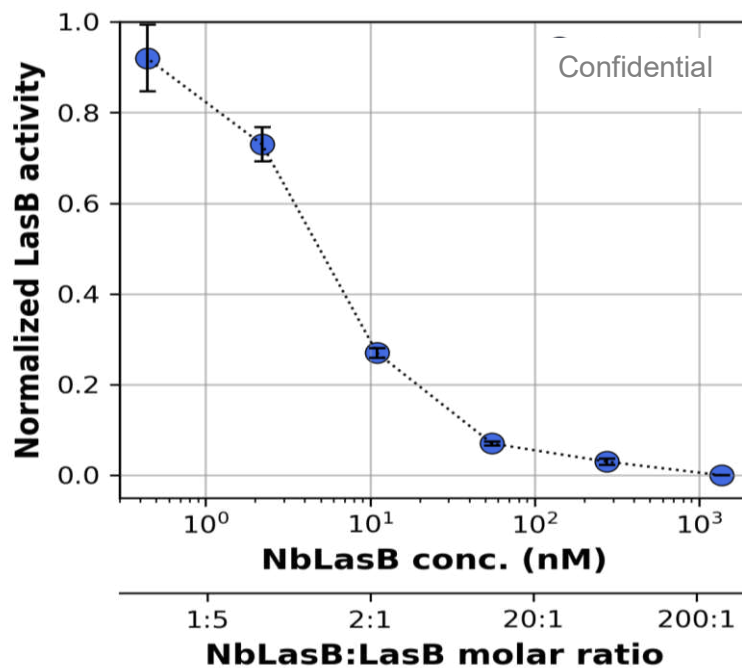


Figure 1: Inhibition curve of LasB by the inhibitory VHH NbLasB. The activity was monitored using a small peptide substrate.

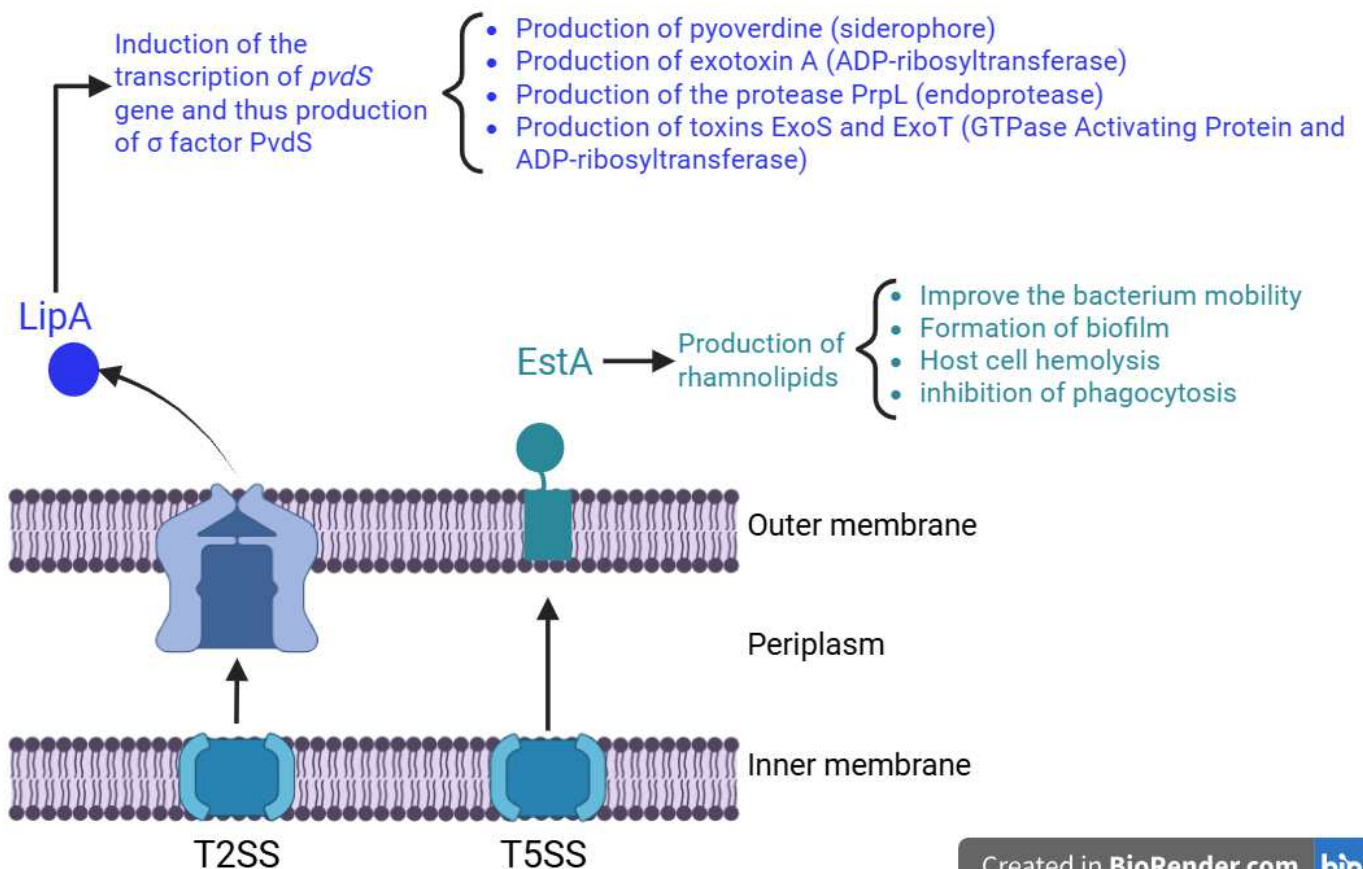


Figure 2: Schematic representation of roles of the lipolytic enzymes LipA and EstA from *Pseudomonas aeruginosa* and their secretion/addressing pathways (T2SS for LipA; T5SS for EstA).

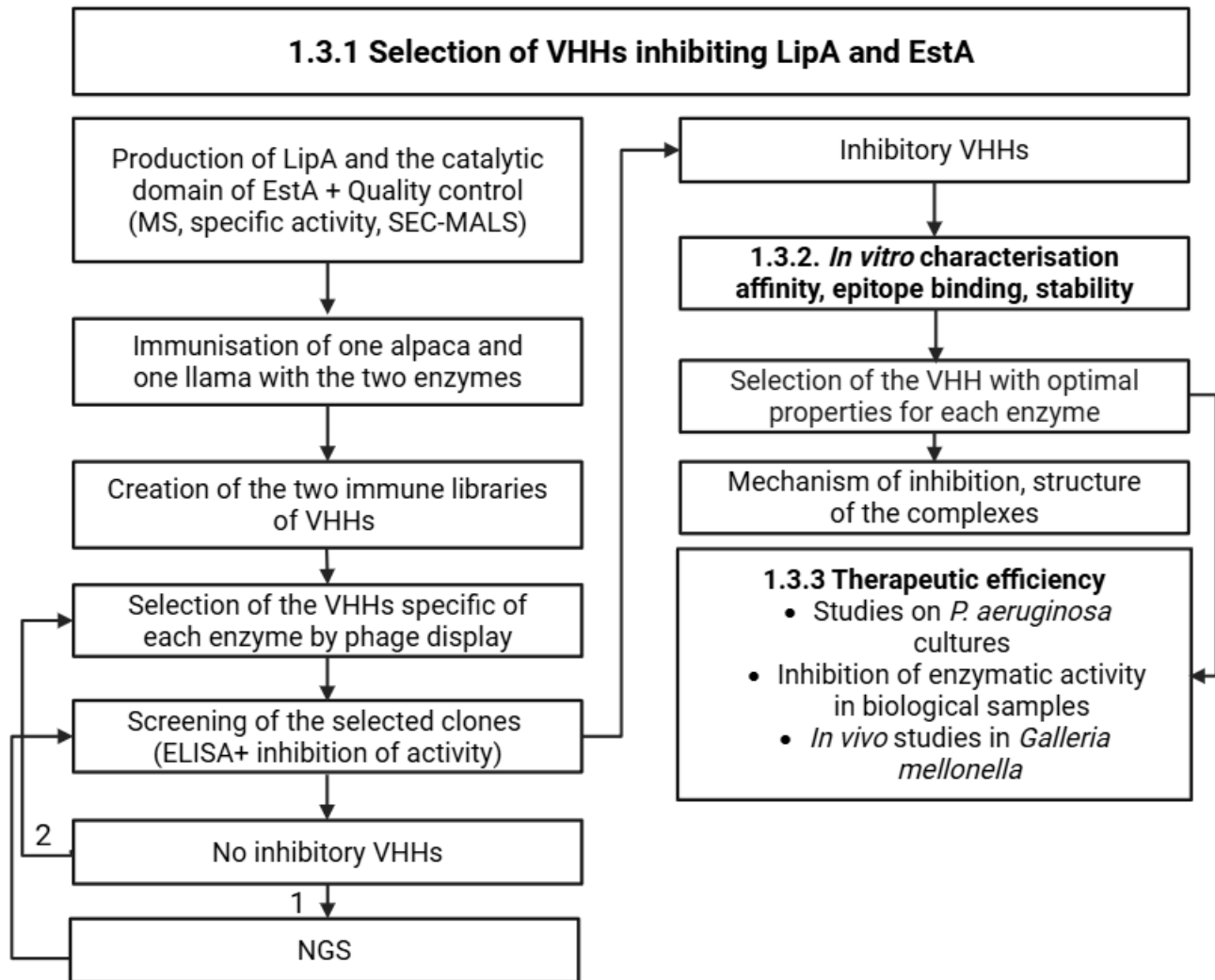


Figure 3: Schematic representation of the workflow. In the very unlikely case that this procedure does not allow the selection of inhibitory VHHs, all the clones selected during rounds 2 and 3 of panning will be submitted to Next Generation Sequencing (NGS) in order to identify the families of VHHs present in low amounts and therefore difficult to isolate using the standard screening procedure (Arrow 1). If necessary new panning campaigns with alternative set-ups will be carried out (e.g., modification of the method of immobilisation of the antigen, alternative elution methods) (Arrow 2).

2. COMMENTS ON CHANGES MADE IN THE RESEARCH PROJECT IN CASE OF RESUBMISSION (OPTIONAL)

In case of former application submitted to the F.R.S.-FNRS via the same funding instrument, please specify the main changes made in your funding application following previous submission, identifying comments from experts that you may have taken into account (max. 1 page).

[Enter text here. Format: Arial 12, single space]

3. ACTIVITIES REPORT ON THE FIRST YEAR OF DOCTORATE

ONLY FOR “1ST GRANT - 2ND YEAR”

Please write a brief report (max. 2 pages) underlining the progress of your research during the first year of your doctorate.

[Enter text here. Format: Arial 12, single space]

4. POTENTIAL INTERDISCIPLINARY APPROACH OF THE RESEARCH PROJECT (OPTIONAL)

If applicable, please identify the interdisciplinary approach of your research project (max. 1 page).

This highly interdisciplinary project requires expertise in the generation of VHHs in alpacas/llamas (1) and their selection by phage display (2), in protein production by recombinant technology in *E. coli* (3), in physico-chemical and functional characterization of proteins (enzyme activity, affinity, epitope binning, and stability, etc) (4), in structural biology (5), in the culture of *Pseudomonas aeruginosa* (growth curve, formation of biofilm, mobility, etc.) (6) and in *in vivo* experiments in *Galleria mellonella* (7). The expertise (1) will be outsourced to the CER-group (Aye, Belgium). The expertise (2-4) and (6) will be provided by the group of the promoter, Dr M. Dumoulin. Expertise (5) will be provided by the group of Dr F. Kerff (X-ray crystallography), with whom the promoter has a longstanding collaboration and the group of A. Vanden Broeck (Cryo-EM). HDX-MS experiments will be done in the laboratory of Prof. Polverino de Laureto at the University of Padova (Italy) with whom the promoter has already collaborated to map the epitopes of several VHHs directed against neutrophil elastase. The expertise (7) is available in the group of Dr Damien Thiry (Bactériologie vétérinaire et maladies bactériennes animales, Faculty of Veterinary Medicine, ULige), with whom the group of the promoter is currently collaborating in the framework of the anti-LasB VHHs.

In late 2019, the promoter has set up a phage display lab in CIP (AlpaNano, www.alpanano.uliege.be) to select VHHs (or other proteins) from immune or synthetic libraries. Since then, the group has created 8 immune libraries from which more than 150 VHHs have been selected against 20 different antigens. The NEPTUNS lab has developed several approaches to favour the selection of enzyme inhibitory VHHs. Using these approaches, it has selected VHHs fully inhibiting the human neutrophil elastase, elastase B from *Pseudomonas aeruginosa* (LasB), the beta-lactamase NDM1, the beta-lactamase CMY2 and the protease Bone morphogenetic protein 1 (BMP1). The expertise strongly supports the feasibility of the project. The NEPTUNS group has all the expertise for the *in vitro* characterization of the VHHs. This includes the determination of their affinity, their specificity, their thermodynamic stability, and their biologic activity (i.e., inhibition of amyloid fibril formation, inhibition of enzymes, etc.) and their engineering to adapt their properties (affinity, stability, immunogenicity, versatility to be labelled, creation of bispecific or biparatopic constructs) to requirements of their applications.

The promoter is involved in two projects related to the anti-virulence therapeutic approach: (i) an interuniversity FRS-FNRS PDR (2021-2025) together with the group of Rita Vanbever (UCLouvain) aiming at generating VHHs inhibiting the *Pseudomonas elastase* LasB; and the MSCA REMOD-HEALING (2025-2029) which aims at deciphering the role of proteases (endogenous and from bacterial origin) in extracellular matrix remodelling in cutaneous wounds to promote better healing.

5. DESCRIPTION OF THE WORK ENVIRONMENT

Please provide the information accounting for the adequacy of the environment (available intellectual and/or material means) to carry out the research as detailed in the submitted project. Please specify the assets of the research environment related to the project and the main publications of the laboratory/promoter (max. 1 page).

[Enter text here. Format: Arial 12, single space]

NEPTUNS is part of the Center for Protein Engineering (CIP) at the ULiege. Based on the expertise of ten principal investigators various research themes, all centred on proteins, are developed including antibiotic resistance, protein folding, protein misfolding and aggregation, protein engineering, *Streptomyces* genetics and development, bacterial cell walls and cell division. The research projects are therefore varied and interdisciplinary; they are enriching for each lab member. Exchanges of scientific expertise are stimulated through regular lab meetings and equipment is shared between the Principal Investigator teams.

All the techniques, equipment and associated expertise needed to carry out the project are available in the Center for Protein Engineering or available through collaborations.

From the Center for Protein Engineering (C.I.P., www.cip.ulg.ac.be), the group of M. Dumoulin has access to all the modern equipment needed for research in protein chemistry and molecular biology. The CIP has developed, a 'Production and Purification' platform (Protein Factory) and a robotic platform for high-throughput microplate mutagenesis and purification (Robotein®). The use of the equipment from these platforms (www.proteinfactory.ulg.ac.be/equipment and www.robotein.ulg.ac.be) will allow us to efficiently produce and purify the VHHs of interest in sufficient quantities and to characterize them.

The equipment available in these two platforms includes: various incubators/shakers, fermenters (from 1 to 15 L), a range of purification systems (three NGC Chromatography Systems from Bio-Rad, two ÄKTA Prime, one ÄKTA Purifier 100, one ÄKTA Explorer 100, three ÄKTA Explorer 10S 2D LC with an autosampler and a Frac 950 Collector (Deepwell, microtitre plates) for 2D chromatography from GE Healthcare), a liquid handling workstation, an EasyPick Microlab STARlet workstation, a Microlab STAR Microfluidics Capillary Electrophoresis for protein characterization, an Octet HTX platform for measuring biomolecule interactions, and 1 SEC-MALS (size exclusion chromatography-multiple angle light scattering).

CIP equipment also includes: all equipment for classical molecular biology work, fluorescence spectrophotometers, UV/visible absorbance and circular dichroism, fluorescence and UV / visible absorbance spectrophotometers for microplates and an Ellipse robot (ASM) to carry out high-throughput enzyme activity measurements.

The group of the promoter has set-up a platform (AlpaNano) to generate and select VHHs from large combinatorial libraries. The equipment of this platform includes several hoods, a spectrophotometer, two incubators and a Kingfisher-Flex robot.

6. SUMMARY OF THE MASTER'S THESIS OR EQUIVALENT

Please provide a summary of your master's thesis or any equivalent, even if you have not graduated yet (max. 1 page).

[Enter text here. Format: Arial 12, single space]

My master's thesis is divided into two distinct projects with a common focus on the selection and characterization of Nanobodies® (VHHs). VHHs are binding domains of heavy-chains antibodies found in the blood of Camelidae. Discovered in 1989, VHHs possess many interesting properties that have led to their increased use in both fundamental research and in biotechnological and medical applications. The first project focuses on TFIP11. TFIP11 is a protein involved in numerous interactions, particularly via its G-Patch domain, with several important components of the spliceosome. These interactions are not always possible due to the presence or the absence of reversible post-translational modifications, which means that splicing may not occur. Currently, the necessary and sufficient post-translational modifications required to ensure TFIP11's function within the spliceosome are unknown. This first project aims to select VHHs targeting the G-Patch, specifically focusing on two post-translational modifications. The goal is to conduct experiments such as *in vivo* visualization to determine the presence or the absence of post-translational modifications and better understand their role in the formation of the spliceosome. To achieve the selection of VHHs, a panning by phage display was carried out from an immune library of VHHs genes, followed by a screening via an ELISA have been performed. The selected VHHs were produced in *E. coli* and purified before being characterized. In this project, only one VHH was selected, but after characterization by ELISA and Biolayer interferometry (BLI), it unfortunately did not bind to the G-Patch. The second project concerns the LasB metalloprotease from *Pseudomonas aeruginosa*. *P. aeruginosa* is an opportunistic pathogenic bacterium in the top 3 of antibiotic-resistant strains responsible for more than 500,000 deaths in 2019. The LasB protease is a zinc metalloprotease and is one of the main virulence factors secreted by *P. aeruginosa*, causing damage to host tissues and affecting the immune response. No effective and selective inhibitors have yet been found. This second project aims to select VHHs targeting LasB, specifically inhibiting LasB effectively and selectively. To achieve this aim, the same strategy as that described above for TFIP11 was carried out. The selected VHHs were produced and purified and their ability to bind/inhibit LasB was investigated. In this project, only one VHH was selected, but after characterization tests (BLI), it unfortunately did not bind to LasB.

7. ADDITIONAL COMMENTS (OPTIONAL)

If you want to communicate elements that have not been mentioned elsewhere in the file, please provide this information below in max. 2 pages.

Please note that in case the presented project provides for the involvement of patients and/or human or animal subjects, it is important that the project includes justifications on the planned sample size (number of subjects included in the study/studies) and how the size is relevant (based on statistical power calculations, for instance). It is also important to explain how the number of patients/subjects expected can be reached. In case the project provides for the involvement of patients and/or subjects, please provide those pieces of information under this section (if not already mentioned elsewhere in the project). Ultimately, this information (or the lack of information) may be taken into account by experts in the frame of the evaluation of your funding application

1. Parts of the work involve the culture of *P. aeruginosa* which requires the use of an L2 biosafety cabinet. Such equipment is available both at CIP and in the laboratory of Dr Damien Thiry. The group of M. Dumoulin is currently working with several strains of *P. aeruginosa* in the context of an FRS-FNRS interuniversity project aiming at inhibiting the metalloprotease LasB with VHHs. Thus, all the expertise to work in an L2 biosafety cabinet is available as well as some of the downstream analyses (quantification of biofilm formation, enzyme inhibition from supernatant).

2. Wounds exudate samples will be provided by the group of Dr Alexander Nyström from the University of Freiburg (Department of Dermatology, Germany).with whom M. Dumoulin is collaborating within the MSCA project ROMOD-HEALING, which aim at deciphering the role of proteases in Extracellular Matrix Remodelling in Cutaneous Wounds to Promote Better Healing. The biological samples are collected as residual material from medical interventions; consequently, no specific ethical authorization is necessary.

3. *In vivo* studies will involve *Galleria mellonella* larvae as infection model of *P. aeruginosa*. The use of *G. mellonella* as *in vivo* model for bacterial infection is an established procedure to perform initial *in vivo* screening of novel compounds prior to using mammalian models.

The larvae survival assay will be performed in the laboratory of Prof. Damien Thiry (University of Liège) following established protocols ([doi: 10.3390/v11050411](https://doi.org/10.3390/v11050411)). Larvae that exhibit lack of movement and do not respond to touch will be considered dead. The model will be generated by injecting a bacterial suspension into the *G. mellonella* larvae. Additionally, color change to dark brown or black, which indicates melanization, can serve as a supplementary indicator of death. The Groups of 10 larvae will be infected with inocula of *P. aeruginosa* containing between 2.5×10^1 CFU/mL to 2.5×10^3 CFU/mL. The effects of VHHs will be tested by using different VHH concentrations and larvae survival will be monitored for 4 days.

8. PH.D. WORK CALENDAR PER MONTH

Please provide a calendar on a monthly basis for your Ph.D. works planned for the next 3 years (1st grant - 2nd year) or 4 years (1st grant - 1st year) (max. 2 pages).

[Enter text here. Format: Arial 12, single space]

Task	Semesters							
	1	2	3	4	5	6	7	8
<i>Selection of anti-LipA and anti-EstA VHHs (WP1)</i>								
Production and purification of the antigens	■							
Immunisation of one alpaca and one llama with LipA and EstA		■						
Creation of the two immune libraries		■						
Selection of inhibitory VHHs against the 2 enzymes			■					
<i>Characterization of VHHs (WP2):</i>								
Production of the inhibitory VHHs in large amounts			■	■				
<i>In vitro</i> characterization (affinity, epitope binning, stability)			■	■	■			
Mechanism of inhibition & structure of the complexes				■	■			
<i>Therapeutic efficacy studies (WP3)</i>								
Studies on <i>P. aeruginosa</i> cultures						■	■	
Inhibition of LipA and EstA activity in clinical samples						■		
<i>In vivo</i> experiments in <i>Galleria mellonella</i>						■	■	
<i>Articles, presentation at conferences and thesis</i>				■			■	■

RÉSULTATS ACADÉMIQUES ET CLASSEMENT, TOUTES SPÉCIALITÉS CONFONDUES

ACADEMIC RESULTS AND RANKING *CONSIDERING ALL DISCIPLINES*

Document à faire compléter par la(les) Faculté(s) ayant délivré le(s) diplôme(s), à dupliquer autant de fois que nécessaire, avant de le transformer en un seul document (format PDF). / Document to be completed by the Faculty/Faculties which awarded your degree(s), to duplicate as many times as necessary before converting into a single file (PDF format).

Si la Faculté n'est pas en mesure de délivrer ces informations, elle complètera les cases par "NA" (non applicable). / In case required information may not be disclosed by the Faculty, it should be mentioning "NA" (not applicable).

Nom et prénom de la candidate ou du candidat / Full name of the applicant	PROPS Charles-Henri
---	----------------------------

Cycle(s) précédant le doctorat <i>Cycle before postgraduate</i>	# années effectives suivies pour obtenir le diplôme / # années théoriques prévues dans le cycle <i># effective years for obtaining the degree / # years theoretically provided for in the degree cycle</i> Ex / e.g.: 5/4	Mention ou % obtenu <i>Honours/classification or % obtained</i>
Master ou équivalent ¹ / <i>Master or equivalent</i>	2/2	Distinction
Bachelier / <i>Undergraduate</i>	3/3	Distinction
Classement de la candidate ou du candidat concernant le diplôme de Master ou équivalent par rapport au nombre de candidat-e-s en fin de cycle / <i>Master or equivalent ranking of the applicant out of the number of students to be graduated.</i>		
12 ^e / 35 étudiants (Finalité approfondie) et 12 ^e / 38 étudiants (toutes finalités confondues)		
Mémoire de Master : mention ou % obtenu / <i>Master's thesis: Honours/classification or % obtained.</i> <i>Pour les étudiant-e-s devant encore terminer le cycle, indiquez « en cours » / For students who have not finished yet, indicate "In progress".</i>		
75 %		

Date
Le 19 août 2025

Cachet de la Faculté² / Seal of the Faculty²



Apparitorat de la Faculté des Sciences
Kristel KARREMANS

K. Karremans
BUREAU DE LA FACULTE DES SCIENCES
Institut de Chimie Bât. B 6
Sart-Tilman - B-4000 Liège

¹ Pour les candidates et candidats n'ayant pas encore terminé leur cursus, il y a lieu de joindre un relevé de notes des examens présentés dans le cadre du Master. / Applicants currently in pursuit of their degree must submit a copy of their Master degree transcript listing the exam taken and marks/grades awarded.

² Ce document n'est pas valable sans le cachet de la Faculté. / The document is invalid if the seal of the Faculty is missing.



U N I V E R S I T É D E L I È G E

COMMUNAUTÉ FRANÇAISE DE BELGIQUE

Université de Liège

Faculté des Sciences

Domaine : Sciences

Vu le décret du 7 novembre 2013 définissant le paysage de l'enseignement supérieur et l'organisation académique des études;

Nous, Président, Secrétaire et Membres du jury chargé de conférer le grade académique concerné, déclarons que

Charles-Henri A.A. PROPS

né à Liège (Belgique), le 4 décembre 2001 (n° de Registre national : 01120400905)

a obtenu en l'année académique **2023-2024**

le grade académique de

Master en biochimie et biologie moléculaire et cellulaire, à finalité approfondie

avec distinction

En foi de quoi, nous lui avons délivré le présent diplôme, attestant en même temps que les prescriptions légales relatives aux conditions d'accès, aux programmes, au nombre de crédits y associés (minimum 120 crédits) et à la publicité des examens ont été observées.

Le Président du Jury

Le Secrétaire du Jury

La Rectrice

Le Titulaire

Asvysen



Communauté française de Belgique

Université de Liège

SUPPLÉMENT AU DIPLÔME

Ce supplément au diplôme est conforme au modèle élaboré par la Commission européenne, le Conseil de l'Europe et l'UNESCO / CEPES.

Le supplément au diplôme vise à fournir des données indépendantes et suffisantes pour améliorer la "transparence" internationale et la reconnaissance académique et professionnelle équitable des qualifications (diplômes, acquis universitaires, certificats, etc.). Il est destiné à décrire la nature, le niveau, le contexte, le contenu et le statut des études accomplies avec succès par la personne désignée par la qualification originale à laquelle ce présent supplément est annexé. Il doit être dépourvu de tout jugement de valeur, déclaration d'équivalence ou suggestion de reconnaissance. Toutes les informations requises par les huit parties doivent être fournies. Lorsqu'une information fait défaut, une explication doit être donnée.

This Diploma Supplement model is consistent with the one developed by the European Commission, Council of Europe and UNESCO / CEPES.

The purpose of the supplement is to provide sufficient independent data to improve the international "transparency" and fair academic and professional recognition of qualifications (diplomas, degrees, certificates etc.). It is designed to provide a description of the nature, level, context, content and status of the studies that were pursued and successfully completed by the individual named on the original qualification to which this supplement is appended. It should be free from any value judgements, equivalence statements or suggestions about recognition. Information in all eight sections should be provided. Where information is not provided, an explanation should give the reason why.

AVERTISSEMENT: Ce présent supplément ne vaut qu'accompagné du diplôme officiel / This diploma Supplement is only valid if presented with the official diploma.

1. INFORMATIONS SUR LE TITULAIRE DU DIPLÔME / INFORMATION IDENTIFYING THE HOLDER OF THE QUALIFICATION

- 1.1. **Nom de famille** / Family name(s) : PROPS
- 1.2. **Prénom(s)** / Given name(s) : Charles-Henri A.A.
- 1.3. **Date (jour / mois / année) et lieu de naissance (pays)** / Date (day / month / year) and place of birth (country) : 4 décembre 2001, Liège (Belgique)
- 1.4. **Numéro de matricule** / Student identification number : 20195871

2. INFORMATIONS SUR LE DIPLÔME / INFORMATION IDENTIFYING THE QUALIFICATION

- 2.1. **Intitulé du diplôme et titre conféré** / Name of qualification and title conferred :
Master en biochimie et biologie moléculaire et cellulaire, à finalité approfondie
- 2.2. **Domaine d'études correspondant au diplôme** / Main field(s) of study for the qualification : Sciences
- 2.3. **Nom et statut de(s) établissement(s) ayant délivré le diplôme (dans la langue originale)** / Name and status of awarding institutions (in original language) :
Université de Liège
Place du 20-août, 7 - 4000 Liège (Belgique)
<https://www.uliege.be>
Statut : public (établissement d'enseignement universitaire reconnu officiellement par la Communauté française de Belgique conformément à l'article 10 du décret du 7 novembre 2013 définissant le paysage de l'enseignement supérieur et l'organisation académique des études et contrôlé par son gouvernement via un commissaire de ce dernier (décret du 12 juillet 1990 sur le contrôle des institutions universitaires))

2.4. Nom(s) et statut(s) de l' (des) établissement(s) (si différent(s) du point 2.3.) dispensant les cours /
Name(s) and status of institution(s) (if different(s) from 2.3.) administering studies :

Non applicable

2.5. Langue(s) de formation/d'examen / Language(s) of instruction/examination :

En Communauté française :

La langue d'enseignement et d'évaluation des activités d'apprentissage est le français.

Toutefois, des activités peuvent être dispensées et évaluées dans une autre langue :

1° dans le premier cycle d'études, à raison d'au plus un quart des crédits;

2° pour les études menant au grade académique de master, sauf pour les crédits spécifiques à la finalité didactique, à raison de la moitié des crédits;

3° pour les études coorganisées par plusieurs établissements d'enseignement supérieur, dont au moins un établissement extérieur à la Communauté française;

4° pour les études de spécialisation;

5° pour les études de troisième cycle;

6° pour les études de formation continue et autres formations.

De manière générale, toute activité d'apprentissage d'un cursus de premier ou deuxième cycle peut être organisée et évaluée dans une autre langue si elle est organisée également en français; cette obligation est satisfaite pour les options ou pour les activités au choix individuel de l'étudiant s'il existe au moins un autre choix possible d'options ou d'activités organisées en français.

Pour l'application des points 1° et 2°, les enseignements de langues étrangères, les travaux de fin d'études, les activités d'intégration professionnelle ainsi que les activités d'apprentissage qui sont coorganisées par des établissements extérieurs à la Communauté française reconnus par leurs autorités compétentes en matière d'enseignement supérieur n'entrent pas en ligne de compte.

Pour les études de deuxième cycle, le Gouvernement peut en outre accorder aux établissements d'enseignement supérieur des dérogations lorsque les études visées ont un caractère international dérivant de l'excellence du champ scientifique ou artistique, ou de sa nature particulière. Les dérogations sont accordées sur proposition de l'ARES.

Concernant l'étudiant :

Langue des Unités d'enseignement (Hors TFE) : en français 100%.

Voir le point 4.3.

3. INFORMATIONS SUR LE NIVEAU DE QUALIFICATION / INFORMATION ON THE LEVEL OF THE QUALIFICATION

3.1. Niveau de qualification / Level of qualification : Etudes universitaires (enseignement de type long) de 2^e cycle, niveau 7 du cadre des certifications de l'enseignement supérieur de la Communauté française de Belgique. Voir rubrique 8.

3.2. Durée officielle du programme / Official length of programme : 120 crédits minimum

3.3. Condition(s) d'accès / Access requirement(s) :

Conditions légales minimales :

Accès aux études de 2^e cycle

a) Admission jusqu'à l'année académique 2014-2015

- soit le grade académique de premier cycle du même cursus

- soit le même grade académique de deuxième cycle, mais avec une autre finalité

- soit un grade académique des universités, en vertu d'une décision des autorités académiques et aux conditions complémentaires qu'elles fixent (maximum 15 crédits supplémentaires)

- soit un grade académique de premier cycle du type long non universitaire correspondant à un grade académique universitaire en vertu de l'article 38, §2, aux conditions complémentaires fixées par les autorités académiques

- soit un grade académique du type long qui y donne accès en vertu d'une décision du Gouvernement et aux conditions complémentaires qu'il fixe

- soit un grade académique similaire à ceux mentionnés aux littéra précédents délivré en Communauté flamande, en Communauté germanophone ou par l'Ecole royale militaire, aux mêmes conditions
- soit un grade académique étranger reconnu équivalent à ceux mentionnés aux littéra 1 à 4 en application de ce décret, d'une directive européenne ou d'une convention internationale, aux mêmes conditions
- soit d'un grade académique de premier cycle de l'enseignement supérieur hors université délivré en Communauté française aux conditions. Ces conditions peuvent consister à suivre des enseignements complémentaires représentant maximum 60 crédits supplémentaires. Lorsque la charge supplémentaire dépasse 15 crédits, elle constitue une année d'études préparatoire.
- soit d'un grade académique d'une université belge ou d'un établissement d'enseignement supérieur en Communauté flamande ou germanophone ou de l'Etat fédéral ou de l'Ecole royale militaire ou d'un grade étranger, sanctionnant des études de premier cycle et valorisé par le jury pour 180 crédits au moins, et ne donnant pas accès aux études de deuxième cycle en application des littéra 1 à 8.
- soit d'une expérience personnelle ou professionnelle valorisée par le jury au terme d'une procédure d'évaluation organisée par les autorités académiques.

Cas particulier de l'étudiant auquel il reste un maximum de 12 crédits pour se voir conférer le grade de premier cycle

Cet étudiant a accès aux études de deuxième cycle s'il est inscrit simultanément aux études de premier cycle. Cet étudiant ne pourra être délibéré par un jury de deuxième cycle avant d'avoir obtenu le grade académique de premier cycle nécessaire.

Cas particulier des masters à finalité didactique

L'étudiant ne peut être admis aux épreuves d'un master à finalité didactique que s'il a fait la preuve d'une maîtrise suffisante de la langue française.

b) Admission à partir de l'année académique 2015-2016

Ont accès aux études en vue de l'obtention du grade académique qui sanctionne des études de deuxième cycle les étudiants qui portent :

- 1° soit un grade académique de premier cycle du même cursus;
- 2° soit le même grade académique de deuxième cycle, mais avec une autre finalité;
- 3° soit un grade académique de premier ou de deuxième cycle de type long, en vertu d'une décision des autorités académiques et aux conditions complémentaires qu'elles fixent;
- 4° soit un grade académique similaire à ceux mentionnés aux littéras précédents délivré par un établissement d'enseignement supérieur, en Communauté française ou extérieur à celle-ci, en vertu d'une décision des autorités académiques et aux conditions complémentaires qu'elles fixent;
- 5° un grade académique étranger reconnu équivalent à un grade académique de 2e cycle donnant accès aux études visées en application de ce décret, d'une directive européenne, d'une convention internationale ou d'une autre législation, aux mêmes conditions.

Est similaire à un grade académique délivré en Communauté française, un titre ou grade conduisant aux mêmes capacités d'accès professionnel ou de poursuite d'études dans le système d'origine.

Les conditions complémentaires d'accès visées au 3° et au 4° sont destinées à s'assurer que l'étudiant a acquis les matières prérequis pour les études visées. Lorsque ces conditions complémentaires d'accès consistent en un ou plusieurs enseignements supplémentaires, ceux-ci ne peuvent représenter pour l'étudiant de 60 crédits supplémentaires, compte tenu de l'ensemble des crédits qu'il peut par ailleurs valoriser lors de son admission. Ces enseignements font partie de son programme d'études de deuxième cycle.

Ont également accès aux études en vue de l'obtention du grade académique qui sanctionne des études de deuxième cycle les étudiants qui portent :

1° un grade académique de premier cycle de type court, en vertu d'une décision du Gouvernement ou des autorités académiques et aux conditions complémentaires qu'elles fixent, sans que ces conditions ne puissent être plus restrictives que celles fixées par le Gouvernement ni n'établissent de distinction entre établissements ayant délivré le grade académique;

2° un grade académique similaire délivré par un établissement d'enseignement supérieur, en Communauté française ou extérieur à celle-ci, en vertu d'une décision des autorités académiques et aux conditions complémentaires qu'elles fixent;

3° un grade académique étranger reconnu équivalent à ceux mentionnés aux littéras précédents en application de ce décret, d'une directive européenne, d'une convention internationale ou d'une autre législation, aux mêmes conditions.

Les conditions complémentaires d'accès sont destinées à s'assurer que l'étudiant a acquis les matières pré-requises pour les études visées. Lorsque ces conditions complémentaires d'accès consistent en un ou plusieurs enseignements supplémentaires, ceux-ci ne peuvent représenter pour l'étudiant plus de 60 crédits supplémentaires, compte tenu de l'ensemble des crédits qu'il peut par ailleurs valoriser lors de son admission. Ces enseignements font partie de son programme d'études.

Par dérogation, les étudiants visés à l'article 100, § 2, 3° et 4° (étudiant n'ayant plus que 15 crédits à acquérir en 1er cycle et étudiant ayant plus de 15 crédits à acquérir et ayant obtenu l'autorisation du jury de 2e cycle pour s'inscrire) ont également accès aux études de 2eme cycle.

Aux conditions générales fixées par les autorités académiques, l'étudiant porteur d'un titre, diplôme, grade ou certificat délivré hors Communauté française qui ne lui donne pas accès aux études de deuxième cycle en vertu des paragraphes précédents peut toutefois y être admis par le jury des études visées, si l'ensemble des études supérieures qu'il a suivies avec fruit est valorisé par le jury pour au moins 180 crédits. En ce qui concerne les enseignements supplémentaires, l'étudiant est assimilé à ceux admis aux conditions visées au § 2.

Aux conditions générales que fixent les autorités de l'établissement d'enseignement supérieur et en application de l'article 119 du décret du 7 novembre 2013, en vue de l'admission aux études, les jurys peuvent valoriser les savoirs et compétences des étudiants acquis par leur expérience professionnelle ou personnelle.

Admission avant 2014-2015 : décret de la Communauté française de Belgique du 31 mars 2004.
Admission à partir de 2015-2016 : décret de la Communauté française du 7 novembre 2013.

Condition(s) remplie(s) par le diplômé :

Est titulaire d'un diplôme de bachelier en sciences biologiques délivré par l'Université de Liège le 4 juillet 2022.

4. INFORMATIONS SUR LE CONTENU ET SUR LES RÉSULTATS OBTENUS / INFORMATION ON THE CONTENTS AND RESULTS GAINED

4.1. **Organisation des études** / Mode of study : Etudes temps plein

4.2. **Exigences du programme** / Programme requirements : <https://programme.uliege.be>

4.3. **Précisions sur le programme** / Programme details :

	Note	Pondération	Crédits
Enzymologie	12/20	3,33	3
Bioénergétique	16/20	3,33	3
Biologie structurale	15/20	3,33	4
Spectroscopies optiques pour la biochimie	13/20	3,33	2
Bioinformatique	14/20	3,33	3
Biologie des systèmes	19/20	3,33	2
Génie génétique	12/20	3,33	3
Génomique	19/20	3,33	3
Evolution génétique et biochimique	13/20	3,33	3
Stages ou travaux pratiques intégrés (y compris séminaires)	17/20	3,33	12
Mémoire (complément)	16/20	3,33	10
Du laboratoire à l'entreprise	14/20	3,33	3

	Note	Pondération	Crédits
Ecriture scientifique	16/20	3,33	2
Mémoire: Sélection et caractérisation de Nanobodies® dirigés contre TFIP11 et LasB	15/20	20,08	25
Stage en laboratoire dans le cadre d'un programme d'échange (Erasmus, Erasmus Belgica ...)	13/20	3,33	20
<i>Option « Biochimie et microbiologie »</i>			
Microbiologie industrielle	12/20	3,33	2
Virologie, immunologie et vaccinologie	18/20	3,33	3
Protistologie	16/20	3,33	2
Pathogenèse bactérienne	14/20	3,33	2
Microorganismes extrémophiles	16/20	3,33	2
Développement des microorganismes	18/20	3,33	2
Biochimie et physiologie des microorganismes	12/20	3,33	2
Spectrométrie de masse biologique	18/20	3,33	2
Application de techniques spectroscopiques à l'étude du repliement et de la stabilité des protéines	16/20	3,33	3
Bioénergétique appliquée	15/20	3,33	2

4.4. Système de notations et informations concernant la répartition des notes / Grading scheme and grade distribution guidance :

Conformément aux articles 139 et 140 du décret du 7 novembre 2013 définissant le paysage de l'enseignement supérieur et l'organisation académique des études, l'évaluation finale d'une unité d'enseignement s'exprime sous forme d'une note, comprise entre 0 et 20, le seuil de réussite étant 10/20. Si ce seuil n'est pas atteint, le jury peut souverainement proclamer la réussite d'une unité d'enseignement, de l'ensemble des unités suivies durant une année académique ou d'un cycle d'études.

Les notes inférieures à 10/20 (*) considérées par le jury comme ayant atteint le seuil de réussite ont été modifiées en ce sens en suivi de délibération.

Jusqu'à l'année académique 2014 – 2015, le seuil de réussite d'une année ou d'un cycle d'étude nécessitait, outre des notes égales ou supérieures à 10/20, une moyenne globale de 12/20, le jury restant toutefois souverain pour déroger à ces deux exigences.

A titre informatif, la distribution statistique des notes de réussite donne le tableau suivant (année 2015-2016 – cf. Guide d'utilisation ECTS) :

Note Locale	Pourcentage	Pourcentage cumulé
20	1,00 %	1,00 %
19	1,58 %	2,58 %
18	5,00 %	7,58 %
17	7,93 %	15,51 %
16	12,86 %	28,37 %
15	14,52 %	42,89 %
14	16,37 %	59,26 %
13	13,92 %	73,18 %
12	12,37 %	85,55 %
11	8,17 %	93,72 %
10	6,28 %	100 %

Tableau réalisé sur la base des notes obtenues lors des années académiques 2013-2014 et 2014-2015.

Règlement des examens : <https://www.enseignement.uliege.be/examens>

4.5. Classification générale du/de la diplômé-e / Overall classification of the graduate :

Sur base de l'ensemble des notes obtenues par l'étudiant-e au cours du cycle, le jury octroie éventuellement une mention {satisfaction (60%), distinction (70%), grande distinction (80%), plus grande distinction (90%)}

Mention obtenue par l'étudiant : **Distinction**

5. INFORMATIONS SUR LA FONCTION DE LA QUALIFICATION / INFORMATION ON THE FUNCTION OF THE QUALIFICATION

5.1. Accès à un niveau d'études supérieur / Access to further study :

Les titulaires d'un grade académique de bachelier de type long ont accès aux études conduisant au grade de master, médecin ou médecin vétérinaire; les titulaires d'un grade académique de master ont accès aux études universitaires sanctionnées par le grade académique d'agrégé de l'enseignement secondaire supérieur qui habilite à enseigner dans un établissement d'enseignement secondaire, aux études universitaires sanctionnées par un grade académique de master de spécialisation et aux études de 3e cycle; les titulaires d'un grade académique de master de spécialisation ont accès aux études de 3e cycle.

5.2. Statut professionnel / Professional status :

Non applicable

6. INFORMATIONS COMPLÉMENTAIRES / ADDITIONAL INFORMATION

6.1. Informations complémentaires / Additional information :

Stage chez IHU-Méditerranée Infection (France) du 3 octobre 2023 au 22 décembre 2023

6.2. Autres sources d'information / Further information sources :

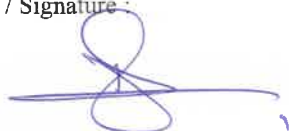
- Université de Liège : <https://www.uliege.be/>
- Faculté : <https://www.sciences.uliege.be>
- Ministère de la Communauté française: www.federation-wallonie-bruxelles.be et www.enseignement.be
- ENIC-NARIC : www.enic-naric.net
- ARES : www.ares-ac.be

7. CERTIFICATION DU SUPPLÉMENT / CERTIFICATION ON THE SUPPLEMENT

Le présent supplément au diplôme concerne les documents originaux suivants : le diplôme n°236928 de Master en biochimie et biologie moléculaire et cellulaire, à finalité approfondie

7.1. Date / Date : 10 septembre 2024

7.2. Signature / Signature :



7.3. Fonction / Capacity : le Secrétaire du Jury

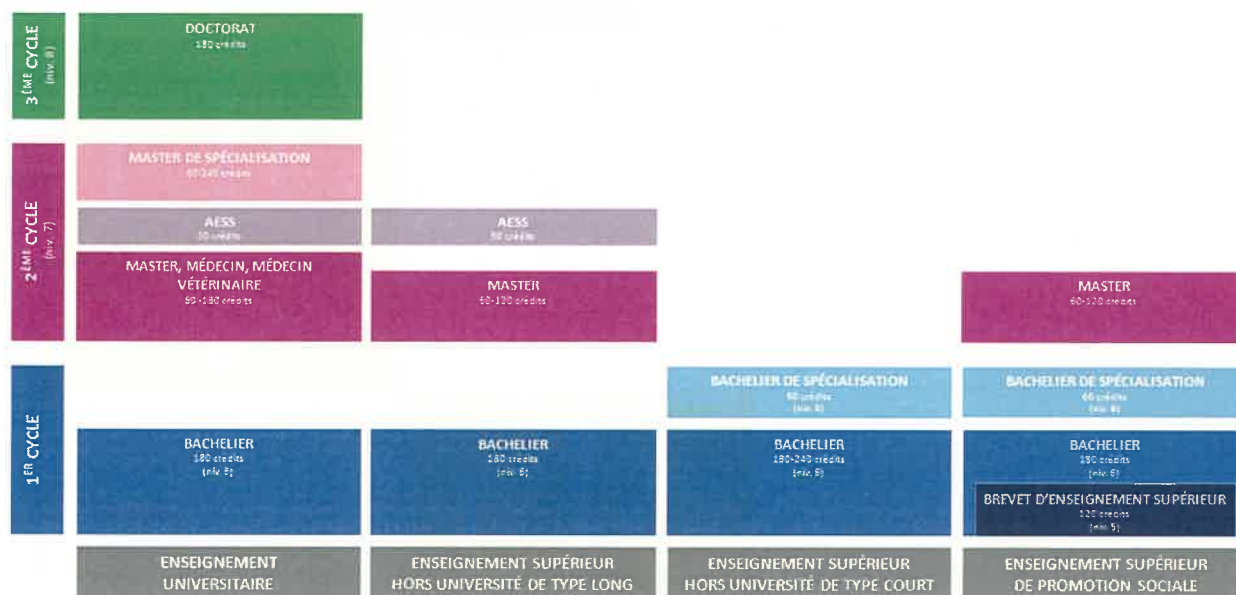
7.4. Tampon officiel ou sceau / Official stamp or seal :



Eva ZERMETZ
Directrice du Service des Affaires académiques

8. INFORMATION SUR LE SYSTÈME NATIONAL D'ENSEIGNEMENT SUPÉRIEUR / INFORMATION ON THE NATIONAL HIGHER EDUCATION SYSTEM

Aperçu de la structure, des diplômes, grades, titres et types d'enseignement supérieur en Fédération Wallonie-Bruxelles (conformément aux dispositions du décret de la Communauté française du 7 novembre 2013 définissant le paysage de l'enseignement supérieur et l'organisation académique des études)



Les études de médecine entamées par un étudiant avant l'année académique 2012-2013 comportaient 7 années d'études.