Project Number: [956004]
Project Acronym: [BioTrib]
Project title: [**Advanced Research Training for the Biotribology of Natural and Artificial Joints in the 21st Century**]

Supervisor Training

Deliverable D2.2
Month Due: M3
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Project coordinator name	Prof. Richard M Hall
Project coordinator organisation name	UNIVLEEDS
Report prepared by	Prof Richard M Hall

Dissemination Level of Report

PU	Public	x
PP	Restricted to other program participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

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D2.2	**26.03.21**	**Submitted to Commission**	**Judith Schneider (UNIVLEEDS)**

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1. Introduction

Supervision is one of the corner stones of PhD process. This important, indeed critical relationship, between research academic and the postgraduate researcher (PGR) is of critical importance to the successful completion of the PhD lifecycle and the wider professional development of the candidate. It is increasingly seen as providing a young innovator as having the necessary skills for a career in industry as well as academia.

2. Supervision within BioTrib

The supervisor-PGR relationship is a key aspect of the delivery of the programme of research training that is aligned with the Principles of Innovative Doctoral Training (Table 1). This is achieved either directly in ensuring a support professional environment or indirectly through contributions to wider regulations, standards and contribution to the broader research environment.

Table 1: Adherence to the Principles for Innovative Doctoral Training[i] by BioTrib

Attribute	Evidence
Research Excellence	All five universities are in the global 1%. Three in the top 100 with two, ETH Zurich and Imperial in the top 10 (Times) - all make significant investments to maintain their positions (e.g. UNIVLEEDS has invested over €500M in new facilities including the new BRAGG infrastructure complex for engineering). All have international reputations with facilities to support ESRs. The industrial beneficiaries are leaders in their fields with e.g. SimSol being a leading simulator manufacturer.
Attractive Institutional Environment:	As can be seen from the institutional description in section 5 the ESRs will be hosted in 'state-of-the-art' facilities with high end computational and experimental equipment as well as experienced support services familiar with EU grants. Each beneficiary provides a **supportive professional environment**, adhering to the European Charter for Researchers[ii].
Interdisciplinary Research Options	All the ESRs will be located in substantial engineering groups which have significant expertise in fields such as Tribology (UNIVLEEDS, LTU), Biomechanics (ETH Zurich) Computational Fluid Dynamics (IMPERIAL), and Polymer Science and Multifunctional biomaterials (LTU) and Material Science (UU), which together converge to form an interdisciplinary collective. Exposure to other fields will be generated through colloquium series, application of novel techniques in bioengineering and the supervision by personnel from outside the core medical engineering field.
Exposure to industry and other relevant sectors	Exposure to industry is a key feature of bioengineering where researchers are exposed to different sectors, most notably the healthcare and medical device manufacturing domains. In BioTrib this will be enhanced through the delivery of industrial and/or clinical secondments, supervision by experienced personnel from different sectors and participation in the career development plan.
International networking	The ESRs have significant opportunities to develop an in-depth understanding of the Pan-European dimension in healthcare engineering and the development of deep and lasting networks. This will be gained through secondments, short visits, shared research goals (see the WP descriptions) and conference presentations. We have 3 entities from outside Europe, 2 from China and 1 from Australia reflecting the truly global aspect of the medical device market.
Transferable skills training	Transferable skills training is provided through practice based training, network wide courses delivered in BioTrib and local host training at each beneficiary. In particular, the Innovation Manager will provide mentoring and tutoring on the requirements for successful exploitation. Secondments play a key role in the uptake of transferable skills by each ESR through placement in an environment not accessed in the academic units alone.
Quality Assurance	Each of the Universities has well-honed administrative processes that are transparent and accountable over the whole lifecycle; from application to final career option. The lead University, UNIVLEEDS, holds the 'HR Excellence in Research[iii] accreditation awarded by the EC in recognition of its commitment to ensuring good conditions and career skills for researchers.

BioTrib is delivered with experienced supervisors being a key and central resource to the Network. As well as having experience of one to one or small team supervisions, they have contributed to the wider community in terms of supervisory training, leadership and regulation.

3. Quality of the supervision

To allow the creation of a common platform and to enable consistency across partners a Supervision Training event was held on 16th February 2021. Prof Hall, who was Co-Head of the Graduate School: Physical Sciences and Engineering at the University of Leeds, delivered this training event. This event set out the roles, responsibilities and expectations of the supervisory teams within BioTrib including the use of the Personal Career Development Plan (PCDP). This training will encompass the good practice guidelines set out in the European Charter for Researchers[iv], European Standards for PhD Education[v], Framework for Qualifications of the European Higher Education Area[vi] and The Code of Conduct for the Recruitment of Researchers[vii] together with local provision (e.g. the Quality Code, Chapter B11 set out by the Quality Assurance Agency for Higher Education in the UK[viii]). In this context is important that the secondary supervisors are aligned with the ethos of local, ITN and EU expectation for supervision, given that they often come from a different sector. However, these supervisors often have a different perspective in terms of personnel management that can add to the culture and delivery of an exceptional PGR experience.

Each ESR will be allocated a primary supervisor as well as one or more secondary supervisors forming a supervisory team (**Table 2**). These supervisory teams are developed with the specific ESR in mind and reflect the interdisciplinary skills needed for the successful completion of the project. The main supervisor have expertise in the specific project field and dedicate at least 80 hrs per annum to each ESR. It is the primary supervisor who is responsible for the training, pastoral care, research and professional activities of the ESR during the PhD process. Supervisors will ensure that the ESRs receive and follow through with the training and research plans needed in order to be ready for their thesis defence within the allocated time, and achieve a degree tailored to high standards.

The ESRs will be recruited through an open, equality-led and transparent procedure which is informed by the necessary human resources' best practice and EU codes & laws as well as local guidance and legal responsibilities. Every effort will be made to ensure that both the recruitment and working environment are free from discrimination (e.g. at Leeds courses on Equality/Inclusivity and Unconscious Bias are mandatory by all personnel appointing staff). This will be further encouraged through explicit statements and referral to the generous mobility and family allowance available during the recruitment procedure, which we believe could further facilitate gender balance. Prior to arrival the ESRs will receive the practical information and guidance needed for a smooth insertion into the host country, including contracts, visa requirements and accommodation arrangements. Upon arrival they will acquire a structured introduction to the research group as well as wider resources such as library and language centre provision.

Structured supervisory meetings (minimum 24 per year) will take place regularly, for which agendas and minutes will be kept and logged in the ESR's PCDP. Discussions at supervisory meetings will revolve around advancement towards the global research objectives as well as individual training and career goals. In addition, group meetings will be undertaken, an environment which will allow social and research integration, enhanced critical skills and enable the ESR's project to be placed into the wider research and innovation context. All ESRs undertake a minimum of two secondments with one industrial internship as well as a second clinical and/or academic secondment.

3.1. Qualifications and supervision experience of supervisors

The **supervisory team** members have been chosen based on their **relevant, complementary expertise**, as well as their **experience in research management and student supervision**. All academic personnel have supervised a minimum of 5 PhD students and have considerable teaching experience both in terms of delivery but also in Quality Assurance and other Support Roles. All have experience of delivering training courses and modules to postgraduate students. Academic scientists-in-charge have experience in leading Work Packages in EU funded projects under FP7 or H2020 (e.g. Prof Ferguson led WP3 in LifeLongJoints, whilst Prof Persson is the Co-ordinator for Nu-Spine). Female role

models make up a significant number of ‘scientists in charge’ being at UU and LTU. Quality of the joint supervision can be assured by the experience of the joint supervision teams and the well-honed processes in each of the beneficiaries. Actionable feedback on potential setbacks may be identified through the supervision mechanism, namely written minutes of the regular supervision meetings. In addition, additional feedback will be given during the formal reviews that take place at regular intervals during the PhD lifecycle e.g. transfer stage at the University of Leeds. Feedback is validated at subsequent meetings to ensure compliance. The qualifications and supervision experience of academic supervisors of the ESRs are listed in

Table 3.

Table 2: ESR supervision and location

Researcher No.	Recruiting Participant (short name)	PhD awarding entities	Planned Start Month 0-45	Duration (months) 3-36	Supervision
1.	ETH Zurich	ETH Zurich	8	36	Prof Stephen Ferguson, PD Dr Benedikt Helgason, Prof Dr Michael Leunig
2.	ETH Zurich	ETH Zurich	10	36	Prof Stephen Ferguson, Prof Dr Michael Leunig
3.	ETH Zurich	ETH Zurich	13	36	Prof Stephen Ferguson, Dr Joern Seebeck
4.	LTU	LTU	8	36	Prof Nazanin Emami, Prof Roland Larsson Prof X Wang
5.	LTU	LTU	13	36	Prof Nazanin Emami, Prof Roland Larsson, Prof Joanne Tipper
6.	UU	UU	8	36	Assoc. Prof Johan Kreuger, Prof Cecilia Persson
7.	UU	UU	8	36	Prof Cecilia Persson, Dr Pelle Mellin
8.	UU	UU	13	36	Prof Urban Wiklund, Prof Cecilia Persson, Dr Pelle Mellin
9.	UU	UU	13	36	Dr Gry Hulsart-Billström, Assoc Prof. Johan Kreuger, Prof Cecilia Persson, Prof Nils Hailer
10.	IMP	IMP	8	36	Dr Connor Myant, Dr Robert Hewson
11.	IMP	IMP	8	36	Dr Robert Hewson, Dr Connor Myant,
12.	ETH Zurich	ETH Zurich	8	36	Prof Stephen Ferguson, Dr Joern Seebeck
13.	UNIVLEEDS	UNIVLEEDS	13	36	Prof Richard Hall, Dr Mike Bryant, Dr Greg de Boer, Prof Anthony Redmond
14.	UNIVLEEDS	UNIVLEEDS	13	36	Dr Mike Bryant, Prof Richard Hall
15.	UNIVLEEDS	UNIVLEEDS	13	36	Dr Mike Bryant, Prof Richard Hall
Total	**15**				

The commitment to the work of the Biotrib ESRs by the supervisors will be ensured by:

(1) The need to undertake a minimum number of supervision sessions per annum.
(2) The fact that there are supervisory teams in which share the load.
(3) These supervisors have exemplary records in PhD/ESR training and understand the processes within the PhD lifecycles to ensure successful completion.
(4) The PCDP will allow the supervisory board to validate the supervision being undertaken and the quality of feedback being delivered.

Table 3: Supervisors at the Beneficiaries

Host	Supervisor	Specific qualifications	Supervision Experience
UU	Prof Dr Cecilia Persson	Research: Materials synthesis and characterization, mechanical properties, biomechanics; Training: Co-ordinator and lecturer at UG and PG levels.	15 PhDs (6 ongoing); 9 post-docs;
	Dr Gry Hulsart-Billström	Research: *In vitro* and in vivo response to biomaterials. Training: PG course responsibility. Student supervision.	5 PhDs (1 ongoing); 10 MSc
	Assoc. Prof. Johan Kreuger	Research: Cell signaling, matrix biology, microfluidics, bioprining Training: Course leader and lecturer at UG and PG levels.	12 PhD students (6 as main supervisor: 3 ongoing),
ETH Zurich	Prof Stephen Ferguson	**Research**: Biomechanics, biomaterials, mechanobiology; **Training**: Co-ordinator and lecturer in courses on medical device design, clinical science and simulation.	37 PhDs (8 ongoing); 11 Postdocs (1 ongoing); >70 MSc
	PD Dr Benedikt Helgason	**Research:** Biomechanics, simulation, biomaterials, orthopaedic devices; **Training**: Lecturer in finite element analysis, mechanics and research methods.	6 PhDs (4 ongoing); 20 MSc
UNIVLEEDS	Prof Richard M Hall	**Research**: Biomechanics, Spinal devices; **Training**: Director of PGR studies for Engineering (600 students)	25 PhDs (8 on-going); 1 ongoing Postdoc
	Dr Greg De Boer[ix]		
	Dr Michael Bryant	**Research:** Biotribology, Tribo-corrosion; Biomaterials; **Training**: Coordinator of UG courses. Manages secondments within iFS UNIVLEEDS.	14 PhDs (10 ongoing); 2 post-docs
IMPERIAL	Dr Hewson	**Research:** Computational modelling and optimisation, tribology modelling across the lubrication regimes. **Training:** Programme director of MSc (70 students).	10 PhDs (6 ongoing), 3 postdocs (1 ongoing); 25 MSc projects and 70 UG projects
	Dr Connor Myant	**Research**: Experimental biotribology and rheology, Additive Manufacturing. **Training:** Coordinator for the Imperial-Royal College of Arts Global Innovation Design programme.	5 PhD students (5 ongoing), 1 postdoc (1 ongoing).
LTU	Prof Nazanin Emami	**Research:** Design and manufacturing of self-lubricating, multifunctional polymer composites, Biotribology, polymer-tribology, **Training:** group leader for polymer-tribology at LTU, Director of the National Research School in Tribology, Coordinator of the MSc in Tribology (part of Erasmus Consortium),)	8 PhD students (4 ongoing), 6 postdoctoral fellowships (2 ongoing), >25 MSc projects,
	Prof. Roland Larsson	**Research:** modeling and simulation of lubricated contact. PhD in 1996, chair professor in Machine Element. Dean of the Faculty of Engineering Sciences 2016-2018, **Training:** Modelling of wear and friction in lubricated contacts. Modelling of Elastohydrodynamic processes under dynamic loading. Lubrication performance of environmentally adapted lubricants	16 PhD (3 ongoing as main and 6 ongoing as co-supervisor). Four concluded postdoctoral fellowship About 20 MSc project.

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4. Supervisor Training Event

The event was held on 16th February 2021 and delivered on-line through Zoom.

The following is a description of the course material provided as a pre-read before the supervisory training:

- A series of lecture slides outlining (Appendix :
    - Standards with PhD training
    - Supervisor responsibilities
    - Characteristics of a PhD (student)
    - Features specific to BioTrib/ITNs
- A draft copy of the Training (and professional development) Plan – deliverable D2.1.
- The European Charter for Researchers The Code of Conduct for the Recruitment of Researchers
- University Code of Practice for Research Degree Candidatures (University of Leeds)
    - Specifics will differ between Universities but the ethos of Supervision remains the same and is set out in section 4.
- A copy of the 'The Researcher Development Framework'

- The original source is acknowledged as the 'Vitae Researcher Development Framework'
- The following copyright statement is retained on the RDF and all the RDF Materials 'Vitae, © 2010 Careers Research and Advisory Centre (CRAC) Limited'
- Link is provided 'www.vitae.ac.uk/rdf'

Notes from the Supervisor Training Event

Skills required of a PhD (industrial perspective):

It is noted that a high percentage of successful PhD candidates go into the industrial and/or commercial sector more generally.

Commercial aspects are important, but also the idea of academic freedom and not being constrained by commercial (short-term) aspects. This new knowledge might not lead to any non-academic impact immediately but may support further impact and exploitation going forward.

It was noted that PhDs tend to take on the more risky research questions as they are less constrained by project objectives and reporting requirements required in grant funding.

PhD's often lacked knowledge of project management and other organisational skills. [This is overcome to an extent in BioTrib as students will be taught and undertake exercises in Project Management as part of the Research Innovation and Management Course – equivalent to 2 days plus and assignment to develop a project plan for their own PhD. The course is designed for 4 days in total. An equivalent course in Nu-Spine was delivered on-line and we are currently discussing whether to deliver in this mode, face to face or in hybrid format].

There have been developments over the past 10-20 years of aligning PhDs with industrial requirements with a greater emphasis on skills training as well as research e.g. in the UK the advent of professional doctorates and integrated Masters/PhDs. Fast changing landscape – changing goals – methodology has become important not just results. Current reviews of what is required for a PhD are currently under review within Australia and Switzerland.

Quality of a PhD researchers:

A key skill is the idea of perseverance, tenacity and independence which is often overlooked. Minor differences in the position of PhD candidates in this respect

PhD submission:

UK – thesis (monograph) but have been moves to PhD by publication (e.g. at the University of Leeds, Faculty of Engineering).
Sweden and Switzerland – PhD by publication. No resubmission allowed in Sweden.

Failure rates <3-5 % in all countries.

PhD lifecycle:

Sweden – a combination of thought courses credit and research credits to achieve total of 240 ECTS in maximum four years (Figure 1). Optional half time assessment, exam/seminar open

– can accrue an official degree half way – licentiate. Final submission and public defence assessed by three to five independent examiners (examination committee). Questions from opponent, examination committee and the audience.

Swiss – under review.

Australia – under review, currently just submission which is reviewed by three examiners (score approach) but may include viva voce - can make adjustments.

Recruitment:

Behavioural interviews becoming influential in choosing candidates/applicants. Identifying and discussing real world examples.

Opportunities to reflect diversity are important i.e. ensuring gender representation of the reviewers at all stages of the appointment process is important. Record and retain the shortlisting scores, notes etc is important.

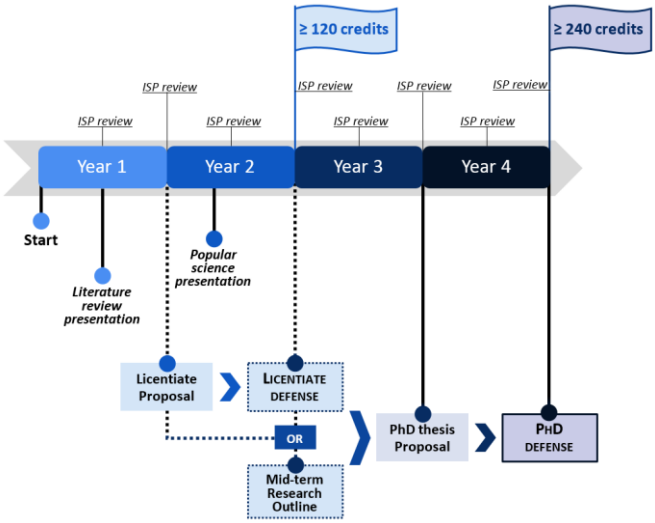


Figure 1: Example of the PhD lifecycle in Sweden – LTU.

Appendix: 1 – Additional Information:

European Regulations

THIRD CYCLE: DOCTORAL EDUCATION - Framework for Qualifications of the European Higher Education Area
http://ehea.info/cid102847/third-cycle-doctoral-education-2009.html

http://ecahe.eu/w/index.php?title=Framework_for_Qualifications_of_the_European_Higher_Education_Area#Third_cycle_-_PhD

EU researcher descriptors:
https://euraxess.ec.europa.eu/europe/career-development/training-researchers/research-profiles-descriptors

More Information on the European Charter and the Code
https://euraxess.ec.europa.eu/jobs/charter

Providing researchers with the skills and competencies they need to practise Open Science
https://ec.europa.eu/research/openscience/pdf/os_skills_wgreport_final.pdf

Examples of the Specific Supervision Requirements/Codes of Practice of University of Leeds and Uppsala:

Uppsala University:
https://dn.uppsalastudentkar.se/content/rules-and-rights/phd-handbook

University of Leeds:
http://ses.leeds.ac.uk/download/713/code_of_practice_for_research_degree_candidatures_201516

ETH Zurich:
https://hest.ethz.ch/en/doctoral-studies/documents.html

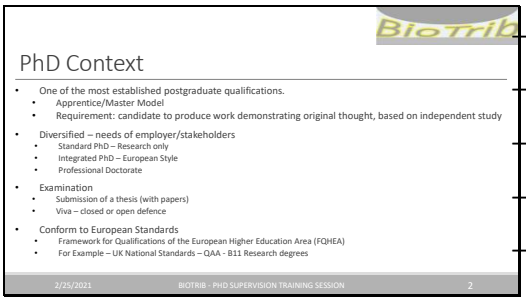
Imperial:
https://www.imperial.ac.uk/media/imperial-college/administration-and-support-services/registry/academic-governance/public/academic-policy/codes-of-practice-for-research-degrees/Code-of-Practice-for-Research-Students.pdf

http://www.imperial.ac.uk/about/governance/academic-governance/regulations/2019-20-regulations-research/

Appendix: 2 – Lecture Slides

Slide 1

Slide 2



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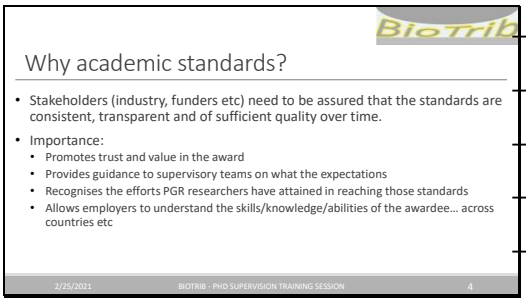

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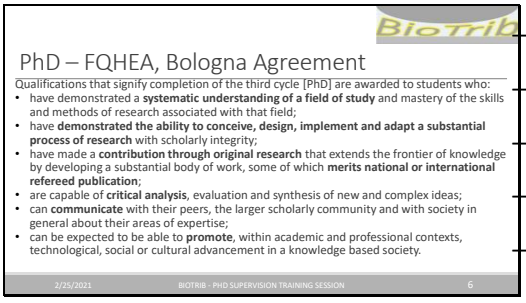

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PhD skills

- search for, discover, access, retrieve, sift, interpret, analyse, evaluate, manage, conserve and communicate knowledge from a range of sources;
- think critically … problems … innovative solutions and create new knowledge;
- plan, manage and deliver projects, selecting and justifying appropriate methodological processes while recognising, evaluating and minimising the risks involved and impact on the environment;
- exercise professional standards in research and research integrity;
- support, collaborate with and lead colleagues, so as to impact on practice, policy and societal well-being, appreciate the need to engage in research with impact;
- to be able to communicate it to diverse audiences, including the public;
- build relationships with peers, senior colleagues, students and stakeholders with sensitivity to equality, diversity and cultural issues;
- Increasingly – enterprise skills/business acumen

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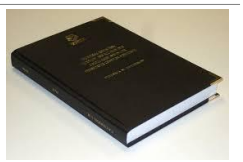
Deliverables/Differences

- Thesis
  - Monologue - UK
  - Thesis by publication – European (UK?)
- Defence of the thesis
  - Independent Examiner(s), Chair
    - Independent reports
  - Closed – Adversarial - UK
  - Open – Co-operative - European



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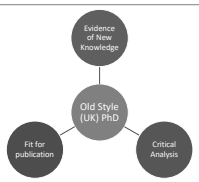
Criteria for the award of PhD



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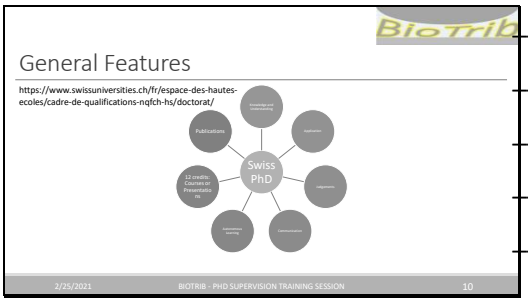

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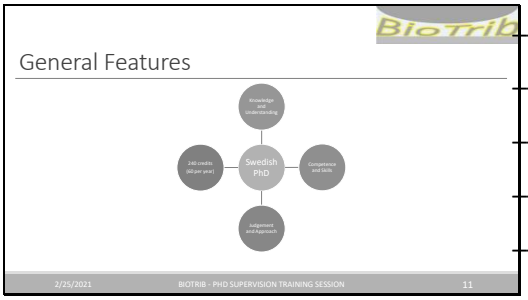

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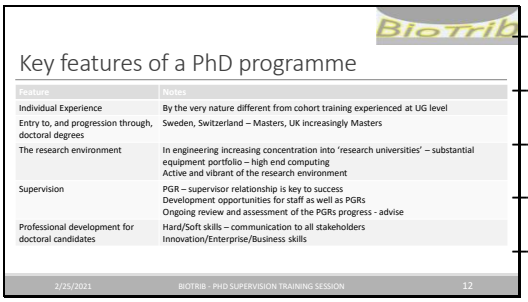

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Characteristics of PhD cycle

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Ideal PhD candidate?

- What are the ideal features of a PhD candidate?
- Applicant versus on course?

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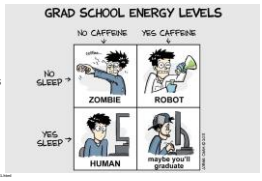
Ideal PhD candidate - qualities

- Intelligence
- Independence / Confidence
- Commitment
- Literacy / numeracy
- Time management / organisational skills
- Curiosity / ability to learn
- Enthusiasm and passion
- Ability to think
- Hard working/ diligence
- Motivation



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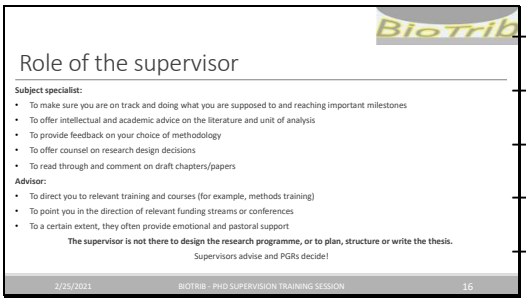

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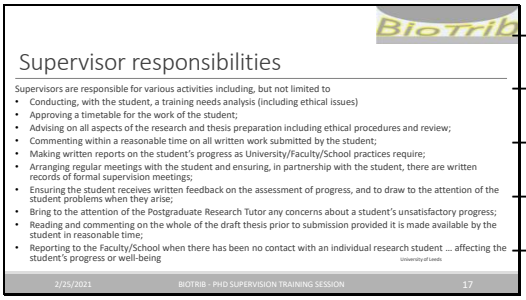

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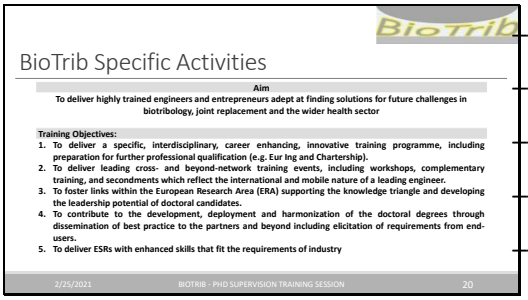

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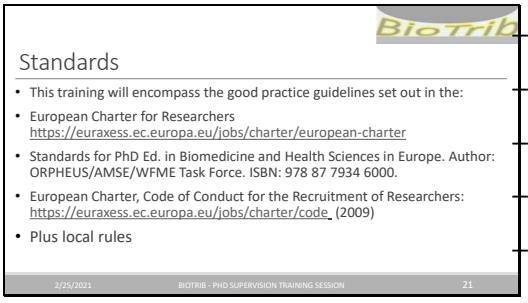

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Principles of Innovative Doctoral Training

Attribute	Evidence
Research Excellence	All five universities are in the global 1%. All have international reputations. The industrial beneficiaries are leaders in their fields
Attractive Institutional Environment:	ESRs will be hosted in 'state-of-the-art' facilities with high end computational and experimental equipment … adhering to the European Charter for Researchers.
Interdisciplinary Research Options	All the ESRs will be located in substantial engineering groups which have significant expertise in fields such as Tribology, which together converge to form an interdisciplinary collective.
Exposure to industry	Key feature of bioengineering where researchers are exposed to different sectors, most notably the healthcare and medical device manufacturing domains.
International networking	Develop an in-depth understanding of the Pan-European dimension in healthcare engineering and the development of deep and lasting networks. 3 entities from outside Europe … truly global aspect of the medical device market.
Transferable skills training	Transferable skills training is provided through practice based training, network wide courses delivered in BioTrib and local host training at each beneficiary.
Quality Assurance	Each of the Universities has well-honed administrative processes that are transparent and accountable over the whole lifecycle; from application to final career option.

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Modes of Training

- 'On-the-Job' Training
  - Research project
- Network Activities
  - Network Wide Workshops
  - Local Host Training
  - Secondments
  - Stakeholder Engagement
- Extra-Network Activities
  - Cluster Events
  - Conferences/Workshops
  - Networking
  - Professional Societies
- International
  - EU + Global
  - Industry
- Intersectorial
  - Healthcare, Industry, Academia
  - SME versus Multinational
- Interdisciplinary
  - Projects are highly interdisciplinary
  - Across domains, manufacturing/materials/tribology/modelling

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Innovation and Enterprise

Training in **Innovation and Enterprise** will be provided through the following mechanisms:

- Deployment of an Innovation Training Manager (ITM) who has the task of overseeing enterprise training for the ESRs
- The generation of an BioTrib dissemination and exploitation strategy;
- The production of an innovation plan for each ESR with specific goals linked to their research agendas.
- Training input delivered by the industrial beneficiaries allowing the new ways of working to be used; and,
- Integration of enterprise training into the course delivery. 'Research Innovation and Management' and 'Innovation Management, Entrepreneurship and IPR''

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Personal Career Development Plan

- Personal Career Development Plan
  - Short terms and long terms goals – updated every 6 months – reviewed by the SB
- Comprises;
  - an individual training needs analysis,
  - the training plan,
  - a record of supervision,
  - a record of training,
  - a record of achievement and competence,
  - dissemination activities and
  - reports of progression.

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Industrial Support

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	Yes – additive manufacturing. Shaping the research agenda.	Yes ESR7 and ESR8	Yes ESR7 and ESR8	Yes – On the job training and expertise	Yes
[illegible]	Yes – Fabrication & testing of implants. Shaping the research agenda.	Yes ESR3, ESR12	Yes ESR1, ESR2, ESR3, ESR12	Yes – part of a Network Wide Event (8)	Yes
[illegible]	Yes – Standards and protocols. Shaping the research agenda.	YES ESR13	Yes ESR13, ESR15, ESR5	Yes – part of a Network Wide Event (4)	Yes
[illegible]	Yes – Definition of clinical need. Shaping the research agenda. Clinical Support.	Yes ESR2	No	Yes – part of a Network Wide Event (8)	Yes
[illegible]	Yes – Definition of clinical need. Shaping the research agenda. Clinical Support.	Yes ESR9	Yes ESR6 and ESR9	Yes – part of a Network Wide Event (6)	Yes
[illegible]	Yes – Definition of clinical need. Shaping the research agenda. Clinical Support.	Yes ESR13	Yes ESR13	Yes, part of Network Event (3)	Yes
[illegible]	Yes – Access to kit/expertise Shaping research agenda	Yes ESR6	Yes ESR6	Yes – On the job training and expertise	Yes
[illegible]	Yes – Sample testing, Shaping the research agenda.	No	Yes ESR9, ESR10, ESR11, ESR14	Yes – On the job training and expertise	Yes
[illegible]	Yes materials support	No	YES ESR4	Yes – On the job training and exp'tise	No

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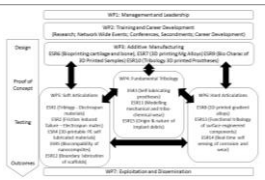
Implementation



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Project description

Fellow	Host institution	PhD enrolment	Start date	Duration	Deliverables
ESR1	ETH Zurich	Y	Month 8	36 months	D5.1, D5.2

Project Title and Work Package(s) to which it is related: Tribological Characteristics of Nanofibrous Electrospun Materials (WP5)

Objectives: Electrospinning and melt-electrospin writing represent two complementary technologies for the production of stochastic or aligned porous fibrous materials that mimic the natural collagenous extracellular matrix of soft tissues. In our previous work we have demonstrated the general mechanical competence and cell compatibility of such materials for use in the reconstruction of cardiovascular, cartilage and intervertebral disc tissues. Natural soft tissues such as cartilage, by nature of their fibre-reinforced hydrated structure, exhibit excellent frictional properties through the mechanism of biphasic self-pressurisation and slow fluid expression under load. We propose a similar function of multi-scale electrospun scaffolds. The first objective is to characterise the tribological properties of such materials, in their base state or after infiltration with a hydrogel, as a path towards the creation of biomimetic self-pressurised bearing surfaces. A second objective is that fibre-reinforced gel scaffolds will be developed, with guidance from fibre-reinforced poro-viscoelastic simulation models. Final objective - Time-dependent mechanical a tribological properties will be measured with a custom-built rotary tribometer. Scaffold fibre architecture and integrity will be characterised through contrast-enhanced microCT, confocal and scanning electron microscopy.

Expected Results: (1) Permeability, fluid pressurisation and therefore friction coefficient are dependent on, and can be tailored by modification of, the electrospun material porosity, fibre diameter, fibre chemistry, fibre orientation and bulk modulus. (2) Frictional properties of the material surface are enhanced through the addition of an interstitial gel phase. (3) Electrospun fibre reinforcement enhances fatigue life of hydrogels, in contrast to non-reinforced hydrogels.

Planned secondment(s): IMPERIAL Dr Rob Hewson M13 3M; Visit to establish a fibre-reinforced poroelastic model of the material surface articulation for in silico preliminary investigation of material combinations and configurations; ZIMMER Dr. Joern Seebeck M18 4M visit for the transfer and application of tribological testing methods and standards (i.e. pin-on-disc)

Enrolment in Doctoral degree(s): ETH Zurich

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Governance

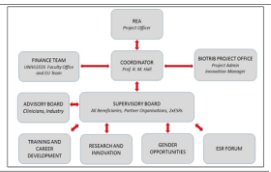

Fig. 3.1 - Committee Structure for BioTrib -- The Project Office through the Co-ordinator interfaces with the Commission.

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ESR monitoring

- **ESRs** will be informed of the **expectations, privileges and responsibilities** of employment as a Fellow under the BioTrib Partnership Document and EU's Fellows' Note
- Professional Conduct
  - Research Integrity including Ethical Standards (Research and Personal)
- PhD lifecycle
  - Supervision
  - Stage-gates
    - Upgrade etc
  - PCDP
  - Quarterly reports to the Training SC/SB

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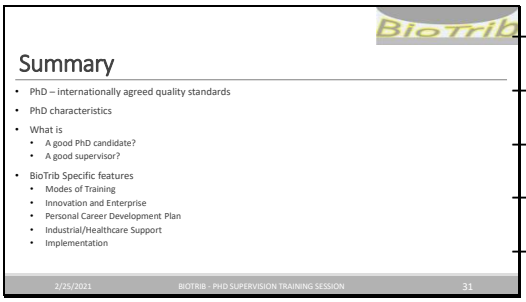

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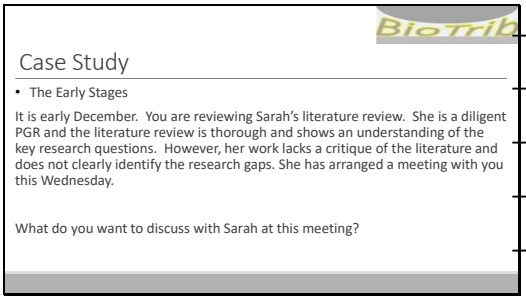

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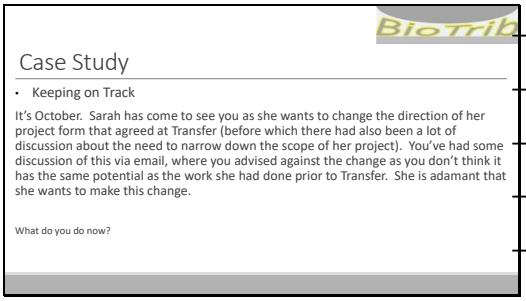

Endnotes

[i] https://euraxess.ec.europa.eu/sites/default/files/policy_library/principles_for_innovative_doctoral_training.pdf 2011

[ii] The European Charter for Researchers https://euraxess.ec.europa.eu/jobs/charter

[iii] HR Excellence in Research - https://www.vitae.ac.uk/policy/hr-excellence-in-research/hr-excellence-in-research-background

[iv] European Charter for researchers, https://euraxess.ec.europa.eu/jobs/charter/european-charter

[v] Standards for PhD Ed. in Biomedicine and Health Sciences in Europe. Author: ORPHEUS/AMSE/WFME Task Force. ISBN: 978 87 7934 6000.

[vi] Framework for Qualifications of the European Higher Education Area. http://ecahe.eu/w/index.php/Framework_for_Qualifications_of_the_European_Higher_Education_Area

[vii] European Charter, Code of Conduct for the Recruitment of Researchers: https://euraxess.ec.europa.eu/jobs/charter/code (2009)

[viii] Chapter B11 of the Quality Code: Research Degrees https://www.qaa.ac.uk/docs/qaa/quality-code/chapter-b11_-research-degrees.pdf 2013

[ix] Dr Greg has replaced Prof Anne Neville who has retired on the grounds of ill health.