

# BioCEED - Centre of Excellence in Biology Education

## 1. PROFILE AND VISION

The Centre of Excellence in Biology Education (BioCEED) merges the strengths of the Department of Biology, University of Bergen ([BIO](#)), the Department of Arctic Biology, University Centre at Svalbard ([AB](#)), the Higher Education Research Unit, University of Bergen ([HERU](#)) and the Institute of Marine Research ([IMR](#)). Together, we offer a unique experience in biology education with programmes spanning from classical theory-based university degrees to more targeted education focusing on particular ecosystems and their management (marine, coastal, arctic) and even highly specialized vocational training such as integrated MSc programmes in aquamedicine and teacher education.

Current developments within the biological sciences are profoundly impacting society, and our vision is that this ‘biological revolution’ should shape not only the content of biology programmes and courses, but also how biology is taught. BioCEED therefore expands on our existing collaboration to reshape biology education in response to changes in the biological sciences, in higher education, and in society’s needs. The new centre will enable development and research-based assessment of learning practices that strengthen the knowledge base, skills sets, and vocational integrity of tomorrow’s biologists. The centre will significantly promote sharing of ‘best practice’ within BioCEED, across the educational sector, and with society.

The BioCEED consortium is uniquely positioned to lead this development. It joins two biology departments with complementary strengths (BIO is large, excels across a range of research and education, is embedded in a large university, and has many societal links; AB is smaller, more specialized, and offers a close-knit academic environment) with an academic unit specialising in research on learning in higher education (HERU), and Norway’s largest centre of marine science closely linked to industry and government (IMR).

Over the last decades, we’ve seen a dramatic expansion of the role of biologists, and biologically-based knowledge and theory, within both science and society. Biology has long had a strong theoretical foundation; since the 1859 publication of Darwin’s ‘On The Origin of Species’ our domain has developed one of the best known, most fiercely debated, but also most widely influential scientific theories. Today, Darwinian evolutionary reasoning directly impacts fields such as medicine, psychology, agriculture, aquaculture, fisheries, and natural resource management and it is rapidly gaining a foothold in the social sciences and humanities. At the same time, the practical and analytical skills of biologists, from genetic engineering to biodiversity and ecosystem assessment, are increasingly sought-after, not only by biologically-based research and industries, but also by governments and NGOs facing increasing demands for evidence-based action on global climate and environmental change. The domain of biology in society is thus expanding, and this expansion is driven by the interplay between a wealth of theory-based biological content knowledge, a rapidly increasing skills ‘toolbox’, and the increasing demands of society for these insights and skills (Fig. 1).

BioCEED is built on the vision that the expanding role of biology - and biologists - in society not only places new demands on the content of the educations we provide, but also on how we train tomorrow’s biologists. They must be competent in the theoretical and practical aspects of biology, but also build the professional confidence and integrity necessary to manoeuvre among conflicting pressures and demands in their professional lives. This requires education that exposes students, from day 1, to learning experiences that span the entire domain of biology (Fig. 1). BioCEED will give us a unique opportunity to develop and test new learning

practices and approaches targeted specifically at developing the knowledge base, skills sets, and integrity required by the different roles biologists occupy in society.

Because of the complementary strengths within the BioCEED consortium, we are uniquely positioned to deliver this vision: We can explore learning methods and approaches across situations varying in theoretical and practical content, goals, and exposure to societal pressures and demands. Towards this end, BioCEED will appoint two PhDs to scientifically evaluate and document effects of our

educational reform. In addition to the educational development *per se*, BioCEED will enable us to more effectively share pedagogic experiences, both within the consortium and across the educational sector, and facilitate dialogue with relevant industries and sectors.

BioCEED will lead a revolution in biology education by combining our vision as described above with two strong trends in higher education:

(i) We will actively encourage and support the often called-for shift from a teacher-centered to learner-centered education; and change focus from what instructors do to how students learn. These ideas date back more than 50 years<sup>1-3</sup>, but the teacher-centered tradition still predominates in higher education. Active promotion of a learner focus, as exemplified by ‘deliberate practice’<sup>4,5</sup>, is needed. We will focus on three essentials<sup>6-10</sup>: a shift in responsibility for learning away from the instructor and towards students, active engagement of students with the learning material, and provision of formative assessment opportunities.

(ii) We will promote a cultural shift towards what Gibbs<sup>11</sup> describes as a ‘professionalized and scholarly approach’ to teaching and learning in our staff (see also <sup>8</sup>). This paradigm shift in teaching culture can be promoted by adopting strengths of the research culture: collaborative efforts towards common goals, focus on documentation and accountability, appreciation of peer-review and debate, internationalization, and recognition and reward for efforts and results<sup>8,11</sup>. BioCEED will work towards developing a culture of shared responsibility, educational creativity, exchange of ideas and experiences, reward for excellence, and alignment of learning environments, methods and evaluation with educational goals.

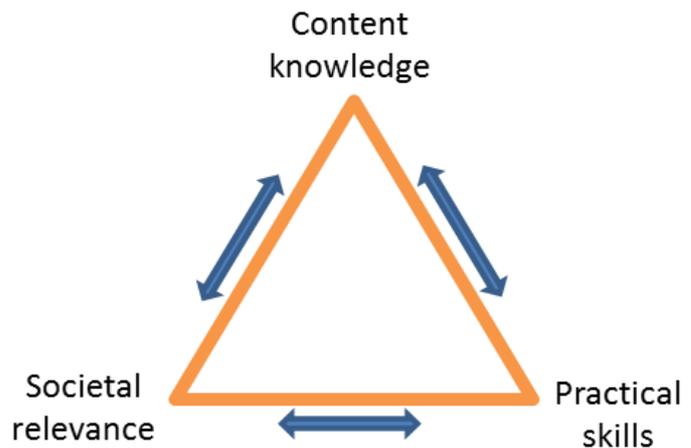
**The education reform will be achieved through seven closely integrated strategies:**

**Strategy 1: A collegial learning culture among teachers**

- Shift from ‘teaching’ to ‘learning’ perspective in teacher thinking and practice
- Develop a culture of shared responsibility for students, courses, and programmes
- Create physical, social, and virtual ‘spaces’ for sharing experience and ideas

**Strategy 2: Optimal learning environments**

- Align curricula, skills training, practice opportunities, and evaluation with learning goals
- Optimize the physical and digital learning environment to foster learning across the biological ‘domain’ (content knowledge, skills, and societal relevance; Fig. 1)
- Continuous optimisation of technical and administrative support to educational needs
- Engage staff and students in renewal of the broader learning environment



**Figure 1.** The ‘domain of biology’, can be defined by the interactions between the development of scientific content knowledge (theory, factual knowledge) and practices within biology itself, and society’s applications of and needs for this knowledge and these skills.

### **Strategy 3: Active and motivated students**

- Set learning goals that engage students actively in pursuit of competence across the biological ‘domain’ (content knowledge, skills, and societal relevance; Fig. 1)
- Integrate development of problem-solving and learning-to-learn skills in the curriculum
- Increase hands-on experience with research, industries, management and education
- Provide students with formative feedback

### **Strategy 4: Aligned quality assurance, evaluation, goals and practice**

- Develop quality assurance and evaluation as tools for monitoring progress, recognizing and rewarding excellence, and spreading ‘best practice’
- Encourage and conduct learning ‘experiments’, and document and report outcomes

### **Strategy 5: Efficient leadership of education**

- Appoint and empower ‘leaders of education’ as part of institutional leaderships
- Integrate education and research in institutional strategies and goals
- Identify and remove (infrastructure) obstacles to development and change
- Develop links to the higher education sector (within our institutions, in Norway, abroad)

### **Strategy 6: Spread of ‘best practice’**

- Enable learning and sharing of experience within BioCEED and beyond through virtual sites and tools, working groups/workshops, and an open biology education conference

### **Strategy 7: Interact with end-users and stakeholders in the private and public sector**

- Increase and systematise communication with employers, end-users, and biology alumni to better understand society’s needs and to communicate the contributions of biologists
- Develop mechanisms for student placement within the sector during BSc and MSc

BioCEED builds upon on-going strategic collaboration, formalised in institutional agreements, between the centre partners towards these goals. The on-going reform process is described in chapter 2, and BioCEED plans for further progress are described in chapter 3.

## **2. QUALITY IN ESTABLISHED EDUCATIONAL ACTIVITIES**

### **Result factors**

Student retention and degree completion rates are generally high for BIO’s MSc programmes; and close to 100% at AB, and BIO’s integrated MSc programme in Aquamedicine. The number of students graduating from our programmes is increasing, at all levels (Attachment 1), while credit production per student is at the [national average](#). There is a strong relationship between various quality indicators and the learning methods and teacher-student interaction modes across different courses and programmes. BIO’s 2011 BSc reform specifically aimed to increase student-active learning and assessment methods, focusing on field and lab training. Preliminary data indicates this has been successful. For AB, the unique destination, international setting, small classes and intimate campus contribute to good results. Our high educational quality and successful reforms have been recognized through a number of prizes<sup>a</sup> at institutional and national levels. In particular, BIO’s introductory course for MSc students has won both the [Owl prize](#) and the prestigious [National Award](#) (Attachment 2).

[Our alumni](#) find relevant jobs within a year of graduation, and candidate surveys<sup>b</sup> find that an MSc from the natural sciences can be a ticket to relevant employment. [Surveys](#) find that graduates are satisfied with the content, relevance and quality of their education. Further, they

---

<sup>a</sup>The UiB Owl prize (2007, 2009) the NOKUT National Award for Quality in education (2002, 2007, 2009), see also staff prizes<sup>l</sup>.

<sup>b</sup>[Kompetanse 2020](#), [Ideas2Evidence rapport 4/2011](#); [Kandidatundersøkelsen 2011](#): [NIFU, Rapport 39/2012](#)

find that employers are satisfied with UiB candidates but think that we understate the competence of our candidates, probably because they value ‘transferrable skills’ like analytical, communication, and cooperative skills more than educators do.

Our students are active and involved. They are represented in decision-making bodies, and in all processes concerning education, and contribute to recruitment<sup>c</sup> and social activities. Student organisations are key in these functions. Senior students also work as teaching assistants, especially in the lab and field, which supports learning in both seniors and juniors.

Both UNIS and BIO have an international student mass, with 30-40% non-Norwegians among BIO’s MSc students and 50-65% among all AB’s students. BIO has long-standing educational partnerships with universities in the south (e.g., [Makerere University](#), Uganda) that support development of higher education, and translational research (funded by [SIU](#)).

### **Process factors**

At BIO and AB, biology students are exposed to an exceptionally broad range of learning and assessment methods (Attachment 2). In particular, we prioritize on-site field work, cruises, and expeditions as part of the education to enhance content knowledge and give hands-on experience with research methods and with arctic, marine and terrestrial biology. As an added value, this extraordinary learning environment supports development of social skills and long-term memory<sup>12</sup>. Course evaluations document that our students appreciate field experiences, and increased field- and lab-based learning was thus implemented in the 2011 BIO BSc revision. BIO is also unique among biology departments in offering vocational training of Aquamedicine biologists through an [integrated MSc programme](#) combining targeted highly-specialized biological courses, laboratory training, and internships in the industry.

Several courses specifically focus on developing independence of thought, and on introducing students to the culture and methods of research (Attachment 2). This is achieved through, for example, discussions, critical reading, writing, peer-review evaluation and feedback, and small research projects where students are supported through the research process (identify research questions, develop aims and objectives, identify study sites, learn new techniques, obtain equipment, collect data in the lab or field, analyse and evaluate these data, and write scientific reports). The learning outcome of such projects is an increased understanding of the scientific process; hence assessment methods evaluate several phases of the process. In most courses, different learning and assessment methods are used in combination, to foster and evaluate different skills and kinds of knowledge.

Linking research and education promotes learning outcomes, but can also ensure effective use of resources, and minimize environmental footprints in fragile field settings. Some courses and many student projects and field activities are therefore directly linked to on-going research projects (Attachment 2). The students benefit by learning relevant research methods and skills through ‘apprenticeship’ with staff in the field or lab.

To support high-quality, student-active professional education with a strong focus on field and lab learning (Strategies 1-5), a new organisational structure has recently been established at BIO. The core element is five Teacher groups, which are fora for coordination of courses and curricula, follow-up on assessments, (peer-review) evaluation, sharing of experiences and responsibilities, and fostering of a collegial teaching culture. The teacher group leaders, along with student and MSc Program representatives, constitute the Education Committee. This committee is led by the Head of Education, who is responsible for all education, in the broad

---

<sup>c</sup>[Welcome Week](#), [MSc information week](#), [International Week](#), [Career Day](#), and as ambassadors to secondary schools.

sense, at BIO, and is also Deputy Head of Department. This structure ensures close links between individual teachers, educational leadership, the Department Head and the educational leadership of the University. The Education Committee is supported by an external Advisory board for Education, consisting of three experienced professors from other universities. Their role is to provide an external perspective and an honest, critical and constructive assessment of the teaching and learning environments at BIO. Student democracy is ensured by student representatives in both the Education Committee and the Department Board.

The Quality assurance (QA) system, as described in the UiB [Quality Assurance Handbook](#) and the UNIS [Annual report 2010](#), is generally well implemented in our educations<sup>d</sup>.

### **Input factors**

Research excellence is a major asset for high-quality education. In the 2011 RCN [Evaluation of biology, medicine and health research in Norway](#), 13 out of 20 evaluated units at BIO, IMR and AB got the top scores “very good” or “excellent”. We are involved in 3 Centers of Research Excellence<sup>e</sup>, 3 Centers for Research-based Innovation<sup>f</sup>, seven Research Schools<sup>g</sup>, and a Centre for Development Cooperation<sup>h</sup>. Our staff includes internationally highly-profiled scientists such as the ISI Highly Cited and ERC Advanced Grant-awarded microbiologist Frede Thingstad, and the ISI Highly Cited palaeoecologist John Birks. We publish more than 400 papers in the international literature per year (BIO: 250; AB: 20, IMR: 150, HERU: 20), and in the last five years, we have had twenty papers published in *Science* and *Nature*.

Both BIO and UNIS offer unique opportunities for student-active learning, and for developing close interactions between content knowledge, practical skills training and relevance (Fig. 1) in our educations. We have excellent research and education infrastructure<sup>i</sup>, including new educational and research labs with high-quality modern equipment, a number of field sites and stations, and geographical locations that offer excellent opportunities for field excursions.

We use this infrastructure to give hands-on experience with different biological phenomena, as well as with the research process. Fieldwork in remote areas with difficult weather conditions, limited emergency help and communication possibilities, require closer attention to safety, and AB has developed safety training and certification of all students (see Attachment 2). The aim of all these activities is to develop a scholarly, scientific attitude in our students, while preparing them for solving real problems in science, industry and society.

Our staff is recognized for and committed to development of educational excellence, as documented by prizes<sup>j</sup> and participation in projects related to educational development ([PEK](#), see [example](#)). The BioCEED leadership is selected to represent broad experience with biology education and educational reform, project leadership, and research and educational challenges across the biological ‘domain’ (Fig. 1). BioCEED will be led by Vigdis Vandvik from BIO. She has extensive experience in teaching, supervision, educational reform, scientific leadership, dissemination and societal communication; particularly in relation to field-based activities and biostatistics. In 2010, she represented BIO in the programme committee for the

---

<sup>d</sup>Follow hyperlinks to access annual reports, student evaluations etc. for [BIO](#) and [UNIS](#).

<sup>e</sup>[Bjerknes Centre for Climate Research](#), [Centre for Integrated Petroleum Research](#), [Centre for Geobiology](#)

<sup>f</sup>[Sea Lice Research Centre](#), [The Michelsen Centre for Measurement Science and Technology](#), [Centre for Research-based Innovation in Sustainable fish capture and Pre-processing technology](#)

<sup>g</sup>[Bergen Summer Research School](#), [National Graduate School in Educational Research](#), [Nordic Marine Academy](#), [Norwegian-Swedish Research School in Biosystematics](#), [The Molecular and Computational Biology Research School](#), [The Norwegian National Graduate School in Teacher Education](#), [The Norwegian Research School in Climate Dynamics](#).

<sup>h</sup>[The Centre for Development Cooperation in Fisheries](#)

<sup>i</sup>See overviews of the field and lab research and educational infrastructure at [BIO](#), [AB](#) and [IMR](#)

<sup>j</sup>The Faculty for Mathematics and Natural Sciences Best Lecturer prize (1998, [2001](#), [2006](#)); The [UiB Meltzer prize](#) for excellent research dissemination (1998, 2005, [2008](#), [2011](#)). See also the course and programme prizes<sup>a</sup>)

international conference “[Academic Writing from Bachelor to PhD](#)”, which brought several distinguished keynote lecturers and more than 150 participants from across the world to Bergen. The deputy leader, Pernille Bronken Eidessen (AB), has extensive research and teaching experience from the Arctic, applying lab- and field-based approaches to problems spanning from ptarmigan management to microbial diversity. Ole Jørgen Lønne (AB) has more than 25 years experience of ship-based research and education, and brings with him insights from employment in private and public research and aquaculture companies. Geir Huse (IMR) contributes key competence in ecosystem-based management and extensive networks with industry and authorities. Arild Raaheim (HERU) has researched a variety of questions related to teaching and learning in higher education over 30 years, and contributes expertise in pedagogical theory and innovative teaching methods. Anders Goksøyr (BIO) contributes molecular and lab-based education experience. CV’s are in Attachment 3.

### **3. POTENTIAL FOR INNOVATION AND DISSEMINATION**

We firmly believe that on-going changes in the domain of biology (Fig. 1) and in higher education internationally<sup>8,9,11</sup> as well as in Norway<sup>k</sup> necessitate radical transformation of our educational processes. This is the motive behind BioCEED. Effective educational innovation requires *recognition* of the need for and goals of reform, *understanding* of the necessary steps towards new and improved educational practices; access to the appropriate intellectual, institutional, technical and financial *resources*; and availability of *channels* through which new ideas and practices can be spread. The BioCEED consortium draws its strength from the complementarity of the two biology departments (BIO, AB) coupled with HERU’s research expertise in learning in higher education and IMR’s close links to the public and private sector. The consortium provides a unique environment to compare, test, and develop educational approaches to integrate the full “domain of biology” (Fig. 1) in tomorrow’s biology educations.

The project activities are organised in Work Packages (WP), where each WP addresses the corresponding strategy in Part 1 and the specific Actions (A) expand on the on-going work described in Part 2. Some represent potential for radical transformation (e.g., A8, A12, A13, A14, A17, A18, A21, A22, A29, A31, A33 and A34) others are more incremental but needed as part of a coordinated educational strategy. Relationships between WPs are seen in Fig.2.

#### **Work package 0: Leadership and coordination (WP leader: BIO)**

- A1. Establish BioCEED organization and decision-making structures to effectively manage Centre activities and resources, fulfil tasks, and communicate internally and externally.
- A2. Set up and maintain physical and virtual project infrastructure
- A3. Appoint an international Advisory Board for BioCEED, with representatives from higher education in biology and pedagogy, relevant industries and sectors
- A4. Daily management of the BioCEED, including monitoring of progress and reporting.

#### **Work package 1: A collegial learning culture among teachers (WP leader: BIO)**

- A5. Annual ‘teacher’s retreat’ where teaching, learning, and curricula are discussed. Each retreat will explore a specific theme in presentations, discussions, and group work.
- A6. Appoint two adjunct Professors (educational scientists) to provide a conduit for exchange of new ideas, discuss and evaluate actions, and publish BioCEED findings.
- A7. Develop ‘Teacher groups’ that share responsibility for education across related courses

---

<sup>k</sup>[Meld. St. 18 \(2012–2013\) Report to the Storting \(White Paper\)](#), where student involvement in research is listed as one of 12 [key measures](#) in Norway’s research strategy; see also [The Norwegian Qualifications Framework](#)

- A8. Promote teaching skills renewal at all career stages through pedagogic courses and educational ‘sabbaticals’ to exchange ideas and develop curricula
- A9. Develop a web forum for presenting and discussing methods and experience.

**Work package 2: Learning environments (WP leader: BIO)**

- A10. Expand the learning environment through integrating field, lab, and internships
- A11. Develop student spaces (room for active, interactive, and varied learning experiences).
- A12. Set up an exploratory ‘digital pack’ where the potential of emerging new technologies

- in education is explored and assessed, focusing especially on lab and field education.
- A13. Increase education support through appointing dedicated educational technical staff, and through targeted training and exchange visits for technical and administrative staff

**Work package 3: Active students (WP leader: AB)**

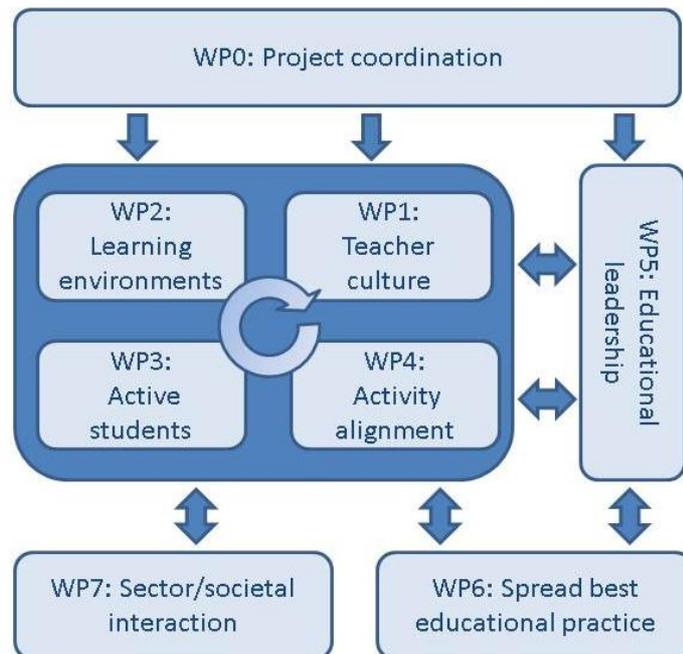
- A14. Redesign programmes and courses and set learning goals that engage students actively in their pursuit of competence across the biological ‘domain’ (Fig. 1, see A14-A17)
- A15. Integrate problem-solving and learning-to-learn skills across the curriculum
- A16. Use students actively in planning and conducting learning activities; provide opportunities for extra involvement and activities, based on student interests
- A17. Offer internships in the public and private sector and research laboratories from year 1
- A18. Provide certification (acquired competence in specific topic, lab and field security, etc.)

**Work package 4: Aligning quality assurance, evaluation, goals, practice (WP leader: HERU)**

- A19. Develop quality assurance and evaluation methods that enables monitoring of progress and spread of ‘best practice’ (see WP1)
- A20. Focus on institutional learning in implementation of *The Qualifications Framework*
- A21. Appoint and supervise two PhD students to do their research on BioCEED activities
- A22. Experiment with and assess selected traditional and new learning methods, e.g., deliberate practice<sup>5</sup>, flipped classroom<sup>13</sup>, open labs, ‘gaming attitude’ in students<sup>6</sup>, teaching-on-demand. Develop new learning methods that link theory and practice across the biological ‘domain’(Fig. 1).
- A23. Expand alternative learning methods, and reduce lecturing by 20% relative to 2011.

**Work package 5: Strengthen and empower educational leadership (WP leader: AB)**

- A24. Appoint and empower ‘education leaders’ as part of institutional leaderships
- A25. Integrate and align teaching and research in strategic planning at the institutions



**Figure 2.** Relationships between work packages within BioCEED in terms of work and information flow. Circular arrow indicates strong inter-relationships between WP2-4. Note that coordination of the project (WP0) is kept distinct from the development of educational leadership at the partner institutions (WP5).

- A26. Identify and remove obstacles to development and change, and develop actions and strategies to remove or mitigate them (local, institutional and national level)
- A27. Incorporate teaching and education efforts and success into staff reward systems
- A28. Explicitly promote education in our internal communication (weekly newsletter, web,...)

**Work package 6: Spread of ‘best practice’ (WP leader: HERU)**

- A29. Develop the web forum (A8) into a well-structured freely-accessible ‘idea-bank’ and discussion forum for biology educators.
- A30. Publish project results in educational science journals and in educational practice fora.
- A31. Develop ‘test cases’ that will be tried out in other biology educations in Norway
- A32. Arrange an open, international conference in biology education every 3 years, with shifting focus to match project needs and development of knowledge

**Work package 7: Strengthen links between education and society (WP leader: IMR)**

- A33. Annual meetings between BioCEED students and industry and sector representatives to exchange ideas and communicate biologists’ contributions and society’s needs
- A34. BioCEED workshops with end-user panels to discuss biology-society interactions
- A35. Present BioCEED findings in sector-specific journals and meetings

## **4. ORGANISATIONAL PLAN**

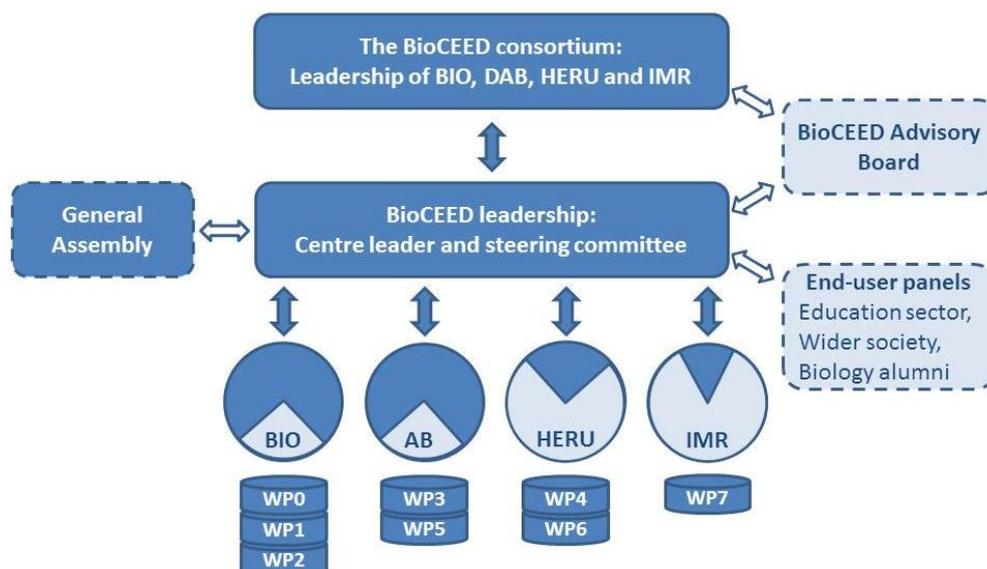
The BioCEED consortium consists of 4 partners, and is based on a strong understanding of common goals and joint responsibility. Management procedures are designed to promote effective decision-making, communication and collaboration among the decision-making and advisory bodies (see Fig. 3). The collaboration will be regulated in a consortium agreement.

*The centre leader* (UiB, Vigdis Vandvik) and her deputy (Pernille Bronken Eidessen) will be responsible for project leadership. They will report to the project consortium; chair project meetings; monitor progress; prepare periodic reports; communicate with NOKUT; manage the project financially and administratively; foster contact and communication in the consortium; ensure that all partners respond to the Strategies and Actions as committed in the consortium agreement and, after consultation with the involved partners and the steering committee, decide on any changes to plans when necessary to fulfil project goals and commitments. Supported by their departments, they will oversee the daily management and ensure efficient and transparent administration, financial management and communication.

*The Steering committee* includes the centre leader and deputy and the leaders of education at BIO (Øyvind Fiksen) and AB (Ole Jørgen Lønne) and the centre representatives at at HERU (Arild Råheim) and IMR (Geir Huse), and student representatives from BIO (TBA) and AB (TBA). It supports the leader in decisions of strategic and/or financial consequence.

*The Work package leaders* (TBA) who are responsible for work package-specific questions and decisions. They will report to the Centre leadership concerning the activities within the work package; ensure progress according to plans and schedule; produce reports on status of Strategies and Actions; maintain communication with WP participants; and publish progress updates on the web forum. The WP leaders will have the capacity to request Actions from the partners; organize short meetings as necessary, and travel to support the implementation of the WP as needed. WP2-WP4 will be supported by the dedicated technical staff.

*The General assembly* is constituted by all staff involved in the project and the boards of the student organisations at BIO and AB. This body will meet at project workshops and conferences, and advise the project leadership in important strategic decisions.



**Figure 3.** BioCEED project leadership, co-ordination, communication, and responsibilities. Rectangles represent governing (solid outline) and advisory (hatched outline) bodies, circles represent the educational activity at each of the partner institutions, stacked disks represent project work packages, and filled and open arrows represent decision-making/reporting and advisory communication, respectively. Dark shading represents core BioCEED activities, light shading represents associated activities at the partner institutions, and involvement of external bodies.

*The BioCEED Advisory Board* with ca. 10 members from research, industry, governmental and non-governmental organizations, the education sector, students and alumni will be established. They will oversee the development of the Centre and give feedback on strategies, actions, research, results, communication, and future development.

*End-user panels* will ensure a wider sector and societal involvement, including established collaborations (Attachment 4). These will be mobilized directly in contact with the students (e.g., courses, internships, annual meetings) and in an advisory role to ensure that research, industry, resource management and nature conservation authorities, and the education sector can guide and respond to BioCEED activities and findings.

### **Main communication avenues internally and with society and the education sector**

*Skype meetings:* Held both one-to-one and between groups of project partners and students as needed to ensure timely and efficient communication, sharing of experience, and discussion of plans, and progress within and across WPs. Digital presentations can also be given over Skype to ensure clear communication over important aspects.

*Project meetings:* These will be held at least once a year to discuss plans, status, progress, and reporting. Specific attention will be given to evaluation of fulfilment of Strategies and Actions, any change of plans, and their consequences. Since interaction between work packages is high, both conceptually (all strategies and WPs are motivated by the same underlying conceptual framework and vision) and practically (Actions interact across WPs, see Fig. 2), all WP leaders will participate. Meetings within WPs will be held as needed.

*Workshops:* Project workshops will be held annually, open to staff, student organisations at the partner institutions, and external collaborators. This will be an arena for sharing experience with teaching, educational development, BioCEED research (A21), and Actions. Reports and findings from these workshops will be presented at the web site (see below).

*Web forum:* A project web forum will be established in the initial phase of the project (see A9). This will be an important tool for internal as well as external communication. It will include members-only pages where internal information, documents of common interest,

reports on WP findings, and the project database will be made available. As the project proceeds, the web forum will be developed into an open-access resource-base for biology teaching (see A29). The website will be hosted by BIO as part of WP0.

*BioCEED conference:* Every third year, BioCEED will host an international conference on issues in biology education. Each conference will focus on a specific theme, which will be explored through keynote presentations, practice, research, and student reports, demonstrations, workshops and discussions. The themes will reflect the project development.

## 5. COLLABORATIVE PARTNERS

The BioCEED consortium is based on existing research and education collaboration among the partner institutions. BioCEED will also mobilise our extensive collaborative networks (detailed in Attachment 4) in educational reform as follows:

The integration of student placements within industry, research, and the public sector into biological education ‘from day 1’ (A17) is a novel aspect of BioCEED. This is an expansion of the pioneering work in the aquamedicine programme and in the student-active research at AB and in BIO’s MSc introductory course (see Attachment 2) where such partnerships have been successfully applied. The aquamedicine programme has focused on placements in industry (e.g., [Marine Harvest AS](#), [MSD Animal Health](#), [Aqualab AS](#), [Mattilsynet](#)), AB has focussed on placements within research, and BIO 300 has initiated collaboration with the municipality of Bergen. BioCEED will expand these kinds of collaborations to a wider range of collaborative partners, including our research projects (e.g., our CoE’s [Geobio](#) and [NorMER](#), CoI [Salmon Lice Centre](#), and ERC projects), research collaborators (in particular [Uni Research](#)), conservation and nature management authorities ([County Governor](#), [The Norwegian Biodiversity Information Centre](#), [Statens vegvesen](#),) and a wider range of industry partners. In particular, the extensive marine sector in Bergen will provide a unique asset towards this end, as is our partnership within the [FRAM Centre](#) where we are collaborating with 21 industry, research, government, and management institutions.

Many of the above partners also contribute directly to our programmes though involvement in teaching, MSc- and PhD supervision, and expert lectures. For example, [The Master’s Programme in Nutrition](#) is a collaboration between BIO and the [National Institute of Nutrition and Seafood Research](#). BioCEED will expand such collaboration, focussing on the kinds of institutions mentioned above.

Cross-disciplinary collaboration, such as [The Bachelor’s Programme in Environment and Resources](#) which involves two departments at the Faculty of Mathematics and Natural Sciences and two departments at the Faculty of Social Sciences, will also be expanded. In particular, a stronger of public management and legal aspects is needed in our education.

UiB is committed to increase the awareness of and recruitment to mathematics and natural sciences through existing and future cooperation with schools in the region. This includes a focus on training of teachers and strengthening their motivation and competence, and to soften the transition from school to university for students.

For disseminating BioCEED results within the sector, we will utilise UNIS agreements with NTNU, UiB, UiO, UiS, UiT and UiA. In particular we will seek to develop annual action plans, under the agreement, with a focus on development and dissemination of results from BioCEED. UNIS actively recruits adjuncts and guest lectures from the Norwegian universities, and these may be natural dissipation vectors.

All collaborators (see Attachment 4) will be activated in the sector communication (WP7).