ISBE Infrastructure for Systems Biology Europe

WP15

Innovation, Impact and Exploitation

ISBE WP15 REPORT

Industry survey document with results including an expertise and technology matrix

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ISBE Infrastructure for Systems Biology Europe

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1. Executive Summary

This report describes the results of the survey carried out in 2015 to 15 industrial organisations in the fields of Health, Agriculture and Industrial biology. The aim of the survey was to obtain an understanding of industrial participation in the Systems Biology and life sciences research community, to identify the main challenges for industry, as well as to understand how an infrastructure for systems biology could be beneficial in overcoming current research barriers and contribute to European innovation and economic growth.

Almost 47% of the organisations participating in the survey were small enterprises (1-50 employees). Medium-sized enterprises (50-250 employees) comprised 20% of the total whilst large companies (250+ employees or an annual turnover greater than 50 million) comprised the remainder at 33%.

Up to 93% of the organisations surveyed were performing systems biology activities. However, there was not a common understanding of the definition of 'Systems Biology'.

73% of the interviewees stated that systems biology was critical to their future with the majority belonging to the SME sector. Most of the large multinationals organisations interviewed stated that it is not too critical to their future as they have a wide range of activities not related to systems biology.

The main area of research activity stated by interviewees was in Pharma with over 75% of respondents selecting it.

The most common service identified by respondents is in selling systems biology services, (modelling and data analysis) with 56% of respondents stating this was the case for their organisation.

86% of organisations collaborate with Academia or other research organisations and 60% of these engage in collaborative activities with companies located in other industries or in their own sector.

A common problem for some SMEs included in the survey was in forming effective partnerships with academic institutions. These respondents suggested that guidance from ISBE on how to form such partnerships could have a significant impact on their research.

Standardisation of models and metadata is a major challenge for industry and needs to be undertaken by an international body, such as ISBE. Several initiatives are already in place and this task requires strong cooperation with other organisations and wide dissemination amongst the research community.

67% of industry participants stated they would find it useful to have some form of training in Systems Biology given by the infrastructure with modelling (predictive, bottom-up, data-driven) and Data Integration the activities most in need of extra training, followed by Data Analysis.

If the ISBE infrastructure were able to act as a 'marketplace' for companies to meet new clients, participants also highlighted such a service as being very beneficial to industry participants, particularly SMEs.

Regarding further barriers to innovation, a lack of knowledge of existing resources was highlighted by the survey. Companies surveyed felt that they were not fully aware of the products and services that can be accessed to further their systems biology projects as this information is not widely available or publicised.

91% of the participants surveyed saw the ISBE infrastructure as a possible source of research acceleration. By providing standardisation and guidance to users on how to use systems biology and the infrastructure itself, it was thought that time and money will be saved in the long-term.

2. Introduction

This report describes the results of a survey carried out in 2015 to 15 industrial organisations in the areas of Health, Agriculture and Biotechnology. The aim of the survey was to obtain an understanding of industrial participation in systems biology, to identify the main challenges for industry, as well as to understand how an infrastructure for systems biology could be beneficial in overcoming current research barriers and contribute to European innovation and economic growth.

The survey was designed and executed by ISC Intelligence, a Brussels-based communication agency specialising in science, technology and R&D research and policy, in collaboration with University College Dublin.

Sections 3-7 in this report reflect the different areas covered by the survey. Section 3, 'Description of Participating Industry', provides an understanding of the industry sectors involved, the countries they are active in as well as research results produced from Research and Development (R&D) programs of companies located within them. Section 4, 'Industry Operating in Systems Biology', then looks into the services and products provided by companies across industrial sectors as well as a description of the activities and tools that they use in relation to systems biology. This section also deals with how collaboration within industry takes place as well as looking at more specific outputs of their research. 'Industrial Challenges' (Section 5) provides an understanding of the main challenges facing companies and the discipline of systems biology over the next few years as well as lines of enquiry that systems biology could help researchers tackle. The survey also investigated 'ISBE as a Driver of Innovation', discussed in Section 6. This section illustrates current barriers to innovation from an industrial participant's viewpoint whilst outlining the possible benefits that an infrastructure such as ISBE may have. The final section of the report entitled, 'Proposed ISBE Services by Industry', looks at the services and expertise that ISBE could provide, that would be of most use to the various sectors of industry involved in the survey as well as their favoured way in which to access the infrastructure.

3. Description of Participating Industry

3.1. Position of the interviewee

Interviews were carried out by telephone with senior representatives of a range of industries. The position of the interviewee is important because the needs, or objectives, of a CEO are very different from those of a researcher within the same organisation.

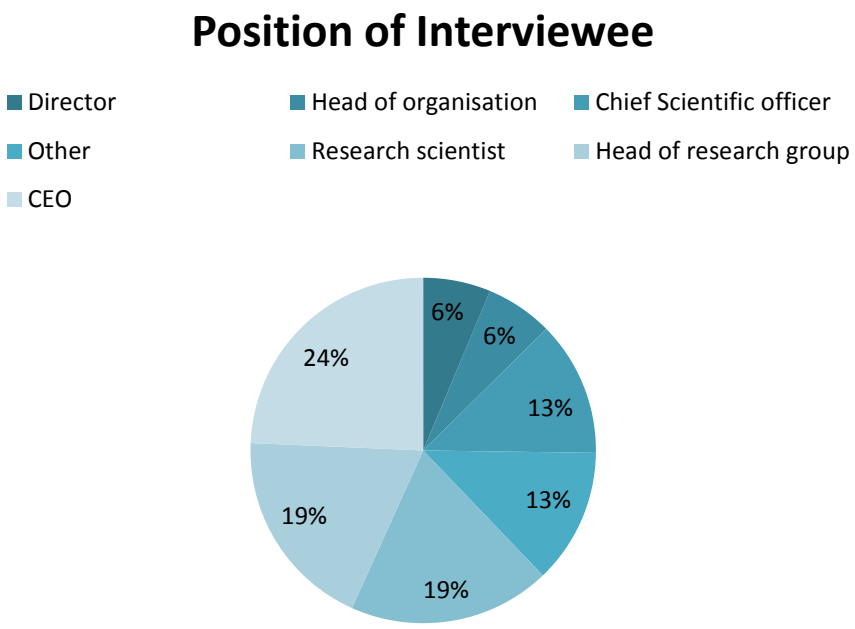

Figure 1 – Company position of the interviewee

Amongst the CEO interviewees, all were from SMEs and working in the Bioinformatics sector. Interviewees drawn from large multinational companies all either held positions as head of research or as research scientists (figure 1).

3.2. Sector

Around three quarters of the industries surveyed are located within the bioinformatics sector with the pharmaceuticals sector contributing the second highest number of survey participants. Participants from the agricultural sector made up the remainder of the interviewees.

67% of SMEs included in the survey were drawn from the bioinformatics sector. All of the pharmaceutical companies included were large, multinational organisations.

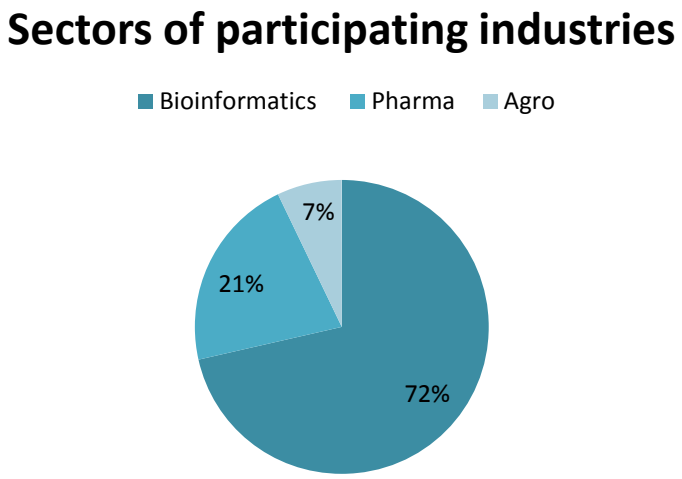

Figure 2 – Sectors of participating industries

3.3. Country

This refers to the country in which the selected company was headquartered. This did not necessarily correspond with the working location of the interviewee themselves.

Most companies included in the survey were located in the UK, with Germany providing the next largest cohort. Two companies in both France and The Netherlands each provided two interviewees, whilst the USA, Switzerland, Belgium and Finland provided the remainder.

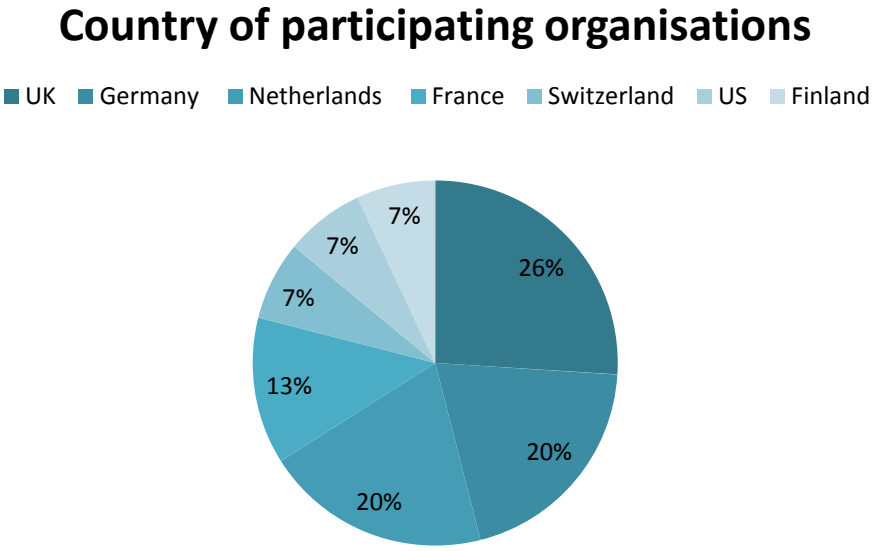

Figure 3 – Country of participating organisations

3.4. Industry Size

Almost 47% of the organisations participating in the survey were small enterprises (1-50 employees). Medium-sized enterprises comprised 20% of the total whilst large companies comprised the remainder (33%).

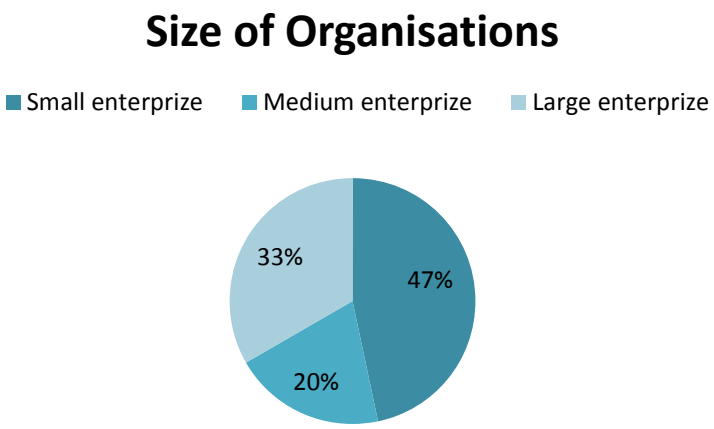

Figure 4 – Proportion of participating organisations, categorised by size

3.5. Type of industry

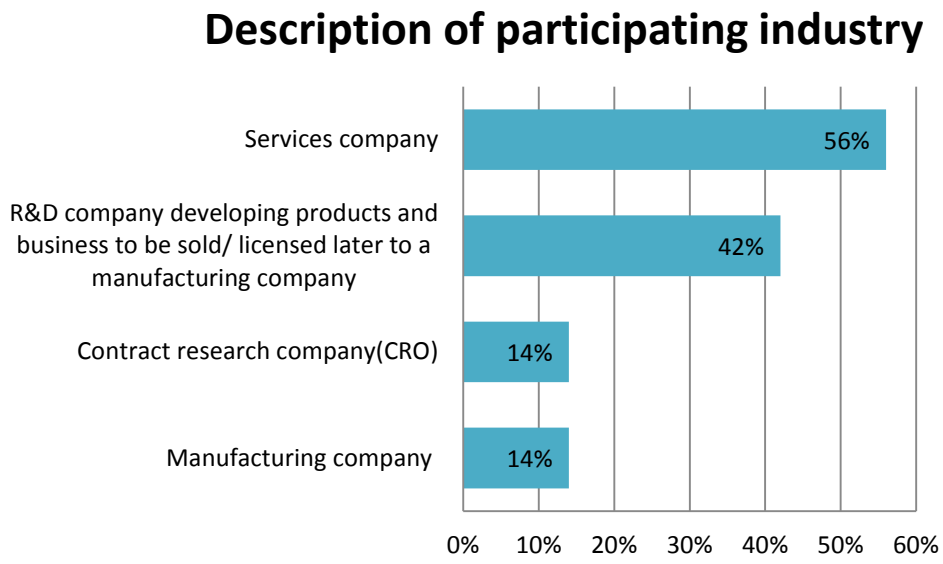

Figure 5 – Description of participating industry

Interviewees were asked to classify their organisation by category according to 'core economic activity'. Interviewees were able to use more than one category.

The different types of economic activity are described below:

- Services Company: These organisations sell consultancy services, such as developing models, carrying out data analysis, mainly in the discipline of bioinformatics.
- R&D Company: These organisations in this industry develop products and business from research in the area of systems biology. They invest in research activities. Most of the pharmaceutical companies included in the survey had this as their core economic activity.
- Manufacturing Company: These organisations only carry out manufacturing activities
- Contract Research Company (CRO): These organisations are contracted to carry out research for other companies.

Organisations classed as 'Service companies' represented 56% of the total organisations surveyed and of these the majority were SMEs working in the Bioinformatics sector. Organisations within the R&D industries counted 42% of the total whilst almost 40% of the organisations surveyed stated that they belonged to two or more categories.

Of the manufacturing companies, all were large, multinational companies working in the pharmaceutical sector. Of the companies that could be described as R&D companies, the survey encompassed an even spread of differently-sized organisations, across multiple industrial sectors.

3.6. Areas of research

The main area of research stated by interviewees was Pharma with over three quarters of respondents selecting it. The interviewees could select multiple options and the majority did so.

Biotech and Bioinformatics was the next most popular selection while Health came closely after. Agriculture sector represents 7% and most of the IT and Software industry were included in the 'Bioinformatics' sector.

The percentage of the budget that organisations spent on R&D depended on the organisation's size. The large multinationals had an R&D budget of up to 20% whilst SMEs usually spent 80% or more, making them 'research intense'. The R&D budgets of medium-sized enterprises varied significantly between 30% and 100%.

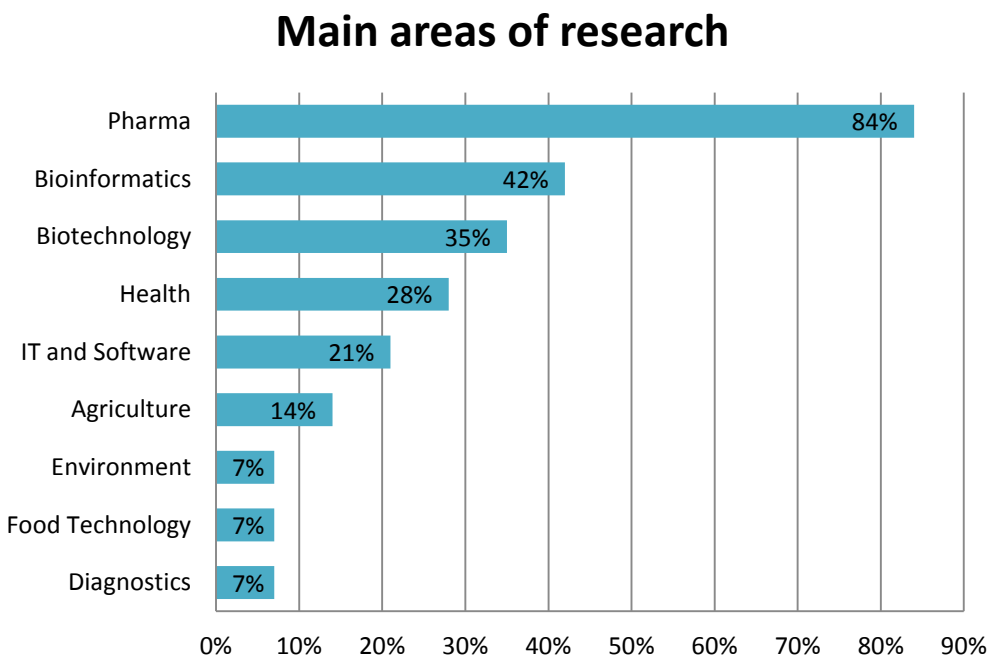

Figure 6 – Main areas of research

Of the main areas of research, as shown in Figure 6, all of the SMEs chose pharma as their main area of research with most of these located in the bioinformatics sector.

Interviewees were also asked to specify further as to the sub-categories of research they are involved in and the most popular selections were Drugs and Clinical trials. Pharmacology also had a high ranking. In addition, almost 44% of the organisations surveyed selected four or more of the research sub-categories with one company being involved in all categories.

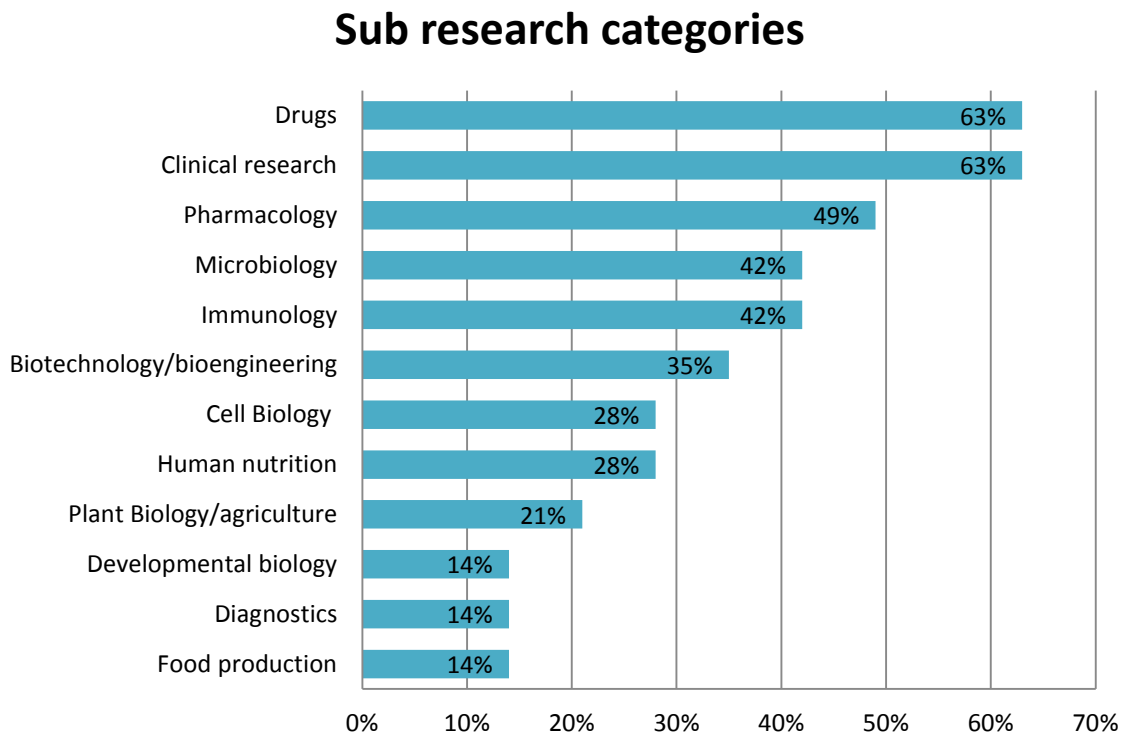

Figure 7 – Sub research categories

4. Industry Operating in Systems Biology

4.1. Services provided by industry

The most popular service provided is selling systems biology services, modelling and data analysis, with 56% of respondent selecting this category.

Providing access to systems biology platforms was the next most popular with 35% while developing new technologies had 28%. Organising or supporting systems biology training courses, selling proprietary research and developing medical products and drugs were each selected by a 21%of the interviewees. Of the organisations that took part, a third was involved in three or more of these systems biology services.

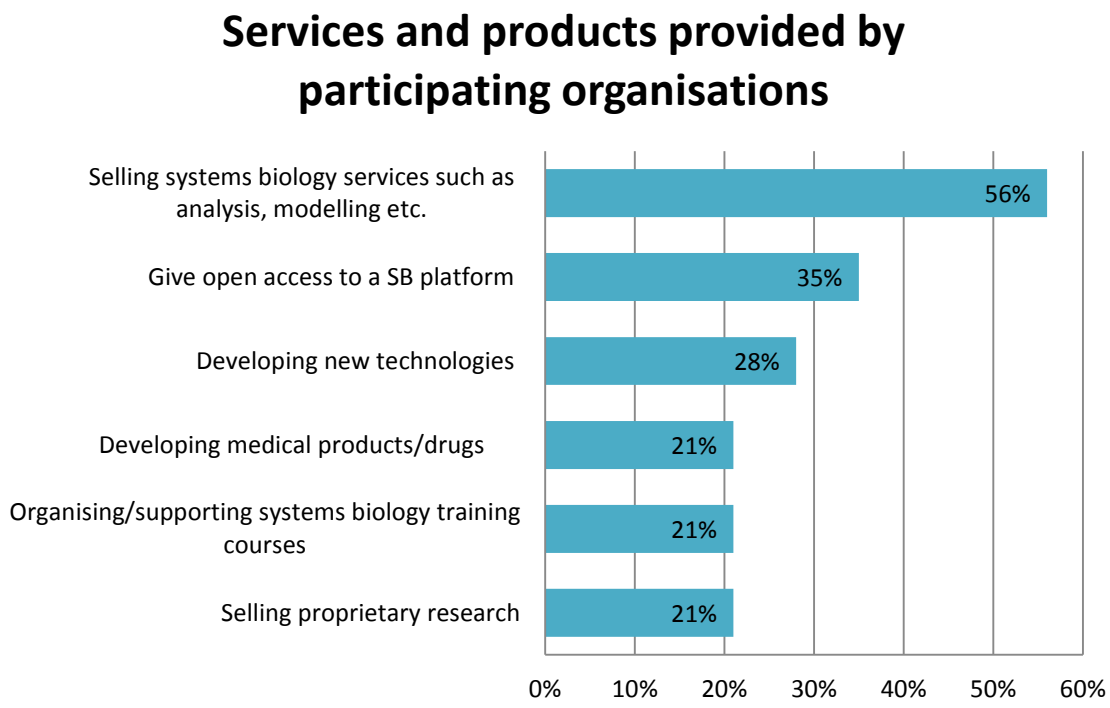

Figure 8 – Services and products provided by participating organisations

4.2. Description of systems biology industry activities

Up to 93% of the organisations surveyed were performing systems biology activities. However, there was not a common understanding on the definition of 'Systems Biology'.

The respondents who performed systems biology were also asked to specify which areas of systems biology they were involved in. The majority said that they carried out data integration and modelling, whilst data processing was conducted by three quarters of the organisations. Experimentation and data generation was an area that had the least amount of participation and of those organisations that carried out experimentation and data generation, 50% were large multinational companies.

73% of the interviewees stated that systems biology was critical to their future. For most of the large companies interviewed, systems biology was not critical to their future as they have a wide range of other activities not related to systems biology.

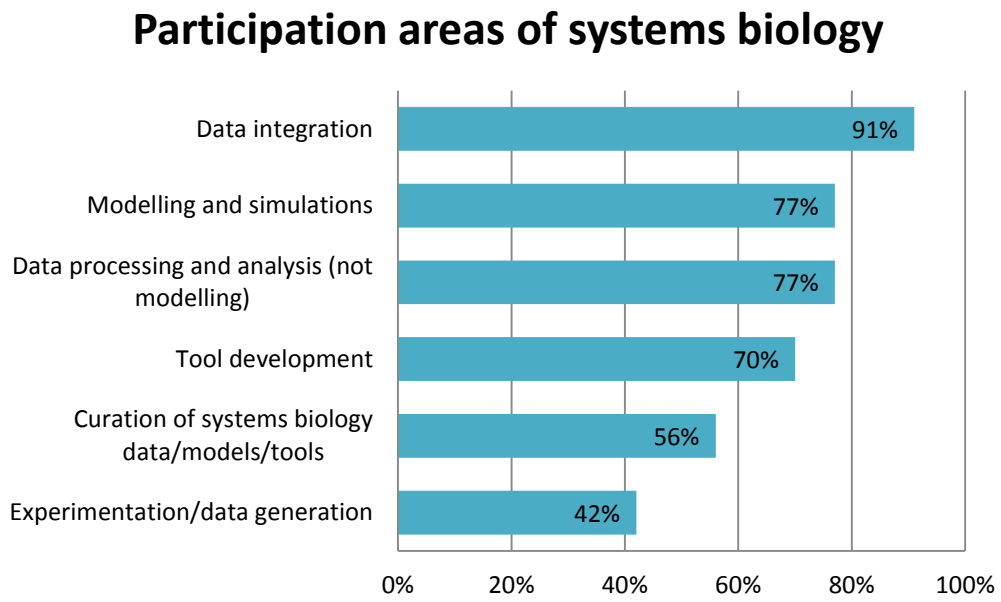

Figure 9 – Participation areas of systems biology

4.3. Systems Biology Tools

Systems Biology Tools refers to the type of instruments or techniques industry uses to perform their research in systems biology. A quarter of the industry participants replied that they use all of the tools listed. Two thirds of these companies were large, multinational companies.

Modelling and computational biology tools were most popular, with a majority selecting them, whilst bioinformatics tools were close behind on 84%.

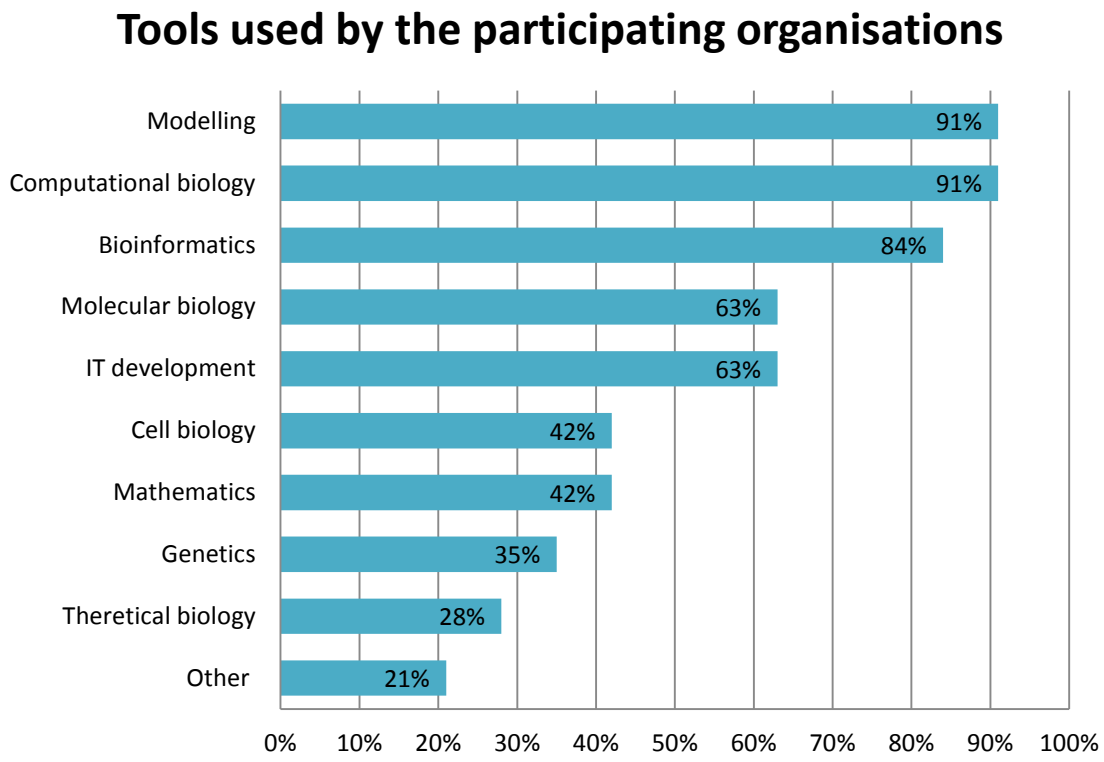

Figure 10 – Tool used by the participating industry

4.4. How do they collaborate with others

All of the organisations surveyed said that they do take part in some form of collaboration with other organisations when they carry out research.

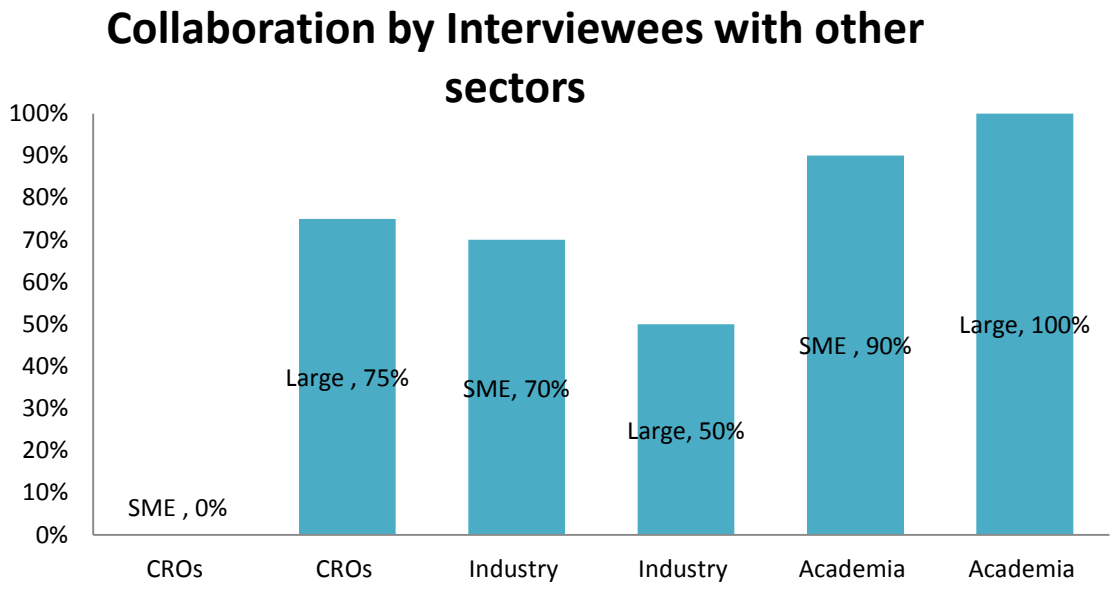

Figure 11 – Collaboration with other sectors (academia, CROs, industry)

87% of those interviewed collaborated with academia, 60% collaborated with other industrial companies and 20% collaborated with CROs.

A common problem for some SMEs was in forming collaborations with academic institutions. They also suggested that guidance on this from ISBE could have a significant impact on their research.

4.5. Commercialisation and Innovation

The outputs from research projects based on systems biology were mainly publication of papers (77%), enhanced collaboration (70%) and registration of a patent (63% of all respondents).

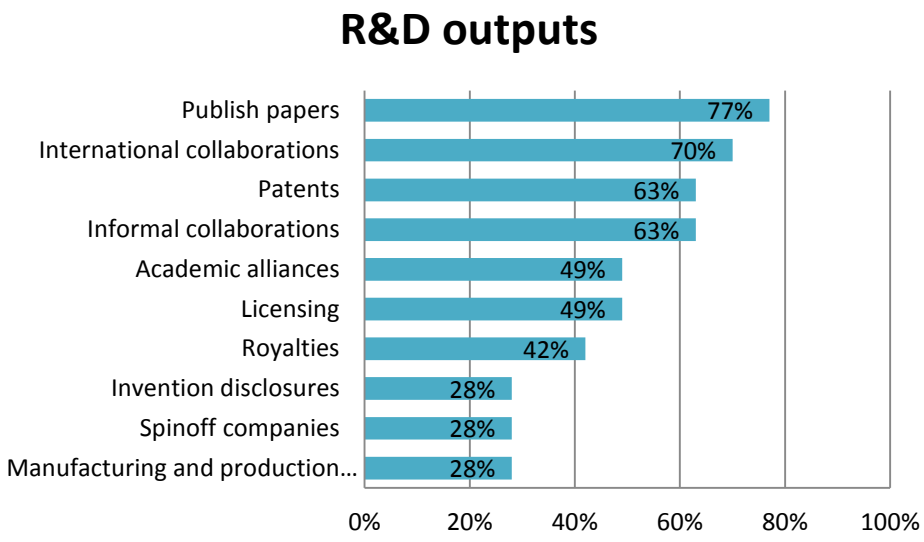

Figure 12 – R&D outputs from Systems Biology approach

Of the SMEs interviewed 50% started that they have patents as an R&D output where as 80% of the large multinational companies interviewed have patents as an R&D output.

5. Industry Challenges

5.1. Challenging research areas

Organisations were asked to identify those diseases most suited for research using a systems biology approach. All the diseases were perceived as equally good subjects for systems biology and other diseases were included spontaneously by the respondent. The 'other' category includes ophthalmology, rare diseases, respiratory diseases, mental diseases, pain and inflammation.

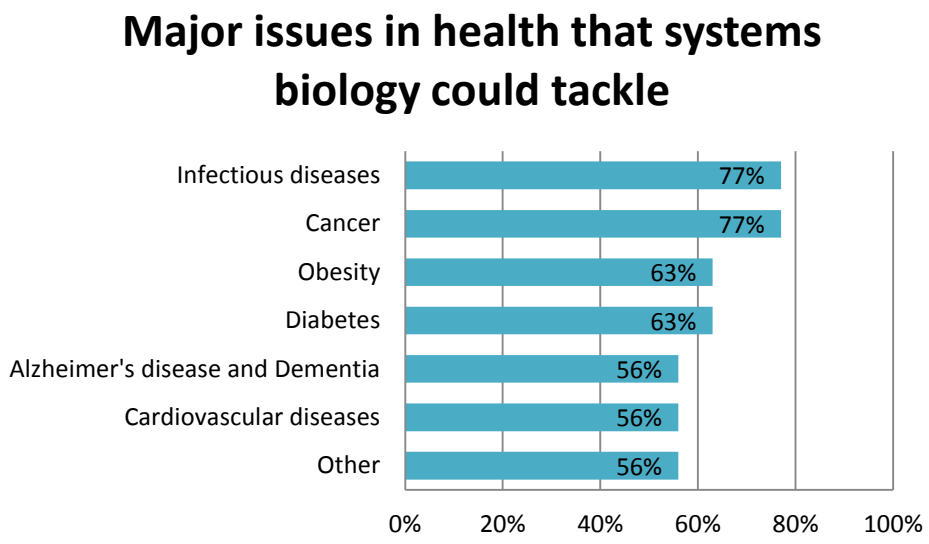

Figure 13 – Major issues in health that systems biology could tackle

The same question was asked for organisations in the agriculture sector. The answers were distributed amongst the potential responses, increased crop yields being the most important.

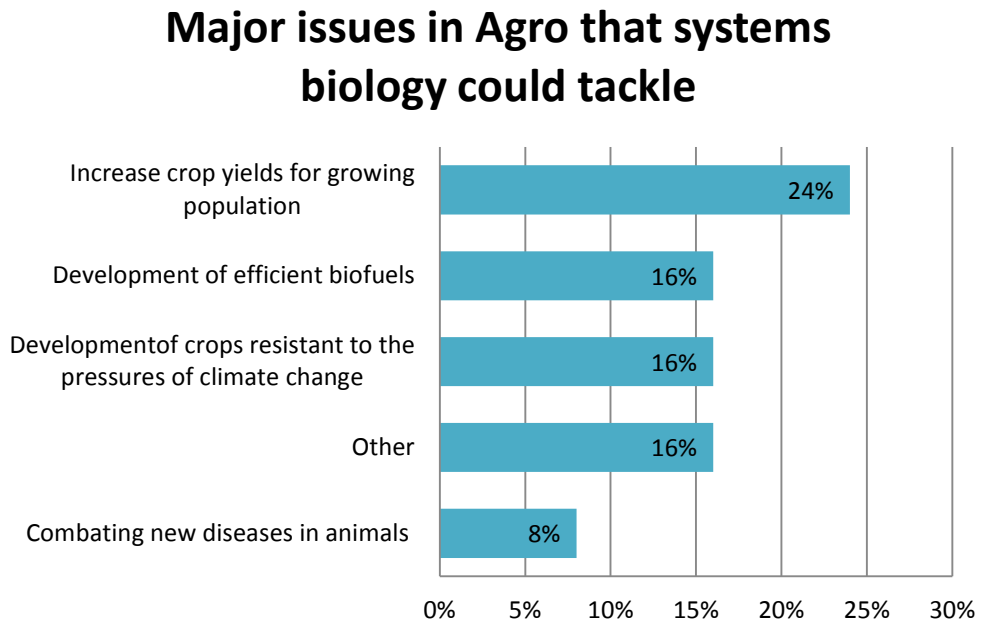

Figure 14 – Major issues in Agro that systems biology could tackle

5.2. Challenges in Systems Biology

Organisations using a systems biology approach (84% of respondents) envisaged, in the next 10 years, the standardisation of models, data and tools as major challenges. This refers to establishing common standards when developing models that can be implemented across the various sectors.

Standardisation of data tends to mean establishing a 'metadata code' that is then used by organisations in different industrial sectors: biology, ICT, patenting, etc. This is a major problem in the view of many organisations because a large amount of time is spent sorting different metadata and data from several sources so that can actually be integrated.

Standardisation of models and metadata is a major challenge for industry and needs to be undertaken by an international body, such as ISBE. Several initiatives are already in place and this task requires strong cooperation with other organisations and wide dissemination amongst the research community.

Competition from US and Asia is not seeing as major challenge, with only 14% of respondents selecting this option.

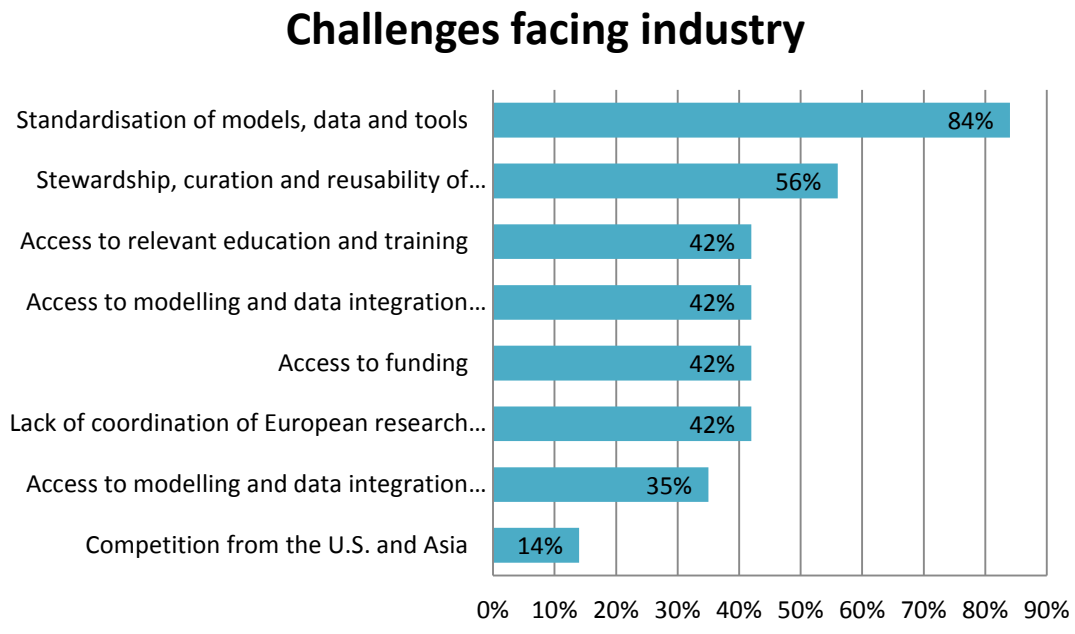

Figure 15 – Challenges facing the Systems Biology industry when performing research

Stewardship, curation and reusability of models and data were seen as major challenges by 56% of the organisations surveyed. Access to relevant education and training is also seen as needed by organisations as systems biology represents a new approach undertaking research and there are not many suitable graduates available. In addition, experience of working in this field is crucial as systems biology depends on the interconnectivity of different expertise; biologists, mathematicians, informatics, physiologists, etc.

6. ISBE As A Driver of Innovation

6.1. Barriers to innovation

This section relates to the main obstacles or barriers that the industry faces in performing systems biology. Several types of answers were provided by interviewees. First, 63% of participants stated that a lack of knowledge about existing resources, and concern about proprietary research, are the main concerns in terms of achieving innovation success. This issue is closely followed by a severe competition for limited time and materials resources and cost.

Other barriers mentioned by the industry include a lack of data quality and finding the necessary resources that will help them, for example whether an approach exists that can further their research – often, existing models are not adequate.

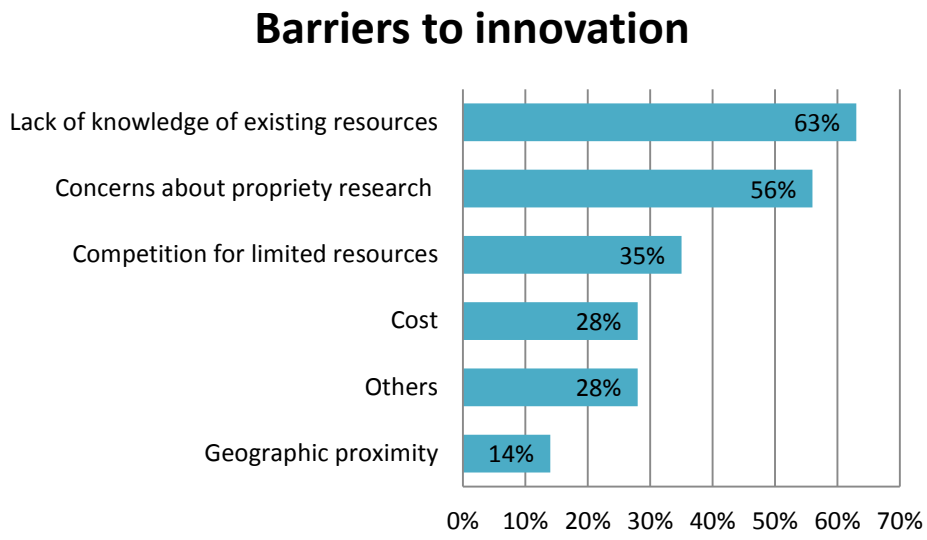

Figure 16 – Barriers to innovation

With regards to a lack of knowledge of existing resources; companies surveyed felt that they are not fully aware of the products and services that can be accessed to further their systems biology projects as this information is not widely available or publicised.

A number of companies, particularly SMEs stated that if information about which academics are working on certain projects was freely available this would help them to target their engagement with academics most able to accelerate research and boost collaboration.

With regards the barriers to innovation the most frequent categories chosen by SMEs were lack of knowledge and concerns about propriety research. These were also the categories most frequently chosen amongst companies located in the bioinformatics, pharma and agricultural sectors on a whole.

There was also concern expressed by some companies about the types of safety features that the infrastructure may have to ensure that data is not stolen by outside parties.

6.2. Benefits of ISBE

Industries were asked what benefits they would forecast as a result of using the services provided by the ISBE infrastructure.

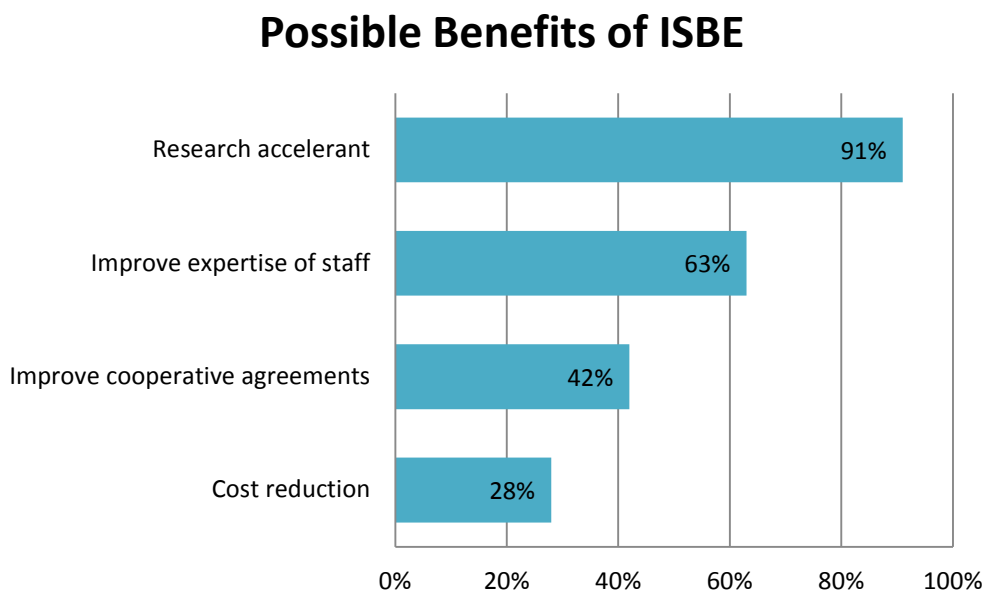

Figure 17 – Possible benefits of ISBE

From the graph it is clear that most of the organisations see the ISBE infrastructure as a possible source of research acceleration. By providing standardisation and guidance to users on how to use systems biology and the infrastructure itself, it was thought that time and money will be saved.

In addition, providing common models (understood as generally accepted models) as a starting point would be useful particularly for SMEs.

As shown in Figure 17, research accelerant was chosen by 100% of medium and large enterprises as a possible benefit of ISBE. The majority of companies in the bioinformatics sector saw this as the most likely benefit of ISBE.

Possible education and training provided by ISBE would result in an improvement of the staff expertise.

6.3. Training in Systems Biology

67% of respondents suggested training could be a core activity of the ISBE infrastructure. Furthermore, they identified which specific training areas would be most relevant.

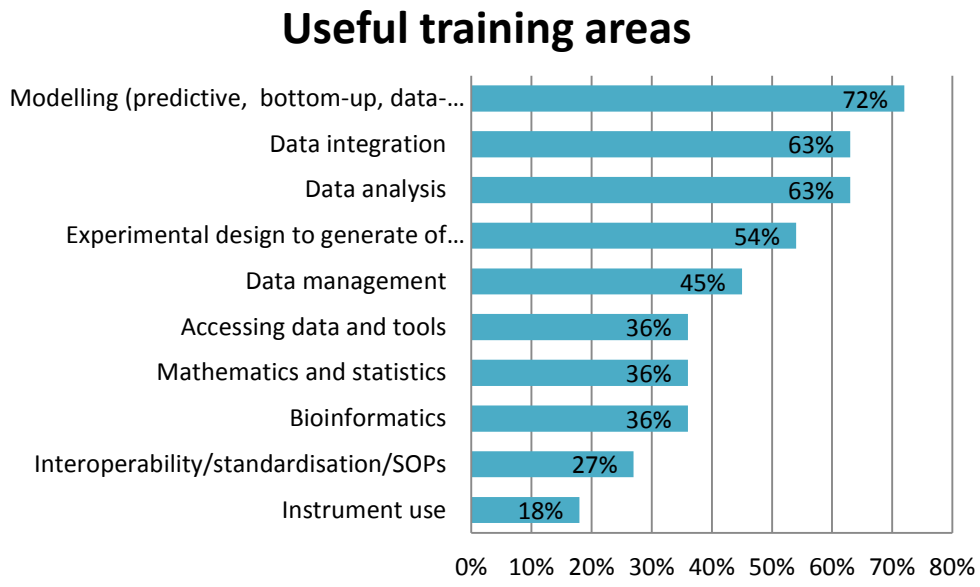

Figure 18 – Useful training areas

Modelling (predictive, bottom-up, data-driven) and data integration are the activities most needed for training, followed by data analysis.

The organisations were also asked if they provide any in-house training to their staff and 60% said that they did. They were also asked if access to training in aspects of systems biology would be useful to them with 67% responding in the affirmative.

6.4. Industry knowledge on Research Infrastructure

Participants were asked about their knowledge of other European Research Infrastructures in Life Sciences and the majority of the respondents knew at most only one or two. However, 40% of those interviewed did not know of any other infrastructures.

The main conclusion to be drawn from the answers to this question is for policy-makers to be aware that industry attitudes are far removed from the aim of European Union initiatives. The success of a Research Infrastructure lies in encouraging research and involving relevant industry players along the way, something that is key to encouraging economic growth and competitiveness across Europe.

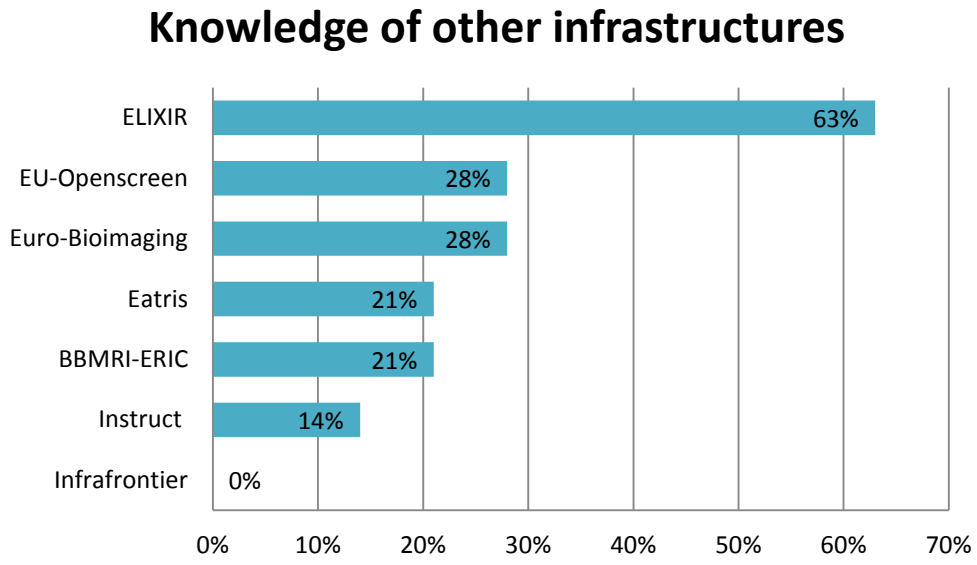

Figure 19 – Knowledge of existing infrastructures

7. PROPOSED ISBE SERVICES BY THE INDUSTRY

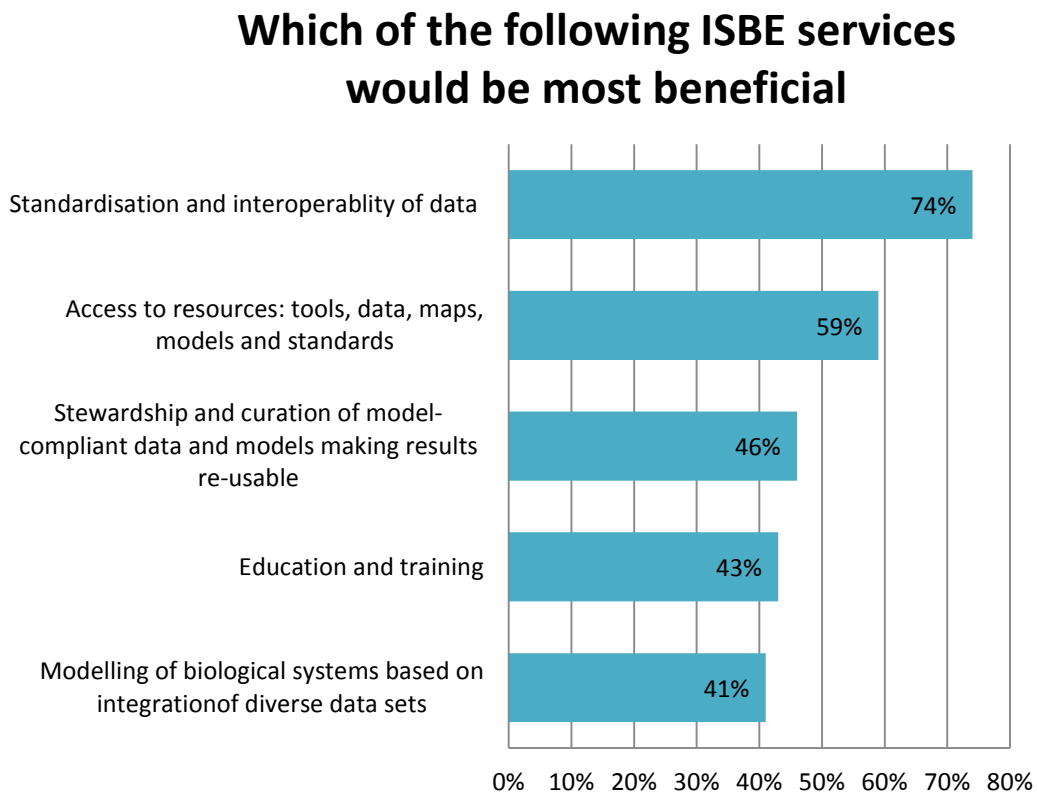

Figure 20 – ISBE Proposed services by the industry

Interviewees were asked to rank the ISBE Services that would be most beneficial to industry on a scale of 0-5. The results of which category was highest ranked are shown in the graph above. It is clear that standardisation and interoperability were seen as the most beneficial of services with the highest ranking of 5, with many still giving a ranking of 4 if not the highest ranking. Education and training however were seen as the least important, with no interviewees ranking this as relevant. Organisations did however state that it would be useful for more university courses to be geared towards systems biology. It was explained that this would save time and money on having to train new employees on understanding the principles of systems biology, in-house.

From the more subjective and open question relating to the preferred, or needed, services to be provided by ISBE the following services were put forward by industry dependent on whether they were an SME:

7.1. SME proposed services

- Being able to tap into public libraries and repositories would be useful for a knowledge platform.
- Knowledge-driven modelling built on data, and existing literature, and involving mining the large amount of knowledge available in scientific literature (models based on this is predictable over time). Conversely, data-driven modelling is time and context-dependent and therefore limited in scope.
- A Scientific Committee would be useful in terms of providing guidance on how to approach problems of systems biology and provide scientific advice.
- Creation and maintenance of a compound library for all to use.
- Provision of certain data: protein-protein interaction data, enhanced data and information about them.
- Regulatory networks, metabolic networks, etc.
- The infrastructure could act as a marketplace, in order for other companies to find and link up with each other and showcase their expertise.
- If the infrastructure could coordinate, and link, existing open-source databases this would be beneficial. A standardisation of associated processes is needed for this to be put in place.
- Providing expertise on setting the right context when carrying out experiments.
- There are missing links between Systems Biology and other EU initiatives. ISBE could be the link between those. For example, pharmacology applies systems biology in the development of drugs, but it seems that there are initiatives already in place for this which should be covered by ISBE. For example the Innovative Medicines Initiative (IMI).
- Providing access to the work of academic groups which are developing further understanding of biological pathways for drug development activities, in relation to specific diseases. For example, what aspect of the disease has changed the characteristics of a cell and as a result how this could change the way in which ways of tackling the disease are developed.
- Access is needed to experimental data, such as those that the BBMRI Research Infrastructure can provide (e.g. biological tissue samples).

7.2. Industry (excluding SMEs) proposed services

- Predicting outcomes that cannot be measured through experimentation alone.
- Standardisation of data and models developed. Standardisation of file formats, type of metadata used between researchers. Provide standards and expertise so that systems biology is easier to do.
- On-demand, and financially cost-free, access to sample data and resources not affected by existing intellectual property rights and collaborative agreements.
- Accessing new data generated from the platform would be of use to one of company, one of the companies surveyed, in generating new software for data analysis and modelling.
- Identification and validation of targets suitable for therapeutic interventions.
- One company surveyed carries out project work on a case-by-case basis and are considering using systems biology in the future if it is specifically required for such projects.
- Network development would be very useful. For example, improving communication between academics on the types of project they are involved in.
- Open access to data, particularly data from experiments.
- Facilitating the use of a systems biology approach. Make it easier to bring information together for companies to build models with.
- Publicly available systems biology models, for example used for oncology.

7.3. How best accessing ISBE services

Industries were also asked to identify the most suitable way to access the ISBE services.

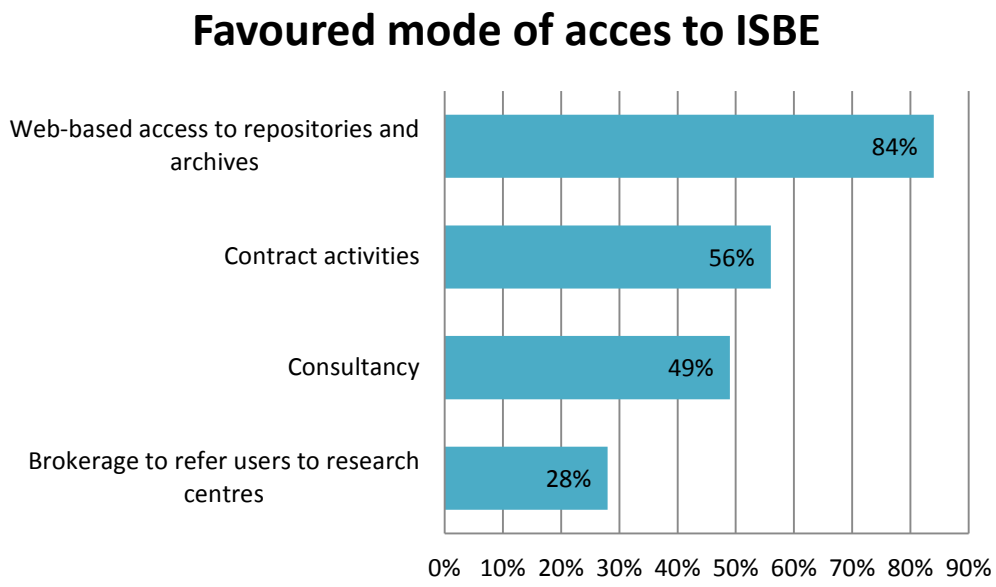

Figure 21 – Favoured mode of access to ISBE services

84% of industry participants stated that access to the internet is the most suitable way to access data and archives from ISBE. In addition, contract research activities and consultancy are other types of accessing the services when the request for data and modelling is specific.

Another way that the infrastructure could be of use to these companies would be if it was used as a type of market place for promoting services provided in systems biology. This would be particularly beneficial to SMEs that specialise in bioinformatics who see this infrastructure as a way to increase their client base.

ISBE Infrastructure for Systems Biology Europe

ANNEX I – List of industry participants that completed the questionnaire

No.	Company	Name/position	Size	Sector	Country
1	Nova Discovery's	Francois Boissel Chief executive officer and co-founder	SME	Computational modelling and consultancy	France
2	Syngenta	Stuart Dunbar Head of research group	Large Multinational	Agriculture	Britain
3	BM Systems	Francois Iris Chief scientific officer and co-founder	SME	Bioinformatics	France
4	Genedata	Timo Wittenberger Head of research group	Medium Multinational	Bioinformatics	German
5	Grunenthal GmbH	Petra Bloms-Funke Project leader	Large Multinational	Pharma	German
6	e-Therapeutics	Malcolm Young CEO	SME	Bioinformatics	UK
7	TNO	Jildau Bouwman Research scientist	Large NGO	Bioinformatics	The Netherlands
8	EdgeLeap	Marijana Radonjic and Thomas Kelder Founders	SME	Bioinformatics and consultancy	The Netherlands
9	Biomax	Dieter Maier Head of Department	Medium	Bioinformatics	Germany
10	Pfizer	Lutz O Harnisch Research Scientist	Large Multinational	Pharma	US (location UK)
11	LYO-X GmbH	Matthias Machacek CEO	SME	Bioinformatics	Switzerland
12	KinDyn Consulting Ltd	Peter Lloyd Director	SME	Bioinformatics	UK
13	Heptares	Rob Cooke Head of research	Medium	Bioinformatics	UK
14	GSK	Robert Van den Berg	Large	Pharma (vaccines)	Belgium

15	MediSapiens	Henrik Edgren CSO	SME	Bioinformatics	Finland

ANNEX II – Questionnaire template

1. Identify the organisation

1.1: Name of organisation

1.2: Date of creation

1.3: Size of organisation

(a) Small enterprise (1-50 employees)
(b) Medium enterprise (50-250 employees)
(c) Large enterprise (250+ employees or an annual turnover greater than €50 million)

1.4: Is your company a multinational and where is your HQ located?

1.5: What is your position in the organisation?

(a) CEO
(b) Director
(c) Head of organisation
(d) Chief Scientific Officer
(e) Head of research group
(f) Research scientist
(g) Other (please specify)

1.6: Which of the following best describes your company?

(a) Manufacturing company
(b) Service company

(c) R&D company developing products and business to be sold/licensed later on to a manufacturing company
(d) Contract research company (CRO)
(e) Other (please specify)

1.7: What is the main area(s) of research for your company?

(a) Health
(b) Pharma
(c) Biotechnology
(d) Bioinformatics
(e) Diagnostics
(f) IT and software
(g) Agriculture
(h) Food technology
(i) Environment
(j) Other (please specify)

1.8: Please specify further if possible:

Research sub categories

(a) Plant biology/agriculture
(b) Developmental biology
(c) Pharmacology
(d) Diagnostics
(e) Drugs
(f) Immunology
(g) Human nutrition
(h) Food production
(i) Microbiology
(j) Biotechnology/bioengineering
(k) Cell biology
(l) Clinical research

Tools

(a) Molecular biology (NGS, proteomics, metabolomics analysis)
(b) Cell biology
(c) Genetics

(d) Bioinformatics
(e) Mathematics
(f) Theoretical biology
(g) Computational biology
(h) IT development
(i) Modelling (predictive, dynamic, stochastic etc.)
(j) Other (please specify)

1.9: Percent of budget your company allocated to research activities annually

(a) 0-20
(b) 20-40
(c) 40-60
(d) 60-80
(e) 80-100

1.10: How many employees working in research?

1.11: How many employees are currently working on systems biology activities? Do you have a dedicated team/department?

1.12: The education profile of staff working in research?

(a) Biologist
(b) Mathematicians
(c) Informatics
(d) Physiologists
(e) Regulatory an clinical development professionals
(f) Other

1.13: What are the funding resources for research?

(a) Venture capital
(b) Internal resources
(c) Public:
    a. National
    b. EU
    c. International
(d) Charitable organisation
(e) Other (please specify)

1.14: Do you access research infrastructure facilities or services for your research? For example: EBI, NIH, other databases, etc.
Research infrastructure definition: facilities, resources and related services that are used by the scientific community to conduct top-level research in their respective fields.

(a) Yes
Please describe
(b) No

2. Description of systems biology activities

Discussion of interviewee's understanding of systems biology, based on factsheet and background reading provided.

"Biological processes are the result of complex and dynamic interactions within and between cells, organs and entire organisms. Systems biology is a field of research which aims to enhance our understanding of and even predict such processes of life. It follows an interdisciplinary approach and combines the latest experimental methods in biology with knowledge and technologies in the fields of mathematics, computer science, physics and engineering. This iterative cycle of laboratory experiments and modelling explains the special potential of systems biology." (ISBE definition)

2.1: When your company performs research, do you apply a systems biology approach?

(a) Yes
(b) No <<go to 2.3>>
    a. Are you interested in the potential benefits of systems biology research?
    b. Will you implement it in the future?

2.2: In which aspect of systems biology does your company operate?

(a) Experimentation / Data generation
(b) Data processing and analysis (not modelling)
(c) Data integration
(d) Modelling and simulations
(e) Tool development
(f) Curation of systems biology data/models/tools
(g) Other (please specify)

2.3: What kind of products and/or services does your organisation provide?

(a) Developing new technologies - and/or manufacturing new technologies.

(b) Developing and manufacturing chemicals

(c) Developing medical products/drugs -and/or manufacturing medical products/drugs

(d) Selling systems biology services such as analysis, modelling etc. (Please specify)

(e) Selling proprietary research

(f) Give open access to a SB platform (data, modelling, analysis etc.)

(g) Organising/supporting systems biology training courses

2.4: Does your organisation collaborate with others when doing research?

(a) Yes – sometimes/always

(b) No

2.4.1: Are the interactions critical?

2.4.2: How do you define your Intellectual Property strategy when you collaborate with others?

2.5: Who does your organisation collaborate with when doing research?

(a) Other companies (competitors yes/no)

(b) Academic or research institutions

(c) Contract research organisations (CROs)

(d) Other (please specify)

2.6: What is the nature of your collaborations with others in systems biology/research?

2.7: In which phase of your research do you involve other parties when utilizing systems biology/research?

2.8: Does your company forecast the use of systems biology to tackle any of the following major issues?

Health

(a) Alzheimer's disease and Dementia

(b) Cancer
(c) Diabetes
(d) Obesity
(e) Cardiovascular disease
(f) Infectious diseases
(g) Other

Agriculture

(a) Increase crop yields for growing population
(b) Development of crops resistant to the pressures of climate change
(c) Development of efficient biofuels
(d) Combating new diseases in animals
(e) Other (please specify)

2.9: How long has your company been involved in systems biology activities?

2.10: Are systems biology activities critical to your future? *(Indicate on a scale of 0-5 - 5 being the most critical)*

(a) Yes
(b) no

3. Commercialisation & innovation

3.1: Which of the following outputs has your company acquired as a result of your R&D?

(a) Licencing
(b) Manufacturing and production agreements (for software, medical devices, drugs etc.)
(c) Spin Off companies
(d) Patents
(e) Royalties
(f) Invention disclosures
(g) Publish papers
(h) International collaborations
(i) Informal collaborations
(j) Academic alliances
(k) Other (please specify)

3.2: If European Union Systems Biology Infrastructure would be created that can be used by any company, what kind of products and services should provide that could benefit your company?

4. Industry challenges

4.1: What are the major challenges facing the European biotechnology industry in the next 10 years? *(Multiple choice)*

(a) Access to modelling and data integration expertise

Describe:

(b) Access to modelling and data integration resources (e.g. Tools, data, models)

Describe:

(c) Stewardship, curation and reusability of models, data and tools

Describe:

(d) Standardisation of models, data and tools

Describe:

(e) Access to relevant education and training

Describe:

(f) Access to funding

Describe:

(g) Competition from the U.S. and Asia

Describe:

(h) Lack of coordination of European research infrastructures

Describe

(i) Other (please specify)

5. ISBE as driver of innovation

5.1: In doing your research, which of the following ISBE services will be the most beneficial? *(Prioritise on a scale of 0 to 5 with 0 not being beneficial and 5 being very beneficial)*

(a) Access to resources: tools, data, maps, models and standards

(b) Modelling of biological systems based on integration of diverse data sets

(c) Stewardship and curation of model-compliant data and models making results re-usable

(d) Standardisation and interoperability of data and models

(e) Education and training

(f) All of the above

(g) None of the above

(h) Other (specify)

5.2: Is there any additional systems biology related expertise that should be covered by a biological research infrastructure?

5.3: What mode of access to resources would you find most beneficial?

(a) web-based access to repositories and archives
(b) consultancy
(c) contract activities
(d) brokerage to refer users to research centres

5.4: Are your employees provided with training related to systems biology? Is this external/in house?

(a) Yes
(b) No

5.5: Would access to training in (aspects of) systems biology be useful to your company?

(a) Yes
(b) No

5.6: Which of the following subjects would your company find useful in terms of systems biology education and training?

(a) Experimental design to generate of systems biology compliant data
(b) Data analysis
(c) Data integration
(d) Data management
(e) Interoperability/standardisation/SOPs
(f) Modelling (predictive, bottom-up, data-driven etc.)
(g) Accessing data and tools
(h) Instrument use
(i) Bioinformatics
(j) Mathematics and statistics
(k) Other (please specify)

5.7: Is your company aware of any of the following existing European research Infrastructures? Are you participating in any EU funded project?

(a) **Euro-Bioimaging.** State-of-the-art imaging technologies in biological, molecular and medical imaging for life scientists in Europe and beyond. http://www.eurobioimaging.eu/

(b) **BBMRI-ERIC**. Biobanking and Bimolecular Research Infrastructure. Infrastructure that provides biological samples and corresponding data that are required for the development of any new drug or diagnostic assay http://bbmri-eric.eu/

(c) **Eatris.** Provides a new development pathway, open to researchers and companies in need of support for advancing biomedical innovations http://www.eatris.eu/

(d) **ELIXIR** Infrastructure that integrates research data from all corners of Europe and ensures a seamless service provision that is easily accessible to all http://www.elixir-europe.org/

(e) **EU-Openscreen** Infrastructure to develop novel molecular tool compounds with external users from all life sciences to address challenges in systems and network biology, structural biology and plant biology http://www.eu-openscreen.eu/

(f) **Infrafrontier** aims to build a world-class research infrastructure that provides the biomedical research community with the tools needed to unravel the role of gene function in human disease https://www.infrafrontier.eu/

(g) **Instruct** Infrastructure providing expertise and access to high quality instruments for structural cell biology researchers https://www.structuralbiology.eu/

5.8: What benefits could you foresee in using a research infrastructure as opposed to a commercial or academic partner?

5.9: What are the barriers for using existing systems biology resources, services and expertise (choose as many as required and provide a brief description of the barrier)? *(Prioritise)*

(a) Lack of knowledge of existing resources

Describe

(b) Competition for limited resources

Describe

(c) Concerns about proprietary research

Describe

(d) Geographic proximity

Describe

(e) Cost

Describe

(f) Others

Describe

5.10: A systems biology infrastructure that provided easy access to resources, services and expertise would have the following benefits for my company (choose as many as required and provide a brief description):

(a) Research accelerant

Describe

(b) Improve cooperative agreements

Describe

(c) Improve expertise of staff

Describe

(d) Cost reduction

Describe

(e) Other