Research Guideline

"To be honest: funding opportunities changed how we approach gender and diversity in our research."

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Abstract:	A guideline for sex, gender and diversity in research projects providing guiding questions, examples and references to literature for research activities. This guideline is based on a guideline by convelop cooperative knowledge design gmbh in cooperation with Graz University of Technology (2015). It was translated and further developed for the Human Brain Project by convelop gmbh in 2018.
Keywords:	Gender, diversity, research framework
Target Users/Readers:	All HBP members, all researchers

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1. RATIONALE: Diversity & Gender Sensitive Research Projects

Science and technology research often include human beings, non-human animals, or living materials as subjects, and research results might be relevant for diverse groups of users. Therefore, some funding regimes specifically demand that sex, gender and other diversity perspectives are integrated systematically into **research proposals** (e.g. Horizon 2020).

A better understanding of what people have in common and what makes them different leads to great **potentials for research outcomes and innovation** (Hewlett 2013, European Commission 2013, Schiebinger 2014, p. 2008). To make use of these potentials, relevant sex, gender and diversity aspects need to be identified and integrated into research projects.

This Guideline contains background information, examples and questions for all stages of the research process regarding sex, gender and diversity dimensions, both in the content of the research and at the research management level. It provides guidance on how to:

- determine whether sex, gender and diversity aspects are relevant for your research, and if yes, which ones;
- integrate sex, gender and diversity into your research project.

The guideline provides guiding questions, examples and references to literature for your research project in six areas (see "OVERVIEW on the areas covered").

Diversity-sensitive research consistently takes into account diversity aspects, *if relevant*, throughout the research cycle.

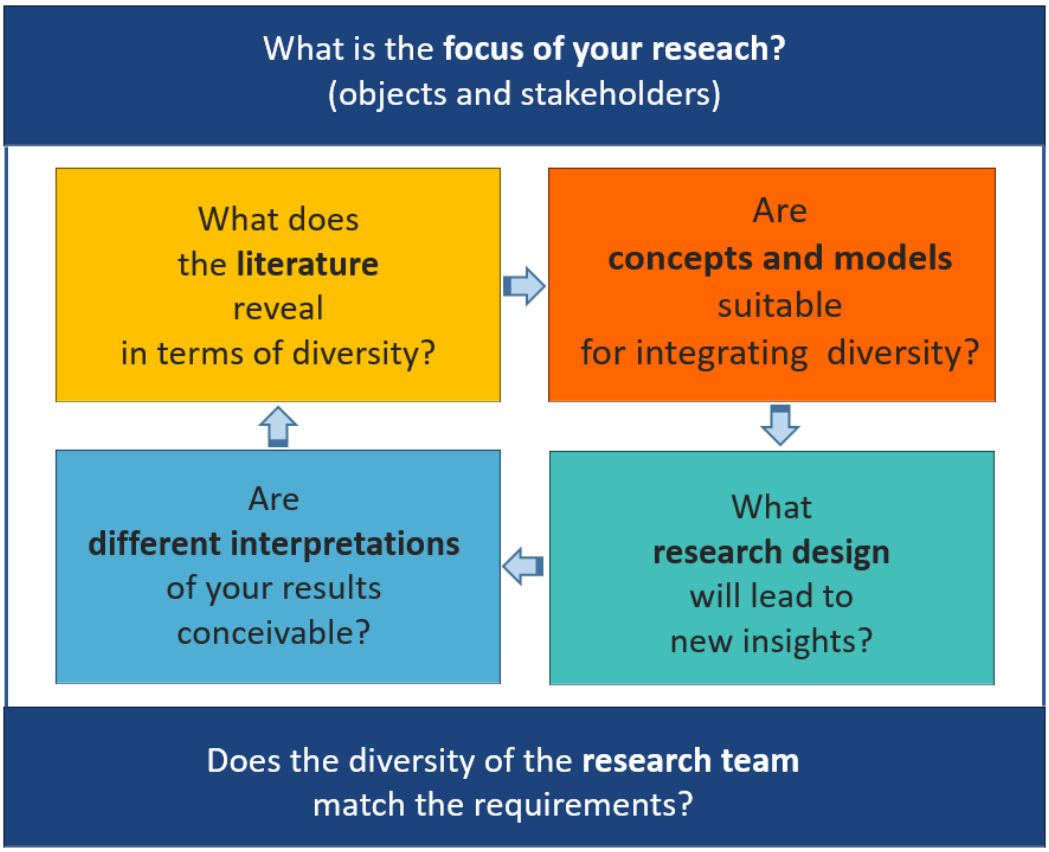

Figure 1: Research cycle

2. OVERVIEW on the areas covered

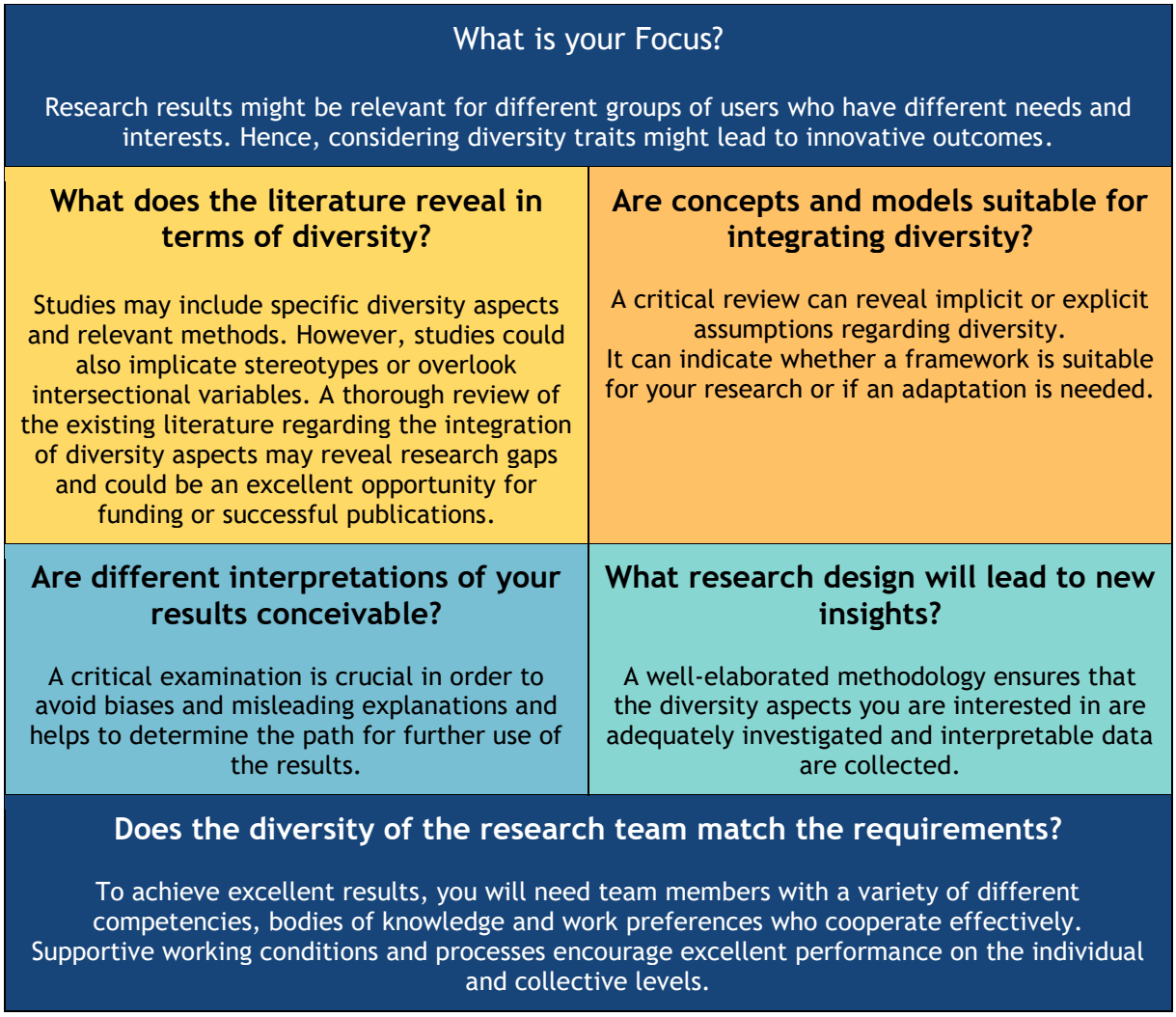

Figure 2: Overview based on research cycle

3. Relevant Definitions and Analytic Dimensions

3.1 Diversity

The term **diversity** comprises the manifold traits, characteristics and differences of human subjects based on various dimensions. Some of these traits are inherent (e.g., sex, ethnicity, sexual orientation, body composition, physiology, age), some are acquired (e.g., skills, knowledge, technological literacy) and others are context related (e.g., different mobility needs in private and working context, social and economic background, working and living environment, lifestyle). The European Union acts to prevent discrimination on grounds of racial or ethnic origin, religion or belief, disability, age or sexual orientation and sex (see also http://ec.europa.eu/justice/discrimination/).

3.1.1 Sex

Sex refers to the **biological differentiation** between "men" and "women", determined by chromosomes, genes, hormones, and anatomy. However, the idea of two discrete sexes is very simplistic. The concept of "intersex" refers to a variety of conditions, in which the combination of sexual, anatomical and physiological factors does not fit to the typical definition of male and female (Ainsworth 2015, ISNA 2015). While sex is a powerful analytical and explanatory variable, there might be other diversity traits of higher explanatory significance that **intersect** or correlate with the variable "sex" (e.g., age, body height or weight, hormone status …). When referring specifically (and only) to sex (as a biological characteristic), the terms "female" and "male" should be used. It is recommended to use the terms "women" and "men" when both biology and culture are concerned (see European Commission 2013, p.50).

For **humans**, epidemiological and clinical studies revealed sex differences e.g. in cardiovascular disease or autoimmune dysfunction, stroke, multiple sclerosis, reaction to pain or response to drugs (Beery & Zucker 2011).

In **animal studies**, sex differences in rodent behaviour include wheel running behaviour, open field activity, aggression, taste preferences, food intake, performance on learning tasks, and responses to brain damage (Beery & Zucker 2011, p.5). But experimental results might also be influenced by **environment** (laboratory milieu) and **social interactions** (e.g., food, the presence of animals of the other sex, light, stress, discomfort, isolation, noise, temperature, the sex of the laboratory staff - due to odours, sounds, handling differences) (Holdcroft 2007).

3.1.2 Gender

The term **gender** refers to the **social construction of women, men and non-binary persons**: societies and cultures associate competences, behaviours and attitudes with a person's biological sex. Expectations and ascribed roles lead to further differences in persons' paths through life, for instance by influencing the perception of talent, occupational choices, income, or experiences with technologies. Therefore, gender is not a variable per se but rather a combination of diverse aspects which change over time (see Johnson et al. 2009).

In animal research, use of the term "gender" is controversial – sometimes, gender is used exclusively for human differences. However, gender might also be of relevance in animal research (see e.g. McGregor et al. 2016, p.66). When discussing **(human) gender** traits (as socio-cultural characteristics), the terms **"femininities" and "masculinities"** should be used (see European Commission 2013, p.50).

3.1.3 Sex/Gender Differences – Sex/Gender dimorphism

The terms "sexual dimorphism" and "sex differences" must be distinguished. **Sexual dimorphism** refers to *"those aspects of differences that come **in two distinct forms**"* (Jäncke 2018, p.3), for instance, male and female genitalia or X and Y chromosomes (in most cases). Many sex/gender related differences, however, occur in a broad spectrum with large **overlaps between two groups**.

In brain anatomy, there are some features that are more typical for females, whereas other features are more typical "male". Still, very few women or men do exclusively show female or male brain characteristics/features. Rather, individual brains are composed of both male and female features. There is thus no evidence of a clear distinction between a typical "male" or "female" brain, *"because the anatomical parameters for men and women overlap far too much"*. (Jäncke 2018)

3.2 Intersections

Intersecting factors are variables that often correlate with sex and gender and may confound results if not taken into account.

These intersecting variables include, but are not limited to: **genetics, age, sex hormones, reproductive status** (pre- or post-pubertal, virgin, or numerous pregnancies), body composition, comorbidities, body size, disabilities, ethnicity, nationality, geographic location, socioeconomic status, educational background, sexual orientation, religion, lifestyle, social interaction, language, family configuration, environment (European Commission 2013, p.115, McGregor et al. 2016, p.66) Considering, understanding and defining these factors can reveal sub-group differences among men/women and helps explaining or predicting outcomes and user needs.

"For example, sex, socioeconomics, gendered divisions of labor, and language have all been found to interact in determining how agricultural workers are exposed to endocrine disruptors." (Gendered Innovations Report, p.115, see as well Case Study: Environmental Chemicals http://genderedinnovations.stanford.edu/case-studies/environment.html)

3.3 Operationalisation

When introducing diversity, sex or gender **variables need to be defined and operationalised. Operationalisation** transforms roughly described terminologies and variables into measurable factors. For instance, "sex" might be differentiated by identifying "men", "women" or "third sex" (often indicated as "X") as defined in their passport. "Income" could be defined as payment for work after taxes or as living standard based on all goods and services a person receives including income, inheritances, estates, other financial support, etc. (see also the World Bank Living Standards Measurement Study, http://surveys.worldbank.org/lsms). But the term could also refer to social capital and standing. The operationalisation of the variable "technological literacy", for instance, is more challenging and might be a combination of different indicators.

3.3.1 Problems to Avoid

The Gendered Innovations website lists a range of problems that should be avoided when analysing sex (http://genderedinnovations.stanford.edu/terms/sex.html):

- All women or all men are the same (e.g. regarding attitudes, preferences, needs, knowledge).
- Women and men are totally different from each other.
- Observed or apparent differences between women and men are solely biological in origin.
- Observed or apparent differences between women and men hold across cultures or different socio-economic realities.

In addition, one should be careful not to assume that all humans are either male or female (which would mean that intersexuality does not exist).

3.3.2 Methodologies

Methodologies must allow to reflect change, variation and the particularities related to a given research question. Gillian Einstein (2012, p.5) points out that *"to study a constantly changing biology, such as women's during their reproductive lives, using static methods is not properly aligning the approach with the nature of the 'kind' under study. Questions must dictate methodologies."*

4. FOCUS: What is the focus of your research project?

Research results might be relevant for different groups of users who have different needs and interests. Hence, considering diversity traits might lead to innovative outcomes.

Does your research involve …	Yes/No
… human subjects? (e.g., as participants or test users)	
… animals, tissues, cells? (e.g., differentiate the sex or age of cells)	
… public policies? (e.g., health, economic or technology policies)	
Will humans be affected by your research in daily life?	

If one or more of the above is true, sex/gender and diversity aspects are likely to require further attention in your research project. Continue to consider these aspects and ask questions until you can clearly determine if and what aspects are relevant.

Gender as *"the biology shaped by environment and experience"* might also be of relevance in animal research: animal-to-animal interaction (role of the physical and social environment in which animals are housed), or the sex of the animal handler (effects on the animal due to sex differences in human odours, sounds, and animal handling) might have an impact. (McGregor et al. 2016, p.66, Holdcroft 2007).

Who are the beneficiaries and users of your research?	
What do the beneficiaries have in common?	
In which ways do the beneficiaries differ?	
What potential influences might your research have on the different users and their interrelations? (e.g., gender equality)	

Commonalities and differences might refer to skills and capabilities, social and economic background, working and living environment, body composition, physiology, age, lifestyle (e.g., diet, physical activity, use of tobacco/alcohol/other drugs) etc. (see as well: "Relevant Analytic Dimensions and Definitions").

For instance, *"if a potential user group is women of reproductive age then 'the problem at hand' requires that the test consider at least four phases of the menstrual cycle (Becker et al., 2005). If a potential user group is pregnant women, then the treatment must be tested over nine months of pregnancy."* (Einstein 2012, p.4)

While it is important to analyse differences, do not forget to recognize and understand similarities (European Commission 2013 p.118).

Diversity analysis in research and technology can help **to meet previously unmet needs or open new markets**. *"For example, **heart disease** has long been considered a male disease and 'evidence-based' diagnostic tests, treatments, and clinical standards are based on the most common presentation and pathophysiology in men. Yet heart disease is a major killer of women as well. Addressing heart disease in women has required changes in research priorities and has led to numerous insights."* (European Commission 2013, p.106)

What are the different needs, assumptions and behaviours of the beneficiaries, users or subjects of research?	
Will the variable "sex" sufficiently explain the phenomenon you are interested in?	
Which other aspects might lead to better insights with regard to the different needs that have been identified?	

Variables that **interact with biological** sex might include gender, age, race, ethnicity, class, sexual orientation or sexual identity (McGregor et al. 2016). Make sure to get a good grasp of the differences between **sex and gender**. (see "Relevant Definitions and Analytic Dimensions")

For instance, **with regard to nutrition, food quality and safety**, there might **be differences related to sex** (e.g., men and women differ in their susceptibility to diet-related diseases, their acute and chronic response to nutrients and the distribution of patterns of genetic coding or polymorphisms) as well as **differences related to gender** (e.g., risk perception, risk attitude, motivation with regard to one's own and the family nutrition, the processing of nutrition information, attendance to different elements of dietary advice) (Klinge and Bosch 2005, p.388).

Gender identity and socialization also play a role with regard to asthma and allergies, for instance: It has been observed that boys face peer pressure to hide their condition and not use their inhalants when in company of peers. Girls, in contrast, are more likely to incorporate their asthma in their social circle (see Genderbasic Project).

If you are working with humans, understanding the characteristics of your research subjects and users is crucial. It can help to consider the "subject" of your experiments an active partner. For instance, in her study of neurobiological effects of female genital mutilation (FGM), Gillian Einstein paid particular attention to affected women's **perspectives and needs**: *"Asking participants what matters to them is both a source of agency and a way of uncovering important scientific ignorance that is a result of assumptions and prejudices of biomedicine." (Einstein 2012, p.17)*

*"For example, **assistive technologies** have the potential to help the elderly remain independent; designers should take into account that the majority of the elderly and of elder care givers are women."* (European Commission 2013, p.108).

5. LITERATURE: What does the review of relevant literature reveal regarding diversity?

Studies may include specific diversity aspects and relevant methods. However, studies could also implicate stereotypes or overlook intersectional variables. A thorough review of the existing literature regarding the integration of diversity aspects may reveal research gaps.

Search Strategy (see "Relevant Definitions and Analytic Dimensions"):

"It may take some practice to develop a search strategy that identifies the full range of sex and gender differences that have been documented. The most straightforward method is to combine the name of a condition or biomedical research topic with MeSHterms [Medical Subject Headings], such as sex factors and sex characteristics, or text words, such as gender differences and sex differences. […] In basic life sciences research, it might be more rewarding to use search terms signaling sex-specific features on, for example, the cellular or hormonal level (e.g., estrogen receptors), which are dependent on the field of research." (Nieuwenhoven & Klinge 2010, p.318).

Which diversity aspects have been investigated so far and what are the results?	
Which variables are used, and how are they defined in order to operationalise relevant dimensions?	
Are there any further terms or variables that might be relevant for your literature review?	
What does the data show? What assumptions are underlying the interpretations?	
Have intersections of different diversity aspects been investigated?	
Which diversity aspects have been neglected and could be of interest for further research?	

What are the most important research gaps?	
Is there a research gap concerning "sex"?	
What research gaps have you identified regarding diversity aspects that might be of relevance as intersectional variables?	
How do these research gaps relate to the diversity aspects you have identified?	

Following strategy regarding research gaps might be helpful (Nieuwenhoven & Klinge 2010, p.318, Beery & Zucker 2011, p.7):

- If you have identified a research gap concerning sex (no or equivocal knowledge about the existence of sex differences), you should consider "sex" as one of the priorities in your research.
- If there is no research gap and there are known sex differences, focus on intersecting diversity aspects but keep "sex" as an analytical entity: Include differences that are known to be relevant, or substantiate your decision not to include these aspects. Studying the mechanisms and causes underlying the known differences could also be a priority.
- If there is no research gap and prior research strongly indicates that there are no significant sex differences, review if there might be other relevant diversity dimensions. In this case, sex might not be required in subject sex selection, but still, the study of both sexes is recommended.

Does the methodology used adequately reflect the aspects of diversity that you are interested in?	
Which methodological steps include diversity aspects, and how are these aspects analysed?	
Which methodology would enable a better reflection of the dimensions you are interested in?	

6. CONCEPTS & MODELS: How is diversity integrated in concepts and theoretical models?

A critical review can reveal implicit or explicit assumptions with regard to diversity. It can indicate whether a framework is suitable for your research or if an adaptation is needed.

Diversity-insensitive concepts or models may reduce the quality and innovative capacity of research, e.g. by taking men/women as the norm; pathologizing normal female biological processes, such as pregnancy or menopause; or by reproducing existing stereotypes without scientific ground (Nieuwenhoven & Klinge 2010, p.318).

Does the theoretical concept or model explicitly integrate diversity aspects?	
What diversity aspects are already covered in your concept and model?	
Is it possible that there are implicit assumptions regarding diversity and sex in the concepts and theoretical models? (e.g., stereotypes, generalisation, spurious correlations)	

Implicit or explicit "background assumptions" about sex and gender within a research community shape the concepts and theories used, and thus the way research is conducted. Try to analyse those assumptions and uncover unconscious ones. (Further questions are provided by the European Commission 2013, p.108).

Make sure to understand the level of detail of a concept or model: When **small sex differences accumulate**, they might substantially influence outcomes. Anita Holdcroft (2007) presents methodological approaches allowing to recognize such small sex differences (by reducing experimental variation in certain factors to obtain more reliable and reproducible results, sufficiently powering studies, and by conducting meta-analyses).

In **animal models of disease**, for instance, the **underrepresentation of females** frequently compromises the understanding of female biology. Researchers frequently assume that females are more variable than males (due to hormonal cycles). Although not formally required in many cases, the study of both sexes is highly recommended: "*If male and female animal models are thought to differ in response to an intervention then the study must be designed with adequate sample sizes to answer the question for each sex.*" (Beery & Zucker 2011, p.7)

Furthermore, animal studies frequently focus on a **few species** (rats and mice, in particular in neuroscience, pharmacology, immunology and physiology). More diverse species and non-rodent models are used in behaviour, zoology and reproduction fields (Beery & Zucker 2011, p.5).

Overemphasizing sex differences or improperly attributing differences to sex, when other factors come into play can also be a problem. For example, companies might develop "gender-specific" products based on stereotypical assumptions that fail to address the actual needs of consumers. E.g., a sex-specific knee prosthesis has been developed, although different prosthesis needs are not based on sex, but rather on body height (European Commission 2013, p.110, and case study De-Gendering the Knee: https://genderedinnovations.stanford.edu/case-studies/knee.html). Typical "blue" (focusing on combat) and "pink" (focusing on fashion) video games are based on the belief that women's and men's interests and skills are fundamentally different – whereas some of the most popular modern games are designed for a broad audience and equally attract men and women players (Gendered Innovations Case Study Video Games: https://genderedinnovations.stanford.edu/case-studies/games.html).

Are your research framework and definitions according to current research?	
In which contexts has the framework been developed and used so far?	
Is the concept used by different scientists (male/female, disciplines, context)?	
Do they use the same definitions and terms within the framework?	

If only specific groups of scientists use a concept or theory, it may potentially be biased and requires critical reflection. In design, for instance, **"I-Methodology"** refers to the (unconscious) tendency of designers to *"create products for users whose interests, abilities, and needs resemble their own."* (European Commission 2013, p.116). As many engineers and designers are men, this may result in a "male default", even when they attempt to design for everybody (e.g., most video games are designed for boys and men and early speech synthesis produced only male voices).

Analyse definitions used and assumptions made. In identifying users / subjects / target groups, be careful to avoid stereotypes. Being aware that not all men and all women are the same, make clear WHICH men or women you are talking about (i.e., consider intersecting variables such as age, level of education, socioeconomic status etc.). (European Commission 2013, p.113)

Standards and reference models are frequently based on specific groups of persons. The "young, white, able-bodied 70kg male" is a widely-used norm in science, medicine and engineering, with other population groups considered as deviations from that norm (European Commission 2013, p.125). Try to critically analyse and, if necessary, adapt and revise standards and reference models used to avoid sex and gender bias.

"For example, in rodent research, "reference females" are usually non-pregnant and non-lactating. Behaviourally, these females are less aggressive than males—a finding congruent with assumptions about gender. Changing the female mouse model to a pregnant or lactating animal would alter the outcome of a behavioural study: female mice are aggressive in controlling food sources when pregnant or caring for pups (Brown et al., 2010)." (European Commission 2013, p.126).

The Gendered Innovations Report of the European Commission (2013) also provides further questions to reflect and revise standards and reference models.

Considering the questions above, is the framework in question useful to integrate diversity aspects into your research topic?	
If no, is it possible to adapt the concept to meet the requirements?	
Which other frameworks can be used that might better fit your requirements?	

Striving for reduced theories and simple models is obvious in science, but may also limit researchers' thinking. This was the case for instance in genetics, where the study of sex determination focused on "testis determination" for a long time, with the ovary-producing female pathway being considered as passive, "default" pathway. Now, geneticists are increasingly aware that both female and male development are parallel, active, gene-mediated processes. (see European Commission 2013, p.113, and the Case Study: Genetics of Sex Determination - http://genderedinnovations.stanford.edu/case-studies/genetics.html)

To study the **cause of sex differences** in the brain, but also in other research fields, decision tree strategies and methodology are provided by McCarthy et al. (2012) or Becker et al (2005). Becker et al (2005) also discuss different animal models to investigate the role of sex chromosomes.

The change of theories, frameworks and concepts (by including diversity aspects) can lead to innovative insights, for example: *"Osteoporosis has traditionally been defined as a disease of white, postmenopausal women. Men, however, account for nearly a third of osteoporosis-related hip fractures in Europe and the US, and it is becoming clear that they have been underdiagnosed because of the limited scope of diagnostic definitions. Redefining osteoporosis to include men as well as at-risk minority groups has led to new research and clinical practices that address osteoporosis in broader populations. […] In contrast, heart disease has been defined as a disease of middle-aged men. Yet heart disease is also a major killer of women. Redefining heart disease to include women has required redefining heart disease symptoms and identifying new diagnostic tools; it may also require redefining populations used in clinical trials away from the traditional 70% men and 30% women."* (European Commission 2013, p.108f)

7. RESEARCH DESIGN: What research design will contribute new, innovative insights?

A well-elaborated methodology ensures that the diversity aspects you are interested in are adequately investigated and interpretable data are collected.

How can you operationalise the diversity aspects you are interested in? (see also: "Relevant Analytic Dimensions and Definitions")	
Do your research questions and hypotheses explicitly reflect the relevant diversity traits?	
Which variables will you use to investigate the diversity traits that you are interested in?	
Will you concentrate on a specific group (e.g., one sex, specific age range) or on comparative analyses?	

In your research questions and hypotheses, pay attention to include the sex(es) or other relevant diversity aspects of the population under investigation. Avoid terms that overgeneralize (e.g., patients, subjects, citizens, consumers) and rather use specific terms (e.g., female subjects). (Nieuwenhoven & Klinge 2010, p.318, European Commission 2011)

Niewenhoven & Klinge (2010, p. 319) provide further questions to operationalise and include sex and gender: *"**Sex** can be included in a study in many different ways, and the choice will have a great impact on the analysis.*

- *Is it merely a prognostic factor or also an effect modifier?*
- *Does it need to be controlled for, or will this obscure interesting findings?*
- *Does a certain research question or design call for sex-disaggregated models, or are dummy variables better suited?*

***Gender** is less easy to reduce to variables that can be included in a statistical analysis, but its explanatory power can be enormous."*

Does the methodology ensure an adequate database for your research questions?	
Are experiments, questionnaires, surveys, focus groups, etc. designed to consider potential diversity traits?	
Will data analyses consider identified diversity variables and their possible intersections?	

For instance, **sex hormone levels** might influence brain activation during task performance in psychological tasks. When comparing women and men in this context, phases of the menstrual cycle and the associated hormone levels should be considered. Furthermore, education, practice, or skill level might be influencing factors as well that should be controlled for (Jäncke 2018).

Guidelines for performing and interpreting rigorous **sex and gender subgroup analyses** are discussed by Aulakh & Anand (2007) (in the context of randomized clinical trials). For all kinds of subgroup analyses, it is important that the statistical power is large enough.

Determining adequate **sample size** can be a challenge. Quantitative studies often require large numbers of participants (especially when effects are small and variation is high). In qualitative in-depth studies that require more time per participant, samples are much smaller. Choosing a within-subject design, rather than a between-subject design, might be helpful in some cases to combine the different needs of quantitative and qualitative approaches. ("[…] *Melding these two numerical needs **is** a challenge but one that reveals a deeper understanding of the reasons for variation from a mean. This is especially important to delve into if science is to tell us something real about biology in all its variation. What seemed most revealing is to use a within subject design and compare the different measures across a single person treating each measure as a different perspective on the same question, rendering quantitative methods as qualitative.*" Einstein 2012, p.11)

Nieuwenhoven & Klinge (2010, p.318/19) provide a set of questions regarding sex and gender sensitive methods that allow to gather sex-disaggregated data (this also applies to other diversity aspects):

- Is it substantiated why women or men are included or excluded?
- Is it necessary or possible to collect sex-disaggregated data?
- Is it necessary to validate an instrument that is being developed for both sexes?
- Is the existing instrument being used validated for both sexes? If not, should it still be used for both sexes?

Does your research take the perspective of the users into account?	
How will the different perspectives of the potential users be integrated?	
Do you intend to use participative methods to integrate different users and their perspectives?	
Does your research team reflect the diversity of your users or study subjects in a way that ensures that their perspectives are considered?	

Taking into account participants' perspectives and needs **by testing and reviewing** the study design with potential user groups can be of high value and identify blind spots. An iterative practice that includes constant, reciprocal interaction with participants and constant interrogation of your own methods can enhance qualitative studies, in particular (see e.g. Einstein 2012).
"For example, researchers who studied divisions of labour in service call centres found that most employees with direct contact to customers were women (Russell, 2008). These women typically used software based on managers' assessments of their needs and not on direct study of their work flow. Engineers who observed how these women worked were able to redesign software in ways that ultimately boosted productivity (Maass et al., 2007)." (European Commission 2013, p.113)

Triangulation of methods is useful to cover the full range of different effects/aspects, cover different perspectives, and can help to serve as an internal control when no control group is possible. E.g., studying the neurobiological effects of female genital mutilation (FGM), Gillian Einstein combined physiological measures with qualitative interviews. This allowed her to ask her questions from multiple perspectives (Einstein 2012, p.18):

- Find out how the participant feels about the question; what is it like for them?
- How does the environment in which the question is being asked and the person asking, affect the participant's account?
- How do standardized measurements and physiological responses relate to what the participant is saying—how does it appear?

How should the study sample be adapted to achieve the aimed results?	
What is known about the distribution of diversity traits in the main population?	
Should the study sample reflect the distribution of diversity traits in the main population?	

In biomedical research, inclusion of **female mammals** might be required. This is more obvious in human clinical trials. In a 2011 review, it was discovered that male **bias** in human studies has declined (but still exists), whereas it has increased in non-human studies in the last 50 years. In animal studies, male biases have been discovered in particular in neuroscience, pharmacology and physiology, but also behaviour and behavioural physiology; and female biases in reproduction and immunology. Studies involving humans show fewer fields with male biases (interdisciplinary biology, neuroscience, physiology, pharmacology, and behaviour) and others with female biases (reproduction, endocrinology, and behavioural physiology) (Beery & Zucker 2011, p.3)

- If possible, include both sexes (or other relevant diversity aspects, e.g. age) in your sample. If only one sex (or one specific group regarding other diversity aspects) is studied, indicate this in article titles and explain the reasons for the exclusion (Beery & Zucker 2011)

- Female mammals are often considered too intrinsically variable (due to **hormonal cycles**), which allegedly decreases the homogeneity of study populations and makes it too costly and complex to routinely include them in research projects. However, it is exactly because of this heterogeneity why detailed study is necessary. Furthermore, meta-analyses suggest that *"the long-held assumption that the estrous cycle of female mice renders them more variable than male mice require reappraisal."* (Beery & Zucker 2011, p.5). Beery & Zucker (2011, p.7) further conclude: *"Females can be studied irrespective of estrous or menstrual cycle state without substantial increase in outcome variance for some traits (e.g., Mogil and Chanda, 2005; Meziane et al.,2007). Alternatively, when traits are known to vary as a function of the estrous or menstrual cycle, or one suspects sex differences, comparison of males with two or more groups of females at known estrous cycle stages is a viable and recommended option (Becker et al., 2005)."* Thus, hormone variations can and should be incorporated in study design. In the Gendered Innovations Report (European Commission 2013), it is summarized as follows (p.122):
  - Sample naturally ovulating women at different phases of the menstrual cycle (or female animals at different phases of the estrus cycle.
  - Take into account the widespread use (and effects) of exogenous hormones, such as oral contraceptives, menopausal hormones, and androgens.
  - Sample women at various points of a pregnancy and post-partum.
  - Collect data on early and late peri- and post-menopausal status in studies of middle-aged women.
- Always specify and disclose on publications the sex of experimental animals, tissues or cell lines (*"[…] every mammalian cell has a sexual signature and basic cell chemistry and organ structure may differ between females and males."* Beery & Zucker 2011, p.5). Also, for experimental animals, record their age and weight, and determine females' reproductive status and ovarian cycle phase as accurately as possible (Genderbasic, Holdcroft 2007).
- In animal studies, think about the possible use of different **species** (vs. a focus on rats and mice) (Beery & Zucker 2011).
- Consider **intersecting variables** that might influence research results and their interpretation in selecting study samples and match your female and male groups accordingly. E.g., observed statistically significant differences between men and women's knee anatomy led to the development of a gendered knee prosthesis. However, body height (which intersects with sex, i.e. on average, women are smaller than men) is a more important factor for the selection and fitting of prostheses than sex. (European Commission 2013, p.111f)

8. RESULTS: Are different interpretations of results conceivable?

A critical examination is crucial in order to avoid biases and misleading explanations and helps to determine the path for further use of the results.

How do you interpret your research results?	
What insights can you gain from your data? Which hypotheses could not be confirmed?	
What significant diversity differences and effects emerge?	
What differences and effects between distinctive groups are not significant?	
What do the diverse investigated groups have in common?	
Which other diversity traits that have not been investigated might contribute to the interpretation of your results?	

Analyse and report results disaggregated by sex or other diversity traits studied (Beery & Zucker 2011, Genderbasic, Einstein 2012, Niewenhoven & Klinge 2010, European Commission 2011):

- In many cases, taking sex as a central variable, and analysing other variables with respect to it (e.g. sex and age, sex and income, sex and mobility, sex and labour) will be a fruitful approach.
- Report detected **differences** as well as **non-differences**. Visualize differences in tables, figures and conclusions.
- If possible, present individual data points as well as statistical differences of the mean – this considers individuals with their particular variations.
- Transparently communicate the influence of the diversity traits studied on participation, continuation and drop-out rates.
- For animal studies, specify the numbers of males and females studied, sex and reproductive state, as well as age and weight in the report.

Use **gender sensitive language and visual representations** in your research reports and publications (European Commission 2013, p.128ff). While including diversity-specific data should become a standard procedure in publications, you might also want to consider specific dissemination actions (i.e., publications or events, disseminating to institutions that focus on diversity) (European Commission 2011).

What different conclusions are conceivable?	
In which way might the results and their further applications have different implications for specific groups (e.g., women and men, age groups …)?	
What conclusions regarding diversity & gender aspects can be drawn for further research?	
Is it necessary that future research on this topic further investigates the role of the studied diversity aspects?	

Be careful to **restrict generalizations** from single-sex studies to the sex investigated (Beery & Zucker 2011, European Commission 2013).

Consider the particular **context** of your study and acknowledge contextual influences and intersections (e.g., culture, geography, time, individual biologies, experiences, sex, gender, role and position of and interaction with the researchers etc.).

- For instance, Gillian Einstein studied Somali-Canadian women with female genital mutilation (FGM in Canada). The study might have gone quite differently if conducted in Somalia, where a different perspective on FGM prevails (Einstein 2012).
- *„For example, the famous memory patient, Henry M., performed much better on language tasks when studied in nursing home—his own environment—than he did when taken out of his context and studied in a psychology lab (Skotko et. al. 2005).”* (Einstein 2012, p.15)

When studying people, keep in mind how a certain participant might respond to the environment and consider this in the interpretation of findings and results (e.g. clothing in interview situation, presence of other people (interpreters etc.), setting in interview / examination rooms etc.). For instance, research subjects might react differently to a man or woman researcher, which can influence the responses in a telephone interview. (European Commission 2013, p.114)

If sex/gender **differences in cognition, emotion and behaviour** are found, **environmental influences** should be considered: *“Besides the fact of strong overlaps between male and female distribution, it has to be considered that brain anatomy is substantially affected by environmental influences. Most importantly, however, is that the relationship between brain anatomical measures as mentioned above and cognition, behaviour, and emotion is currently not clear. We must therefore be very careful if we explain gender differences in cognition, emotion, and behaviour based on brain anatomical findings.”* (Jäncke 2018, p.6). As the brain is an adaptable organ that can change anatomically and functionally through practice and learning, genetic, hormonal and social influences, as well as experience interact in forming brain and behaviour (Jäncke 2018).

Provide conclusions on how the new information on sex / diversity differences and similarities can be **translated into practice.**

9. TEAM: How will the research team be composed?

To achieve excellent results, you will need team members with a variety of different competences, bodies of knowledge and work preferences who cooperate effectively. Supportive working conditions and processes encourage excellent performance on the individual and collective levels.

To put together an excellent team that reflects the diversity you need, you might want to reflect on the recruiting process (including the performance and selection criteria). The **HBP "Guideline for Selection of the Best Candidate: Recruiting and Diversity"** provides detailed information and assistance regarding this issue.

Have you identified the expertise required to cover the diversity aspects of your research?	
Will your team members or partners provide the needed expertise?	
Who might be a specialist in diversity from e.g. gerontology, critical race theory, gender medicine, anthropology? **(e.g., persons known through publications, recommendations by team members and partners)**	
In which way will the specialist(s) transfer knowledge and expertise to the project?	

Depending on the role and importance of diversity aspects in your research, you could…

…engage scientists with the required expertise among your key research staff or

…engage external experts to provide trainings and consulting to help your team develop the required expertise. (Such trainings on the gender dimension can be included as eligible costs in Horizon2020 proposals, see European Commission 2018).

In any case, becoming familiar with field-specific methods of sex/gender and diversity analysis will help everyone on your research team to rethink research priorities and develop high quality, innovative research.

Does your research team reflect the diversity of your field and skill needed?	
Does the gender balance / diversity in your team correspond with the present gender ratio / diversity in your research field?	
What qualities and characteristics are needed to be successful in the discipline / in the job? To whom / to which groups are these qualities attributed usually?	
What performance and selection criteria do you use for recruiting?	

The ideal of an **"objective researcher"** has been challenged *("…the conventional assumption that the researcher is a disembodied, rational, sexually indifferent subject—a mind unlocated in space, time or constitutive interrelationships with others, is a status normally attributed only to angels."* Elizabeth Grosz 1986, cited in Einstein 2012, p.3). Reflect on how the personal particularities and identities of you as a researcher / research team interact to affect your research.

- For instance, research subjects might react differently to a man or woman researcher, which can influence the responses in a telephone interview (European Commission 2013, p.114).
- In design, for instance, **"I-Methodology"** refers to the (unconscious) tendency of designers to *"create products for users whose interests, abilities, and needs resemble their own."* (European Commission 2013, p.116). As many engineers and designers are men, this may result in a "male default", even when they attempt to design for everybody. (e.g., most video games are designed for boys and men, early speech synthesis produced only male voices).
- A gender balanced and diverse research team may be beneficial in broadening your perspective and avoiding these difficulties and biases. However, keep in mind that not all persons of a specific group are the same. For example, *"one women on a team does not represent all women"* (European Commission 2013, p.117).

What processes and structures promote individual motivation and sustainable results?	
Are processes designed to enable learning, and sharing and integration of different expertise?	
How do decision making processes take into consideration different roles and expertise?	
Are resources provided for individual career development, regardless of gender, age, culture, etc.?	

10. Literature used and further material

10.1 Scientific Papers & Publications

Title	Short Description
Ainsworth, Claire (2015): Sex redefined; Nature Vol. 518 / 7539, News Feature http://www.nature.com/news/sex-redefined-1.16943	Article discussing that there is a wide spectrum of sexes, and that the idea of two sexes is simplistic.
Aulakh, Amandev K.; Anand, Sonia S. (2007). Sex and gender subgroup analyses of randomized trials. Women's health issues: official publication of the Jacobs Institute of Women's Health. 2007;17:342–50. DOI: 10.1016/j.whi.2007.04.002	Discussion of guidelines for performing and interpreting rigorous sex and gender subgroup analyses (in the context of randomized clinical trials).
Becker, Jill B. et al. (2005). Strategies and Methods for Research on Sex Differences in Brain and Behavior. Endocrinology. 2005;146:1650–73. doi: 10.1210/en.2004-1142	Article describing methods and procedures to assist scientists in designing and conducting experiments to investigate sex differences in research involving both laboratory animals and humans. The article addresses issues such as how to determine if a sex difference exists and if an effect is related to sex hormones; how to determine the mechanisms for the different effects (eg, estrous cycle, gonadectomy, hormone replacement); what factors to consider in pharmacologic effects; how to measure hormones; and how to assess the effects of stress.
Beery, Annaliese K. & Zucker, Irving (2011). Sex Bias in Neuroscience and Biomedical Research. In: Neurosci Biobehav Rev. 2011 January ; 35(3): 565–572. doi:10.1016/j.neubiorev.2010.07.002. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3008499/pdf/nihms230882.pdf	Review article on sex bias in biomedical research on mammals, including recommendations on more unbiased research strategies.
Choleris, Elena; Galea, Liisa A.M.; Sohrabji, Farida; Frick, Karyn M. (2018). Sex differences in the brain: Implications for behavioral and biomedical Research. In: Neuroscience and Biobehavioral Reviews 85 (2018) 126–145 http://dx.doi.org/10.1016/j.neubiorev.2017.07.005	Review article focusing on the study of sex differences in the neurobiology of social behaviour, memory, emotions, and recovery from brain injury.
Einstein, Gillian (2012). Situated Neuroscience: Exploring a Biology of Diversity. in R. Bluhm, H. Maibom, & A. J. Jacobson (eds): Neurofeminism: Issues at the Intersection of Feminist Theory and Cognitive Science (London, England: Palgrave McMillan), pp.145-174.	Detailed description of a study exploring the neurobiological effects of female genital circumcision/mutilation/cutting (FGC). Discussing the role of context, reflexivity, situated biological exploration, ethics. Opening op areas of neuroscience areas and new neuroscientific questions (adult female nervous system).
Einstein, Gillian (ed.) (2007). Sex and the Brain. MIT Press: Cambridge/Massachusetts; London/Englang. ISBN: 9780262050876	A collection of foundational texts on the nature and behavioural consequences of sex differences in the brain, allowing readers to follow the development of a rapidly growing but contentious field and giving them the tools to analyse emerging scientific findings from many perspectives. (https://mitpress.mit.edu/books/sex-and-brain)

Hewlett, Sylvia Ann; Marshall, Melinda; Sherbin, Laura (2013). How Diversity Can Drive Innovation, Harvard Business Review, December 2013; https://hbr.org/2013/12/how-diversity-can-drive-innovation	Article discussing the benefits of a diverse workforce.
Holdcroft, Anita (2007). Integrating the Dimensions of Sex and Gender into Basic Life Sciences Research: Methodologic and Ethical Issues. In: Gender Medicine, Vol. 4, Suppl. B	Review article aiming to challenge assumptions and develop opportunities to mainstream sex and gender in basic scientific research, including many recommendations.
Jäncke, Lutz (2018). Sex/gender differences in cognition, neurophysiology, and neuroanatomy. In: F1000Research 2018 (F1000 Faculty Rev): 805 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6013760/pdf/f1000research-7-15130.pdf	Article reviewing the current status of sex/gender differences in terms of brain anatomy, brain function, behaviour and cognition, acknowledging the role of intersecting variables and external influences (such as environment, culture, practice).
Johnson, Joy L; Greaves, Lorraine; Repta, Robin (2009). Better science with sex and gender: Facilitating the use of a sex and gender-based analysis in health research in: International Journal for Equity in Health 2009, 8:14 doi:10.1186/1475-9276-8-14 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2689237/pdf/1475-9276-8-14.pdf	Article that includes detailed definitions of sex and gender the discussion of a sex and gender-based analysis (SGBA) at various stages of the research process (revisiting an original study by applying SGBA; augmenting an existing research plan with SGBA; incorporating SGBA from the outset) a case study on knee injuries
Klinge, Ineke & Bosch, Mineke (2005). Transforming Research Methodologies in EU Life Sciences and Biomedicine. European Journal of Women's Studies, SAGE Publications (UK and US), 2005, 12 (3), pp.377-395. DOI: 10.1177/135050680505427	Review on and assessment of the gender sensitivity of EU-funded research within the life sciences and biomedicine.
McCarthy, Margaret M.; Arnold, Arthur P.; Ball, Gregory F.; Blaustein, Jeffrey D.; de Vries, Geert J. (2012). Sex differences in the brain: the not so inconvenient truth. J Neurosci. 2012;32:2241–7. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3295598/pdf/nihms356860.pdf	Helpful article to understanding sex differences, distinguishing between three types of sex differences (sexual dimorphism, sex differences, sex convergence and divergence). Also provides valuable insights into how to study the cause of sex differences, including decision tree strategies & methodologies.
McGregor, Alyson J.; Hasnain, Memoona; Sandberg, Kathryn; Morrison, Mary F.; Berlin, Michelle; Trott, Justina (2015). How to study the impact of sex and gender in medical research: a review of resources. In: Biology of Sex Differences 2016, 7(Suppl 1):46 DOI 10.1186/s13293-016-0099-1 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5073798/pdf/13293_2016_Article_99.pdf	Recent review providing an annotated bibliography of currently available resource tools on how to consider sex and gender as independent variables in research design and methodology. Target groups: basic researchers, clinical investigators, epidemiologists, population, and social scientists.
Niewenhoven, Linda & Klinge, Ineke (2010). Scientific Excellence in Applying Sex- and Gender-Sensitive Methods in Biomedical and Health Research. Journal of Women's Health, Vol19, No. 2, DOI: 10.1089=jwh.2008.1156	Hands-on approach to applying sex- and gender-sensitive approaches along the different phases in a research process, including questions and guidelines.

Page, Scott (2008). The Difference: How the Power of Diversity Creates Better Groups, Firms, Schools & Society, Princeton University Press	"In this landmark book, Scott Page redefines the way we understand ourselves in relation to one another. *The Difference* is about how we think in groups--and how our collective wisdom exceeds the sum of its parts."
Schiebinger, Londa (2014). Gendered innovations: harnessing the creative power of sex and gender analysis to discover new ideas and develop new technologies; Triple Helix 2014, 1:9 http://link.springer.com/article/10.1186/s40604-014-0009-7	"Gendered Innovations" integrate sex and gender analysis into all phases of basic and applied research to stimulate new knowledge and technologies. In so doing, Gendered Innovations enhance creativity, innovation, and gender equality. This paper reports on the interdisciplinary, international collaboration that produced: 1) 12 state-of-the-art methods of sex and gender analysis for science, health and medicine, engineering, and environmental research; and 2) and 25 case studies to illustrate how gender analysis leads to discovery. The project moves gender studies beyond identifying gender bias to prioritizing sex and gender analysis as resources to fuel new discoveries.
Ritchie, Stuart J., et al. (2018). Sex Differences in the Adult Human Brain: Evidence from 5216 UK Biobank Participants. Cerebral Cortex, August 2018;28: 2959-2975 doi: 10.1093/cercor/bhy109	Report on a large single-sample study of structural and functional sex differences in the human brain.

10.2 Reports, Links & Examples

Title	Short Description
3rd A - Z guide why gender matters in research and innovation https://portiaweb.org.uk/assets/docs/A-Z_Guide_why_gender_matters.pdf	Comprehensive collection of examples & literature references
EGERA – Effective Gender Equality in Research and the Academia https://www.egera.eu/	EU Project (completed in 2017, funded by EU FP7) with two main objectives: Gender equality in research and higher education Bringing a gender perspective in research contents and outputs The deliverables include, among others, a "Report on Mapping & Critical assessment of existing tools for including gender in research" (D.6.1.) and a "Database of good practices of Gender Sensitive Research" (D.6.4.) giving further examples.
European Commission (2011). Toolkit Gender in EU-funded research. https://publications.europa.eu/en/publication-detail/-/publication/c17a4eba-49ab-40f1-bb7b-bb6faaf8dec8/language-en	Practical guidance on how to integrate gender into research throughout the entire research project. Including examples for a range of areas: Health food, agriculture and biotechnology, nanosciences, materials and new production technologies, energy, environment, transport, socio-economic sciences and humanities, science in society, specific activities of international cooperation.
European Commission (2013). Gendered Innovations. How Gender Analysis Contributes to Research. Report of the Expert Group "Innovation through Gender" Report: http://ec.europa.eu/research/science-society/document_library/pdf_06/gendered_innovations.pdf	The gendered innovations report is a summary of the contents on the gendered innovations website (Schiebinger et al. 2011-2018).
European Commission (2018). Gender Equality in Horizon 2020. Participant Portal H2020 Online Manual. http://ec.europa.eu/research/participants/docs/h2020-funding-guide/cross-cutting-issues/gender_en.htm	Gender equality is to be integrated in all parts of Horizon2020, e.g. in HR: balanced research teams, in research content: "analysing and taking into account the possible differences between men and women, boys and girls, or males and females, in the research and innovation content of your project."
GARCIA – Gendering the Academy and Research: combating Career Instability and Asymmetries http://garciaproject.eu/?page_id=40	EU Project (completed in 2017, funded by EU FP7) focusing on gender culture in research organisations (organizational culture, gender action plans, career development). Also includes a "Toolkit for Integrating Gender-Sensitive Approach into Research and Teaching", which further references other relevant toolkits.

Genderbasic - Promoting the integration of the gender dimension in basic research in ERA/FP7 http://www.genderbasic.nl/recommendations/	EU FP6 Women and Science Specific Support Action, completed in 2008. Among others, the website provides a compact list of recommendations on research content research processes and methodologies how integration of sex and gender in research contents and processes / methods could be promoted, facilitated and ensured by different tools, guidelines and institutional arrangements Ten peer reviewed papers about the integration of gender in different health-related fields have been published in a special issue of Gender Medicine (Volume 4, Supplement B, 2007): GenderBasic: Promoting Integration of Sex and Gender Aspects in Biomedical and Health-Related Research
GENDER-NET – Promoting Gender Equality in Research Institutions and Integration of the Gender Dimension in Research Contents http://www.gender-net.eu/spip.php?article8&lang=en IGAR Tool: Recommendations for Integrating Gender Analysis into Research http://igar-tool.gender-net.eu/en	EU funded ERA-NET scheme (completed in 2016) promoting gender equality through structural change in research organisations as well as the integration of sex and gender analysis in research. The IGAR Tool was developed by GENDER-NET: Website providing tools and resources to integrating gender analysis in research, including guidelines and checklists, as well as useful references for Funding Agencies, Applicants and/or Peer Reviewers/Evaluators an overview on the regulatory framework of integrating sex and gender in research (EU, United Nations etc.). A follow-up project was launched in 2017 (GENDER-NET Plus)
GenPORT http://www.genderportal.eu	Community sourced Web portal (financed through EU-FP7) that facilitates access to a wide range of research, statistical data, policy reports and practical resources on gender and science, technology and innovation.
ISNA 2015: Intersex Society of North America; http://www.isna.org/	The Intersex Society of North America (ISNA) is devoted to systemic change to end shame, secrecy, and unwanted genital surgeries for people born with an anatomy that someone decided is not standard for male or female.
Schiebinger, L., Klinge, I., Paik, H. Y., Sánchez de Madariaga, I., Schraudner, M., and Stefanick, M. (Eds.) (2011-2018). Gendered Innovations in Science, Health & Medicine, Engineering, and Environment www.genderedinnovations.stanford.edu	Peer-reviewed Website featuring a good overview and detailed definition of important terms (sex – gender, femininities & masculinities, men – women, etc.). state-of-the-art practical methods of sex and gender analysis including critical guiding questions (for scientists and engineers) case studies as concrete illustrations of how sex and gender analysis leads to innovation.
Webinar Einstein, Gillian: Women and dementia: Understanding sex/gender differences in the brain https://vimeo.com/268998912	This webinar discusses understandings of sex and gender, sex differences in Alzheimer's disease, how the higher number of women with AD may be due to both, and a discussion of the role of estrogens in the health of brain regions associated with Alzheimer's disease. (Gillian Einstein)

Human Brain Project

Unifying our understanding of the human brain.

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