1. **Title of the module**  
Chemical Biology Module – GSKCHEM9

2. **School or partner institution which will be responsible for management of the module**  
GSK

3. **The level of the module (Level 4, Level 5, Level 6 or Level 7)**  
Level 7

4. **The number of credits and the ECTS value which the module represents**  
15 credits

5. **Which term(s) the module is to be taught in (or other teaching pattern)**  
Spring

6. **Prerequisite and co-requisite modules**  
None

7. **The programmes of study to which the module contributes**  
This is an optional module for the Postgraduate Certificate in Professional Development.

8. **The intended subject specific learning outcomes.**  
On successfully completing the module students will be able to:

   **Introduction to Chemical Biology**
   8.1 Know the central dogma of biology and the roles of DNA, RNA and proteins.
   8.2 Understand the mechanisms of transcription and translation and have awareness of examples of post-translational modifications.
   8.3 Basic understanding of principles and tools in functional genomics, e.g. CRISPR, point mutation (including unnatural), GWAS and PheWAS.

   **Fragment based lead discovery (FBLD)**
   8.4 Appreciate the value of fragment screening in drug discovery and how it compares with traditional high-throughput screening.
   8.5 Understand fragment screening approaches: SPR, NMR and crystallography.
   8.6 Understand emerging approaches for covalent fragment screening.
   8.7 Awareness of application for covalent fragments in cells and ‘inverse drug discovery’.

   **DNA encoded libraries, cyclic peptides and aptamers**
   8.8 Understand the way DNA encoded chemical libraries, cyclic peptide libraries and aptamers are synthesised. Appreciate the range of chemical reactions that can be used and the criteria for application in library synthesis.
   8.9 Understand the screening workflow for these technologies, including phage display, and the controls that are required.
   8.10 Appreciation of opportunities and challenge of these approaches approach for identification of tool molecules.

   **Chemogenomics**
   8.11 Knowledge of design principles and tools for selection and curation of chemogenomic libraries.
   8.12 Knowledge of examples of phenotypic screens, using tissue culture and primary human tissue.
   8.13 Understand how the transcriptomic and proteomic fingerprints can be generated for a library of molecules, and the application of such data sets in the generation of therapeutic hypotheses.
   8.14 Understand how genetic mutation can be used to identify small molecule targets, and how this complements proteomic approaches.
Chemoproteomics
8.15 Understand how protein identification and quantification is achieved using proteomic MSMS.
8.16 Understand bioorthogonal reaction and enrichment techniques.
8.17 Understand how affinity purification, photoaffinity labelling and other chemoproteomic enrichment approaches work, and how they can be applied to find inhibitor targets and off-targets.
8.18 Understand how target class beads and CETSA platforms work and how they are used to profile inhibitor selectivity.

Bifunctional molecules as chemical tools and therapeutics
8.19 Understand how PROTACs work and appreciation of how proteomics can be used to study the effect of a PROTAC on the cell.
8.20 Knowledge of commonly used ligase binders and the ubiquitin system.
8.21 Understand how ARMs work to deplete selected cells.
8.22 Knowledge of the motifs used for antibody recruitment.
8.23 Appreciate the advantages and challenges in developing ARMs as therapeutics w.r.t small molecules and antibodies.

9. The intended generic learning outcomes.
On successfully completing the module students will be able to:

9.1 Demonstrate a thorough knowledge on the basics of Chemical Biology.
9.2 Understand the principles of Fragment Based Lead Discovery and the impact it has on the Drug Discovery process.
9.3 Understand the principles of DNA encoded library technologies, and how they contribute to the Drug Discovery process.
9.4 Understand how chemogenomic libraries can be used in conjunction with phenotypic screening to identify therapeutic pathways and targets.
9.5 Understand the principles of Chemoproteomics and how they contribute to the Drug Discovery process.
9.6 Understand how bifunctional molecules, specifically PROTACs and ARMs, can be used to manipulate biological systems and their potential application as therapeutics.

10. A synopsis of the curriculum
The module provides a continuing framework of learning for new staff entering the company, primarily recent Chemistry graduates. However, it is also suitable for those who have more industrial experience, but who wish to refresh and build on their knowledge and appreciation of chemical biology. This group may include staff who initially joined the company without a first degree, but who have achieved an equivalent qualification by part time study. Curriculum is defined by the learning outcomes.

11. Reading list (Indicative list, current at time of publication. Reading lists will be published annually)
- Lecture notes are normally made available in advance of each session. Further study of the subject is encouraged, and this will improve the participant’s skills in efficient and effective literature retrieval and extraction of information.
- For most lectures of the module, a relevant textbook is recommended and references to recent literature are provided by the speaker. Here are some examples:
- Chemical Genomics, Edited by Haian Fu, Emory University, Atlanta. 2012.
- Chemical Biology: From Small Molecules to Systems Biology and Drug Design, 1–3. Editor(s): Prof. Dr. Stuart L. Schreiber Prof. Dr. Tarun M. Kapoor Prof. Dr. Günther Wess.
- Fragment-Based Drug Discovery: Lessons and Outlook (Methods and Principles in Medicinal Chemistry) by Daniel A. Erlanson.

- The attendees also have the opportunity to attend in-house symposia, focussing on aspects of chemical biology within GSK research; external conferences including drug discovery, medicinal chemistry and chemical biology presentations from other pharmaceutical organisations.
- All participants are encouraged to discuss session topics with their supervisor, other participants/chemists or mentors.

12. Learning and teaching methods
This module will be taught by means of lectures delivered by internal GSK experts and external academics. Based on programme participant performance, this method of delivery has proved very successful.

Independent learning hours will include literature searching, private study and assessment work.

Learning hours: 150

13. Assessment methods

13.1 Main assessment methods
Successful completion of the module will require the participant to pass two separate assessments. Firstly, the participant, as part of a small group of fellow participants, will contribute to an oral presentation critiquing a recent publication in the field of each course topic to a GSK expert in chemical biology. Secondly, the participant will be required to write an essay of ca. 2500 words maximum (minimum 2000 words), including chemical structures, where appropriate; the essay will be based on the material taught in the module. The participant will have a choice of two topics on which to write. Cross-referencing to recently published literature and/or internal/external lectures will be required. This essay will be assessed by a selected senior/experienced member of staff who has an expertise in chemical biology, and therefore has a good appreciation of the level of knowledge and understanding we wish to assess.

Clear guidelines and training, where appropriate, will be provided to the assessors on how to assess the essay and oral presentations, and the expected level of knowledge and understanding that the participant is required to demonstrate in order to pass the module. The participant will have to pass both parts of the assessment to be awarded the corresponding credits.

The External Examiner will have access to:
- The participant’s essay
- The participant’s visual aids for the critiques of recent publications
- The examiners’ assessment summaries
- Any additional examples where the knowledge acquired has been applied in the workplace

13.2 Reassessment Methods. Like-for-like.

14. Map of module learning outcomes (sections 8 & 9) to learning and teaching methods (section12) and methods of assessment (section 13)
15. **Inclusive module design**

GSK recognises and has embedded the expectations of current equality legislation, by ensuring that the module is as accessible as possible by design. Additional alternative arrangements for students with Inclusive Learning Plans (ILPs)/declared disabilities will be made on an individual basis, in consultation with the relevant policies and support services.

The inclusive practices in the guidance (see Annex B Appendix A) have been considered in order to support all students in the following areas:

a) Accessible resources and curriculum

b) Learning, teaching and assessment methods

16. **Campus(es) or centre(s) where module will be delivered**

GSK Stevenage

17. **Internationalisation**

Chemical biology is an international subject with potential new medicines being discovered, developed and refined by multidisciplinary scientists across the globe. Mastery of the subject-specific learning outcomes will equip students to apply the theories and techniques of this module in a wide range of international contexts. GSK is large multi-national healthcare organisation which enables students to appreciate the international aspects and benefits of scientific research and development.

18. **Partner College/Validated Institution**

GSK Stevenage

19. **University School responsible for the programme**

Physical Sciences
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