



## Teaching Guide

| Teaching Guide           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |                                          |           |
|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------------------------------------------|-----------|
| Identifying Data         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        | 2018/19                                  |           |
| Subject (*)              | Environmental management and floor and air technology                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |        | Code                                     | 610475403 |
| Study programme          | Mestrado Universitario en Biotecnoloxía Avanzada                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |                                          |           |
| Descriptors              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |                                          |           |
| Cycle                    | Period                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Year   | Type                                     | Credits   |
| Official Master's Degree | 2nd four-month period                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | First  | Optional                                 | 3         |
| Language                 | SpanishGalicianEnglish                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |        |                                          |           |
| Teaching method          | Face-to-face                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |        |                                          |           |
| Prerequisites            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |        |                                          |           |
| Department               | Química                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |        |                                          |           |
| Coordinador              | Kennes , Christian                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | E-mail | c.kennes@udc.es                          |           |
| Lecturers                | Kennes , Christian<br>Veiga Barbazan, Maria del Carmen                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | E-mail | c.kennes@udc.es<br>m.carmen.veiga@udc.es |           |
| Web                      | masterbiotecnologiaavanzada.com/                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |        |                                          |           |
| General description      | Profesors of the UVIGO do also participate in the teaching of this subject:<br>Marta Maria Pazos Currás (email: mcurras@uvigo.es)<br>Maria Angeles Sanromán Braga (email: sanroman@uvigo.es)<br><br>The course consists of three parts: air pollution (8h, theory), soil contamination (5h, theory), and waste management (4h, theory). It teaches the students the fundamentals of air and soil pollution, with an emphasis on describing the major sources and types of pollutants as well as techniques for pollution abatement. It also addresses problems realted to the management and treatment of waste. |        |                                          |           |

## Study programme competences

| Code | Study programme competences                                                                                                                                                                                    |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A27  | Coñecer a problemática da contaminación ambiental e saber facer avaliacións do impacto ambiental.                                                                                                              |
| A28  | Coñecer e saber aplicar as técnicas de detección e tratamento da contaminación ambiental.                                                                                                                      |
| A29  | Coñecer e saber aplicar as técnicas de biorremediación e biorecuperación de ambientes contaminados.                                                                                                            |
| B1   | Capacidade de análise e síntese (localización de problemas e identificación das causas e a súa tipoloxía).                                                                                                     |
| B2   | Capacidade de organización e planificación de todos os recursos (humanos, materiais, información e infraestruturas).                                                                                           |
| B3   | Capacidade de xestión da información (con apoio de tecnoloxías da información e as comunicacións).                                                                                                             |
| B4   | Capacidade de planificación e elaboración de estudos técnicos en biotecnoloxía microbiana, vexetal e animal.                                                                                                   |
| B5   | Capacidade de identificar problemas, buscar solucións e aplicalas nun contexto biotecnolóxico profesional ou de investigación.                                                                                 |
| B6   | Capacidade de comunicación oral e escrita dos plans e decisións tomadas.                                                                                                                                       |
| B7   | Capacidade para formular xuízos sobre a problemática ética e social, actual e futura, que propón a Biotecnoloxía.                                                                                              |
| B8   | Capacidade de comunicación eficazmente coa comunidade científica, profesional e académica, así como con outros sectores e medios de comunicación.                                                              |
| B9   | Capacidade de Traballo en equipo multidepartamental dentro da empresa.                                                                                                                                         |
| B10  | Capacidade de Traballo nun contexto de sostibilidade, caracterizado por: sensibilidade polo medio ambiente e polos diferentes organismos que o integran así como concienciación polo desenvolvemento sostible. |
| B11  | Racionamento crítico e respecto profundo pola ética e a integridade intelectual.                                                                                                                               |
| B12  | Adaptación a novas situacións legais, ou novidades tecnolóxicas así como a excepcións asociadas a situacións de urxencia.                                                                                      |
| B13  | Aprendizaxe autónoma.                                                                                                                                                                                          |
| B14  | Liderazgo e capacidade de coordinación.                                                                                                                                                                        |
| B15  | Sensibilización cara á calidade, o respecto medioambiental e o consumo responsable de recursos e a recuperación de residuos.                                                                                   |

## Learning outcomes

| Learning outcomes | Study programme competences |
|-------------------|-----------------------------|
|-------------------|-----------------------------|



|                                                                                |      |                                                                                                             |  |
|--------------------------------------------------------------------------------|------|-------------------------------------------------------------------------------------------------------------|--|
| Knowledge of fundamentals of design and operation of a bioreactor              | AC27 | BC1<br>BC2<br>BC3<br>BC4<br>BC5<br>BC6<br>BC7<br>BC8<br>BC9<br>BC10<br>BC11<br>BC12<br>BC13<br>BC14<br>BC15 |  |
| Designing and managing biotechnology-based projects                            | AC28 | BC1<br>BC2<br>BC3<br>BC4<br>BC5<br>BC6<br>BC7<br>BC8<br>BC9<br>BC10<br>BC11<br>BC12<br>BC13<br>BC14<br>BC15 |  |
| Knowing and applying techniques of bioremediation of contaminated environments | AC29 | BC1<br>BC2<br>BC3<br>BC4<br>BC5<br>BC6<br>BC7<br>BC8<br>BC9<br>BC10<br>BC11<br>BC12<br>BC13<br>BC14<br>BC15 |  |

| Contents                                  |                                                                                                        |
|-------------------------------------------|--------------------------------------------------------------------------------------------------------|
| Topic                                     | Sub-topic                                                                                              |
| 1. Introduction to atmospheric pollution. | Introduction. Selection of the best treatment technologies based on the type and source of pollutants. |



|                                                                                       |                                                                                                                                     |
|---------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
| 2. Introduction to air pollution control and waste gas treatment.                     | Classification of the different technologies and their range of application.                                                        |
| 3. Technologies for particulate matter removal.                                       | Description of technologies for particulate matter removal. Design equations.                                                       |
| 4. Technologies for the removal of gases and vapors:<br>Physical/chemical treatments. | Description of physical/chemical and thermal processes for the treatment of polluted gases and vapors. Design equations.            |
| 5. Bioprocesses for the treatment of polluted gases y vapors.                         | Description of bioreactors for the treatment of polluted gases and vapors. Design equations.                                        |
| 6. Innovative technologies and technologies under development.                        | Description of innovative treatment technologies. Design equations.                                                                 |
| 7. Introduction to soil contamination. Containment techniques.                        | Introduction. Containment techniques: physical barriers, chemical barriers and sealing.                                             |
| 8. Confinement techniques.                                                            | Physical/chemical stabilization, solidification and vitrification.                                                                  |
| 9. Soil remediation technologies: biological treatments.                              | Bioremediation, phytoremediation, biopiles.                                                                                         |
| 10. Soil remediation technologies: Physical/chemical and thermal treatments.          | Washing, flushing, soil vapor extraction, soil venting, electroremediation.<br>Incineration, thermal desorption, pyrolysis.         |
| 11. Soil remediation technologies: combined treatments.                               | Combined treatments.                                                                                                                |
| 12. Introduction to waste management. Agricultural waste.                             | Valorization and management of agricultural waste for its use as fertilizer.<br>Minimization of the environmental impact of manure. |
| 13. Anaerobic waste treatment.                                                        | Anaerobic waste treatment.                                                                                                          |

| Planning                                                                                                                        |                                                                         |                      |                               |             |
|---------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|----------------------|-------------------------------|-------------|
| Methodologies / tests                                                                                                           | Competencies                                                            | Ordinary class hours | Student?s personal work hours | Total hours |
| Guest lecture / keynote speech                                                                                                  | A27 A28 A29 B1 B3<br>B4 B5 B7 B8 B10 B11<br>B12 B13 B15                 | 13                   | 26                            | 39          |
| Problem solving                                                                                                                 | A27 A28 A29 B1 B2<br>B3 B13                                             | 3                    | 6                             | 9           |
| Case study                                                                                                                      | A27 A28 A29 B1 B2<br>B3 B4 B5 B6 B9 B14                                 | 3                    | 6                             | 9           |
| Laboratory practice                                                                                                             | A27 A28 A29 B1 B2<br>B3 B4 B5 B6 B7 B8<br>B9 B10 B11 B12 B13<br>B14 B15 | 4                    | 6                             | 10          |
| Objective test                                                                                                                  | A27 A28 A29                                                             | 2                    | 4                             | 6           |
| Personalized attention                                                                                                          |                                                                         | 2                    | 0                             | 2           |
| (*)The information in the planning table is for guidance only and does not take into account the heterogeneity of the students. |                                                                         |                      |                               |             |

| Methodologies                  |                                                                                                                                                                          |
|--------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Methodologies                  | Description                                                                                                                                                              |
| Guest lecture / keynote speech | Teaching of basic concepts.                                                                                                                                              |
| Problem solving                | Problem solving by the students, using equations and concepts explained in class.                                                                                        |
| Case study                     | Explanation of specific cases of pollution and of abatement techniques applied to real cases.                                                                            |
| Laboratory practice            | Apply the theory learned in class to practical cases of air/soil pollution abatement.                                                                                    |
| Objective test                 | Assessment of the acquisition of the concepts taught in this subject. The test will be a written exam consisting of theoretical questions and/or problems to be solved . |

| Personalized attention |             |
|------------------------|-------------|
| Methodologies          | Description |



|                 |                                                                                                                                         |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| Problem solving | The students will be supervised and will get help to solve problems and exercises, using the concepts and equations explained in class. |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------|

| Assessment          |                                                                         |                                                                                                                                                                                                                                                                                |               |
|---------------------|-------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| Methodologies       | Competencies                                                            | Description                                                                                                                                                                                                                                                                    | Qualification |
| Problem solving     | A27 A28 A29 B1 B2<br>B3 B13                                             | Solving of problems and exercises in the class, individually or in groups. Involvement and behavior of the students are evaluated during the different activities that are planned (A8, A11, A28, A29, A30, B5)                                                                | 10            |
| Laboratory practice | A27 A28 A29 B1 B2<br>B3 B4 B5 B6 B7 B8<br>B9 B10 B11 B12 B13<br>B14 B15 | Realización de las prácticas y entrega de informe/resultados (A8, A11, A28, A29, A30, B5, B8, B15, C2, C6)                                                                                                                                                                     | 40            |
| Objective test      | A27 A28 A29                                                             | El examen podra constar de preguntas de teoría y de preguntas relacionadas con la resolución de problemas.<br>El examen podra tener relación con la materia vista en clase, los conceptos abordados en el laboratorio, o las visitas (A8, A11, A28, A29, A30, B5, B8, B15, C6) | 50            |

| Assessment comments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Similarly as for other subjects of the Master's degree, the learning process will be evaluated in a continuous way during the period assigned to the face-to-face teaching. The final examination represents 80% of the final score; the date of the same will be on the last day of the teaching period of the subject or on any other date agreed on. The practical work in the laboratory, and the laboratory report, represent 20% of the final score. Students attending the first examination sitting will have priority to be awarded the MH ("Matricula de Honor"). |

| Sources of information |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Basic</b>           | <ul style="list-style-type: none"> <li>- WARK, K &amp; WARNER, CF (1981). Air Pollution, its origin and control. Row &amp; Harper Publishers</li> <li>- KENNES, C &amp; VEIGA, MC (2001). Bioreactors for waste gas treatment. Kluwer Academic Publishers</li> <li>- US-EPA (1997). Bioremediation of hazardous waste sites: practical approaches to implementation.. EPA 625-K-96-001</li> <li>- US-EPA (1995). Biorremediation of Hazardous wastes. . EPA 540-R-95-532.</li> <li>- LEVIN, L &amp; GEALT, M (1997). Biotratamiento de residuos tóxicos y peligrosos. Selección, estimación, modificación de microorganismos y aplicación. McGraw-Hill</li> <li>- PICHTEL, J (2007). Fundamentals of site remediation : for metal and hydrocarbon-contaminated soils . 2nd ed. . Rockville, Maryland : Government Institutes</li> <li>- ANDERSON, WC (ed.) (1993). Innovative site remediation technology (Vol 1-8). American Academy of Environmental Engineers</li> <li>- KENNES, C &amp; VEIGA, MC (2013). Air Pollution Prevention and Control. J. Wiley &amp; Sons</li> </ul> |
| <b>Complementary</b>   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

| Recommendations                                                 |
|-----------------------------------------------------------------|
| <b>Subjects that it is recommended to have taken before</b>     |
| Environmental contamination/610475401                           |
| Environmental management and water technology/610475402         |
| <b>Subjects that are recommended to be taken simultaneously</b> |
| Legal and ethical aspects in Biotechnology/610475203            |
| <b>Subjects that continue the syllabus</b>                      |
| Master Thesis/610475006                                         |
| External Practicals/610475007                                   |
| <b>Other comments</b>                                           |



Dado que parte de la bibliografía recomendada para esta materia se encuentra en inglés, es aconsejable tener conocimientos de esta lengua, por lo menos, a nivel de comprensión de textos escritos.

(\*)The teaching guide is the document in which the URV publishes the information about all its courses. It is a public document and cannot be modified. Only in exceptional cases can it be revised by the competent agent or duly revised so that it is in line with current legislation.