



INTRODUCTION

The essential concepts of statistics needed for a degree in biology, environmental sciences, chemistry, and biochemistry, will be developed. Instead of focusing on mathematical concepts and proofs, attention will be primarily given to operative knowledge, i. e. how to implement well tested concepts in a framework that can be useful for life sciences and chemistry. This course also includes an introduction to the R computing language, which is specially well suited for statistics and data handling, with hands-on sessions.

- **Degrees:** Biology, Environmental Sciences, and Biochemistry (6 ECTS). Chemistry (3ECTS) Specific information for Chemistry students is marked in green in this guide.
- Required course (Basic). 2st year, 2nd semester.
- **Professor:** Angel Garcimartín Montero
- **This course will be delivered in English. You are supposed to have a B2 level of General English (e.g. Cambridge First Certificate).**
- Classroom: **Aula 17**, Edif. Biblioteca de Ciencias. Timetable: Lectures will usually take place on Tuesdays (9:00-10:00), Wednesdays (10:00 -11:00 and 11:00-12:00). *See your planning and calendar for details.*
- **You must install R and RStudio on your laptop, and bring it to the computer sessions. Instructions will be given**

COMPETENCIAS

These statements are excerpts from an official document for which no approved translation is available yet.

1. GRADO DE BIOLOGÍA

Competencias específicas:

CE1 Plantear y resolver problemas cualitativos y cuantitativos en biología a través de hipótesis científicas que puedan examinarse empíricamente y que se basen en los conocimientos y teorías disponibles.

CE4 Utilizar las matemáticas, la estadística y la informática para obtener, analizar e interpretar datos y para elaborar modelos de los sistemas y procesos biológicos.

CE10 Comprender las bases de Matemáticas, Física, Química, Estadística e Informática, relevantes para entender los procesos biológicos y los seres vivos, así como para poder aplicar con criterio las técnicas de observación, medida y experimentación propias de la Biología.

Competencias generales y básicas:

CB1 Que los estudiantes hayan demostrado poseer y comprender conocimientos en un área de estudio que parte de la base de la educación secundaria general, y se suele encontrar a un nivel, que si bien se apoya en libros de texto avanzados, incluye también algunos aspectos que implican conocimientos procedentes de la vanguardia de su campo de estudio.



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CG1 Planificar y organizar el tiempo y gestionar la propia formación continua, actualizando el conocimiento de las innovaciones del ámbito científico y saber analizar las tendencias de futuro.

CG2 Pensar de forma integrada y abordar los problemas desde diferentes perspectivas. Tener razonamiento crítico. Aportar soluciones a problemas en el ámbito científico.

2. GRADO DE BIOQUÍMICA

Competencias específicas:

CE1 Analizar problemas cualitativos y cuantitativos en Bioquímica a través de hipótesis científicas que puedan examinarse empíricamente .

CE3 Aplicar las Matemáticas, la Estadística y la Informática para obtener, analizar e interpretar datos y para elaborar modelos de los sistemas y procesos bioquímicos.

Competencias generales y básicas:

CB1 Que los estudiantes hayan demostrado poseer y comprender conocimientos en un área de estudio que parte de la base de la educación secundaria general, y se suele encontrar a un nivel, que si bien se apoya en libros de texto avanzados, incluye también algunos aspectos que implican conocimientos procedentes de la vanguardia de su campo de estudio.

CB3 Que los estudiantes tengan la capacidad de reunir e interpretar datos relevantes (normalmente dentro de su área de estudio) para emitir juicios que incluyan una reflexión sobre temas relevantes de índole social, científica o ética.

CG1 Planificar y organizar el tiempo y gestionar la propia formación continua, actualizando el conocimiento de las innovaciones del ámbito científico y saber analizar las tendencias de futuro.

CG2 Pensar de forma integrada y abordar los problemas desde diferentes perspectivas. Tener razonamiento crítico. Aportar soluciones a problemas en el ámbito científico.

3. GRADO DE CIENCIAS AMBIENTALES

Competencias específicas:

CE1 Conocer las bases científicas necesarias para afrontar la formación específica ambiental.

CE2 Aplicar la terminología y unidades de medida de los procesos físicos

CE3 Describir la estructura, propiedades físico-químicas y reactividad de los elementos y compuestos implicados en los procesos biogeoquímicos.

CE4 Utilizar en el laboratorio las técnicas e instrumentos propios de la experimentación científica.

Competencias generales y básicas:

CB1 Que los estudiantes hayan demostrado poseer y comprender conocimientos en un área de estudio que parte de la base de la educación secundaria general, y se suele encontrar a



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un nivel, que si bien se apoya en libros de texto avanzados, incluye también algunos aspectos que implican conocimientos procedentes de la vanguardia de su campo de estudio

CG2 Pensar de forma integrada y abordar los problemas desde diferentes perspectivas.

CG3 Tener razonamiento crítico.

4. GRADO DE QUÍMICA (3 ECTS)

Competencias específicas:

CE1 Analizar y resolver problemas cualitativos y cuantitativos según modelos previamente desarrollados, así como reconocer nuevos problemas y planificar estrategias para su resolución.

CE2 Procesar, computar, evaluar, interpretar y sintetizar datos e información Química.

Competencias generales y básicas:

CG1 Planificar y organizar el tiempo y gestionar la propia formación continua, actualizando el conocimiento de las innovaciones del ámbito científico y saber analizar las tendencias de futuro.

CG2 Pensar de forma integrada y abordar los problemas desde diferentes perspectivas. Tener razonamiento crítico. Aportar soluciones a problemas en el ámbito científico.

CG6 Usar correctamente el método de inducción. Ser capaz de generalizar el conocimiento obtenido en una ocasión a otros casos u ocasiones semejantes que puedan presentarse en el futuro.

CB1 Que los estudiantes hayan demostrado poseer y comprender conocimientos en un área de estudio que parte de la base de la educación secundaria general, y se suele encontrar a un nivel, que si bien se apoya en libros de texto avanzados, incluye también algunos aspectos que implican conocimientos procedentes de la vanguardia de su campo de estudio.

PROGRAMME

1. Descriptive statistics. Frequency. Central, location and dispersion measures. Graphical display of data.

2. Probability. Basic notions of probability. Discrete and continuous distributions. Some specific distributions: Bernoulli, binomial and Poisson (discrete), normal (continuous).

3. Sampling and estimation. Basic notions of sampling. Estimators for the average and variance of the sample. Central limit theorem. Confidence intervals.

4. Hypothesis testing (I). Parametric tests: p-values. Average and proportion tests for one sample *.

5. Regression. Least squares linear regression. Estimation of regression coefficients. Correlation.

END OF THE FIRST PART (BASIC STATISTICS, 3 ECTS FOR THE DEGREE IN CHEMISTRY)



6. **Hypothesis testing (II).** More on parametric tests.
7. **Analysis of variance.** One- and two-way ANOVA.
8. **Qualitative variables.** Contingency tables. Independence and homogeneity tests.
9. **Non-parametric methods.** Non parametric tests. Bootstrap and resampling. Notions of experimental design.*

** Remark: some topics may be abridged and included in the second part of the course.*

Note that using R to solve some problems is a requirement.

TIMETABLE

1. **Descriptive statistics.** Weeks 1, 2
2. **Probability.** Weeks 3, 4
3. **Sampling and estimation.** Week 5, 6.
4. **Hypothesis testing (I).** Week 7.
5. **Regression.** Week 8.

END OF THE FIRST PART (BASIC STATISTICS, 3 ECTS FOR THE DEGREE IN CHEMISTRY)

6. **Hypothesis testing (II).** Weeks 9, 10.
7. **Analysis of variance.** Week 11.
8. **Qualitative variables.** Weeks 12
9. **Non-parametric methods.** Weeks 13, 14.

This timetable is approximative. Chapters may be extended or shortened depending on the course dynamics

EDUCATIONAL ACTIVITIES

1. Lectures (42 hours at most)

Lectures will cover the syllabus and constitute the matter for the final exam. Some lecture hours can be devoted to problem solving. Attendance to lectures is not a requirement, but it is highly recommended. Students must keep up to date with notices given orally by the professor during the course.

2. Seminars (at least 6 hours)

Some seminars will be devoted to the R computer language: Dates will be given in due time.

Other seminars devoted to problem solving will be held during the course. As they will take place at the end of each chapter, they will be announced at the classroom. More hours can be devoted to seminars if the need is felt by the professor. In this case, the number of lecture hours will be correspondingly reduced. Problem solving is a gradable activity.



3. Computer sessions (12 hours)

Six sessions (of 2 hours each) are scheduled. Dates will be given in due time. **The last session is a gradable examination. For Chemistry Students: only the first three sessions; the last one will be a gradable exam.**

You must bring your own laptop computer to these sessions.

Attendance to the computing sessions is not a compulsory requirement, in the sense that it will result in a 0 mark in the corresponding percentage of the final mark but the course can be passed without attending them. They are nevertheless highly recommended. Note that the ability to perform basic statistical analysis using **R** is a requirement of this course. You can learn it on your own, although it will be probably harder than taking the computer sessions. Students that have to repeat the course and have already attended the computer sessions will not be required to repeat them. The mark from previous years, however, will not be kept.

Note that activities other than programming in R (such as checking your mobile phone, chatting with classmates, surfing the Internet or consulting your e-mail), are banned at the computer room.

4. Midterm tests and final examinations

A midterm exam will be proposed (2 1/2 hours). The midterm exam is not compulsory. The date will be fixed in due time. **This will be the final exam for Chemistry students.**

The final examination will be done during the exam period (3 hours). If anybody is unable to attend the final exam on the set date for duly justified reasons, then an oral examination will be offered on another day.

5. Student's personal study (45 hours)

In order to absorb the matter as explained in lectures, the student is supposed to devote, in average, one hour of personal study for each hour of classroom lecture (including problem solving). This is by far the most important action you can take to ensure your success.

6. Tutoring (ad lib.)

Students can get an appointment for tutoring in office hours.

For students in the Chemistry degree, these figures should be divided roughly by 2.

ASSESSMENT

Sample exams can be found in the Documents folder.

ORDINARY EXAMINATION

Grading system for Chemistry (3 ECTS)

(1) Mark of short tests suggested by the professor, and problem solving.- 10% of the final mark.

(2) Written report from the last computer session.- 20% of the final mark.



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(3) Final exam of the matter in the first module, with questions involving theory and problems.- 70% of the final mark.

The mark from item (1) will only be taken into account if it is beneficial for the final mark. Otherwise the corresponding percentage will revert to the final exam.

Grading system for Biochemistry, Biology, Environmental Sciences, etc. (6 ECTS)

(1) Mark of short tests suggested by the professor, problem solving in seminars.- 10% of the final mark.

(2) Written report from the last computer session, and other marks from computer sessions.- 20 % of the final mark.

(3) Midterm exam, concerning theory and problems of the first module.- 20 % of the final mark. A withdrawal will result in this percentage reverting to the final exam.

(4) Final exam of all the matter, including theory and problems.- 50 % of the final mark.

The mark from item (1) will only be taken into account if it is beneficial for the final mark. Otherwise the corresponding percentage will revert to the final exam.

SECOND EXAMINATION (June)

Grading system for Chemistry (3 ECTS)

- If they have been graded during the current year, marks from items (1), if beneficial, and (2) -see above- will be kept for the second examination. Otherwise, their corresponding percentage will revert to the final exam.

- There will be an exam of the matter in the first module of the course, with questions involving theory and problems. It will represent 70% of the final mark.

Grading system for Biochemistry, Biology, Environmental Sciences, etc. (6 ECTS)

- If they have been graded during the current year, marks from items (1), if beneficial, and (2) -see above- will be kept for the second examination. The mark of the midterm exam [item (3) above] will be kept if it is higher than 5/10. If items (1), (2), or (3), are not taken into account for the reasons explained, their corresponding percentage will revert to the final exam.

- There will be an exam of all the matter (theory and problems). The final exam will account for 50% of the final mark.

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If anybody is unable to attend the exam on the set date for duly justified reasons, then an oral examination will be offered on another day.

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There are no special requirements for students that have to repeat the course. Computer sessions will be optional (contact the professor during the first month of the course if you want to attend; otherwise you will be excluded from the computer sessions). If they do not attend computer labs, then the corresponding percentage of the mark will revert to the final



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exam. No marks will be kept from previous years. *It is heartily suggested that if you are in this situation you take the whole course again (lectures, problem seminars, and computer sessions); but the decision is left up to you.*

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Warning. Information in these web pages may be updated, and this syllabus may be modified as deemed necessary at any time by the professor. Changes will be announced at the classroom during the course: these oral notices are the ultimate information source. Students are responsible for keeping up to date with information about evaluation procedures, timetable changes, notices about activities and so on.

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Plagiarism or cheating will result in a failure. The legal text (in Spanish) concerning this issue is inserted here:

La falta de originalidad o plagio en los trabajos conllevará el suspenso de la asignatura, de acuerdo con la normativa de la Universidad

<http://www.unav.edu/documents/11306/6613867/Normativa+Disciplina+Academica.pdf>

NOTA: Ante la evidencia de un alumno que copia en un examen o comete cualquier tipo de plagio en los trabajos, se le suspenderá la asignatura hasta la siguiente convocatoria

OFFICE HOURS

Angel Garcimartín Montero (angel@unav.es)

Room 0-140, Physics Dept., Bldg. Los Castaños

Office hours will be changed by suggestion of the students' representative at the beginning of the course.

- **Tuesdays from 10:00 to 12:00 and Thursdays from 12:00 to 13:00.**
- ***If you want more office hours, please submit a proposal through the students' representative.***
- Please send me an e-mail if you want an appointment at any other time.

BIBLIOGRAPHY AND RESOURCES

BASIC BIBLIOGRAPHY

There is a free book where you can find most of the material covered in this course. It can be found in the internet:

J. VU & D. HARRINGTON, "Introductory Statistics for the Life and Biomedical Sciences" (1st edition). [Free e-book available online.](#) [Find it in the Library](#)

Remark, however, that additional concepts will be given during the lessons. Therefore you will want to **take your own lecture notes.**



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You can also use the lecture notes included in the folder *Documents*. Remark that they only contain supporting slides for some chapters (they do not constitute a guide for the contents of the course).

ADITIONAL BIBLIOGRAPHY

Other manuals cover the core concepts of the course; they include a lot of problems, both suggested and solved:

M. C. WHITLOCK & D. SCHLUTER, "The analysis of biological data". Macmillan (2015). [Find it in the library](#) .

J. SUSAN MILTON, "Statistical methods in the biological and health sciences" (3rd. edition), McGraw Hill (1999) [Find it in the Library](#). There is a PDF version available (*in Spanish*) [Find it in the library](#)

D. M. DIEZ, C. D. BARR & M. ÇETINKAYA-RUNDEL, "[OpenIntro Statistics](#)" (3rd Edition), a free book available online. [Find it in the library](#).

These books can be helpful for some aspects of the course:

P. DALGAARD, "Introductory Statistics with R". Springer (2008). [Find it in the Library](#) A PDF version is available.

L. GONICK & W. SMITH, "The cartoon guide to statistics". Harper Collins (2005) [Find it in the Library](#);

MURRAY R. SPIEGEL, "Statistics", Schaum's Outlines, Mc Graw-Hill (2014) [Find it in the Library](#)

Concerning the R computing language, many resources are available on the Internet. Some will be presented in the classroom, and some will be stored in the Documents folder in this Web site.