

Study material and exams for Institute

Evaluation objectives

Note: The study/examination material on "Psychology: Anxiety" will be valid for both High School and University environments..

Study material

Anxiety

Anxiety (from the Latin anxiety-anxiety- "anguish, grief") is a response of involuntary anticipation of the organism to stimuli that can be external or internal, such as thoughts, ideas, images, etc., that are perceived by the individual as threatening and dangerous, and is accompanied by an unpleasant feeling or somatic symptoms of tension. This is a warning sign that warns of imminent danger and allows the person to take the necessary steps to deal with a threat.

Adaptive or non-pathological anxiety is a normal feeling or emotional state in certain situations and is a habitual response to different stressful everyday situations. Therefore, some degree of anxiety is even desirable for the normal handling of environmental demands or demands. It is only when it exceeds a certain intensity, when the systems that trigger the normal anxiety response are unbalanced, or when the adaptive capacity between the individual and the environment is exceeded, that anxiety becomes pathological, causing significant discomfort, with physical, psychological and behavioral symptoms, most of the time very nonspecific.

A wide range of medical conditions can produce symptoms of anxiety. To clarify whether these are the direct physiological consequence of a medical disease, the necessary clinical history data, physical examination, laboratory tests and complementary studies are evaluated in terms of the patient's symptoms. Having high levels of neuroticism increases the risk of developing anxiety symptoms.

The difference between normal and pathological

Anxiety Normal anxiety is adaptive and allows the person to respond to the stimulus in an appropriate way. It is presented before real or potential stimuli (not imaginary or non-existent). The reaction is qualitatively and quantitatively proportional in time, duration and intensity.

Anxiety is considered pathological when the stimulus exceeds the organism's ability to adapt and a nonadaptive, intense and disproportionate response appears, interfering with daily functioning and diminishing performance. It is accompanied by an unpleasant and demotivating sensation, physical and psychological symptoms, and persists beyond the reasons that have triggered it. Pathological anxiety has the following

characteristics: it manifests itself intensely; it is prolonged and maintained over time more than it should be, it appears spontaneously without a triggering stimulus (endogenously), it arises in the face of stimuli that should not generate the anxiety response and there is an inadequate response with respect to the stimulus that provokes it.

The boundary between normal anxiety and pathological anxiety is not easy to define and may vary between individuals depending on personality traits or, above all, on what has been described as an “anxiety-prone cognitive style. The diagnostic criteria in the Diagnostic and Statistical Manual of Mental Disorders, Fourth and Fifth Edition (DSM-IV and DSM-5, respectively), indicate that anxiety should be considered pathological when “Anxiety, anxiety, worry or physical symptoms cause clinically significant discomfort or social, occupational or other major areas of activity impairment”. It is useful to distinguish between “state” anxiety, which is episodic and transient, and “trait” anxiety, which is persistent and may reflect a “prone to anxiety” personality.

If a person reacts with high levels of anxiety to a situation that others do not experience as much anxiety at some point in time, it can be considered simply a high intensity reaction, or an acute reaction at a level that is not too high, that is punctual and not extreme. This is usually not a disturbance.

The problem arises when this form of acute reaction is excessively intense, such as in panic attacks or anxiety attacks (where the person cannot control his or her anxiety and reaches extreme levels), or when such an acute reaction is established as a habit, i. e. if a high intensity anxiety reaction becomes chronic, or becomes very frequent.

An acute anxiety reaction is not always pathological, but can be very adaptive. For example, when the situation that causes it requires a strong alarm reaction that prepares for the Action (if a high concentration on a task for which many resources of attention are needed) is required; or if it requires high activation at a physiological level because more muscle tightening, more blood pumping, more oxygen, etc. is needed. Such an anxiety reaction helps to respond better to this situation.

Social Anxiety

Social anxiety or interpersonal anxiety is the anxiety (emotional discomfort, fear, anguish, fear, tension, apprehension, or worry) that a person feels in various social situations, where he or she interacts with others, and where it can potentially be evaluated, examined, or judged by others. The difference between social anxiety and normal anxiety is that the former involves a relatively intense sense of fear in social situations (greater than normal anxiety and less than social anxiety disorder) and especially in situations that are unfamiliar or in which the subject feels or thinks he or she may be evaluated by others.

Social anxiety occurs for different reasons. Social developmental anxiety occurs in childhood as a normal part of the development of social activity, and is a stage that is overcome over time, but chronic anxiety can persist (perhaps inadvertently) until adolescence or early adulthood and can lead to a picture of social phobia or the

development of a personality by avoidance. The frequency of social anxiety experimentation and what kind of situations occurs varies from subject to subject. Safety behaviors play an essential role in differentiating between social anxiety and social phobia and in maintaining the problem.

Social skills

Social skills (sometimes referred to as social competence) do not have a unique and specific definition, since there is a conceptual confusion in this respect, since there is no consensus on the part of the scientific-social community; however, this can be defined according to its main characteristics, and these indicate that social skills are a set of behaviors learned in a natural way (and that they can therefore be taught), which are manifested in interpersonal, socially accepted situations (what is known as “social competence”).

Not in vain, they are also behaviors associated with animals, manifested in relationships with other beings of the same species. In the case of people, they endow the individual who owns them with a greater capacity to achieve the objectives they seek, maintaining their self-esteem without harming that of the people around them. These behaviors are fundamentally based on mastery of communication skills, and require good emotional self-control on the part of the person acting. In many mental illnesses the area of social skills is one of the most affected, so work in psychosocial rehabilitation is very important.

Origin and development of social skills

Although the old dimension related to social behaviour has always been a concern, it was not until the mid 1970s that the field of social skills achieved, it is still being studied and researched. The origins of social skills go back to Salter, around 1949, who is considered one of the fathers of behavioral therapy, and who developed in his book *Conditioned Reflex Therapy* (six techniques for skills).

Several studies based on the beginnings of the so called Salter behavioral therapy were born. These sources mentioned above were developed in the United States, while in Europe, the English Argyle and Kendon (1967) related the term social skill to social psychology, defining it as “an organized, coordinated activity, in relation to an object or a situation, which involves a chain of sensory, central and motor mechanisms; one of its main characteristics is that the act, or sequence of acts, is continuously under the control of the entrance”.

Assertiveness

Assertiveness is a model of interpersonal relationship that consists of knowing one's own rights and defending them, respecting others; it has as a fundamental premise that all people have basic rights or assertive rights. As a strategy and style of communication, assertiveness is situated in the middle between two other polar behaviors: passivity, which consists of allowing third parties to decide for us, or overlook

our ideas; and on the other hand we have aggressiveness, which occurs when we are not able to be objective and respect the ideas of others.

The concept of assertiveness is usually defined as a communicational behavior in which the person does not attack or submit to the will of others, but expresses his or her convictions and defends his or her rights. It is also a form of conscious, congruent, direct and balanced expression, whose purpose is to communicate our ideas and feelings or defend our legitimate rights without the intention to hurt or harm, acting from an inner state of self-confidence, rather than the limiting emotionality typical of anxiety, guilt or anger. Having a criterion of our own within society is essential to communicate in a better way.

Test anxiety

When the exam dates arrive, some students begin a calvary, which is sometimes difficult to get out of. Feelings of insecurity, anguish, fear, blockages or thoughts such as "I won't be able to pass this or that subject..."; "I get to study and I stay blank..."; "When I'm on an exam I'm unable to answer, I stay blank..." or physiological sensations such as tremors, tachycardia, difficulty sleeping... appear. All of these symptoms converge into what experts have called test anxiety. Examination anxiety has been defined as emotional, physiological, and behavioral responses that occur around the potential consequences of negative assessments or a future test, test, or examination (Zeidner, 1998). Spielberg and Vagg (1995) have described test anxiety as an element of general anxiety and as a process of cognitive attention that interferes with performance in academic situations or tests. Like Sapp, et al. (1995)¹³ that consider it a case of general anxiety disorder related to being examined.

Different components (Hodapp, 1991,1995)¹⁴ of test anxiety have been identified:

- **Emotionality:** emotional and physiological response
- **Concern:** thoughts focused on the negative consequences of not succeeding in the test.
- **Interference - Cognitive** processes that interfere with or block performance during the test.
- **Lack of confidence:** Perception of self-efficacy

There are three different coping styles that relate to the different components of anxiety testing in different ways (Stöber, 2014):

- Task oriented: (+) emotional, (+) preoccupation and (-) interference.
- Seeking social support: (-) emotional.
- Avoidance: (-) concern, (+) interference and (+) lack of confidence

The following is a description of the main coping strategies for dealing with test anxiety:

- **Relax.** In the event of excessive physical activation (palpitations, tremors, shortness of breath, etc.) it is advisable to practice strategies to control activation or relaxation. Use activities that you know will relax you or learn to relax through breathing or muscle relaxation.
- A good **diet and a good sleep hygiene** are essential for your body to be rested and able to perform at its best. Do you prefer to have a rested surgeon or one who hasn't slept and eaten badly?
- **Get the timing right.** Set realistic objectives (that you can meet and that fit your schedules) in the short, medium and long term. You see yourself carrying out activities associated with the subject matter you will examine and meeting the established deadlines. Adjust, if necessary, these targets as progress is made. Managing time well helps a lot not to generate unnecessary anxiety. In all planning, you should always include time for review. Don't forget to make your own diagrams, summaries and underlining; these techniques will make your work easier and help you feel more confident when you study.
- **Prize yourself** for accomplishing the goals you have set yourself, this will make it easier for you to keep getting organized and motivated. It doesn't have to be a bike, but it can be a good movie in the movies, listen to our favorite music or have dinner in good company. If, on the contrary, we believe that we have not achieved our objective, the options are to reorganise our planning once again, but also to be realistic in assessing our performance. Sometimes we had planned to study ten pages and it has only given us time to study seven, or we were planning to study three topics and we have reached the second. In these cases, our objectives are not met 100% and must be evaluated as such. Nor is it reasonable to think that we have been a complete failure, because it is not true.
- A good one, **learn to listen to yourself.** Sometimes what we say to each other may have a discrepancy with reality. Certain automatic thoughts may be distorted and make us feel bad, block or interfere with the activity we do, such as an exam. Here are some examples of these cognitive distortions:
 - **Over generalization:** interpreting negative events as models of defeat. For example, failing a test means not passing any more exams.
 - **Magnification and/or minimization:** magnifying your mistakes and the successes of others and minimizing your successes and the mistakes of your colleagues. If you fail, it's a failure, but if you fail, you don't see it that way; however, when you pass you think it's a product of luck.

- **Selective abstraction:** putting all the attention on a detail, taking it out of context. I'm examining myself and I don't remember a question, that means I'm going to suspend.
- **Error of guessing the future:** things will always go wrong, without the possibility of being neutral or positive. A typical example of this distortion is to think that an examination has to be stopped even if you have studied.
- **Uses self-instructions.** Telling us functional and adaptive things before, during and after the test can help us manage anxiety. For example:
 - I'm going to stay focused on the present. What should I do? Answer exam questions. If I studied, in principle, I don't have to have any problems.
 - When the stress comes, I'll pause to relax.
 - I am not going to try to eliminate stress, but to keep it in the right proportions.
 - The test can be a difficult situation, but I can and do things to handle it.
 - I am not going to focus on my anxiety, but simply on what I should do...

Use the information included in the document and that provided by your psychologist to better manage the necessary anxiety you need to have before an exam!

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Exam V. Configuration: Easy

Statement	Answer
Social skills are a set of learned behaviors that we use to relate to each other	True
Social anxiety is the fear of being tested negatively.	True
Fear is an emotion that doesn't help under any circumstances.	False
Fear allows us to face adverse situations, avoid dangers, flee or avoid threats. Only sometimes, the levels of the fear are very high and hinder our psychological, social, academic and/or work performance	True
Fear of tests only appears when we haven't studied.	False
Anxiety is healthy when it allows us to defend ourselves.	True
Planning for long-term testing is the only and best way to eliminate test anxiety.	False
Physical anxiety may be resolved without thinking about the test.	False
Sometimes, our thinking can cause anxiety.	True
Anxiety may be the cause of being blocked during an evaluation.	True

Exam**V. Configuration: Difficult**

Statement	Answer
Social skills are set of learned behaviors that we use to interact with other people and that help us to obtain things and manage situations in our environment.	True
Social anxiety is fear of being evaluated negatively: we think that another person believes that what we have done, said, etc. is wrong or wrong.	True
Fear is an emotion that doesnt help under any circumstances.	False
Fear allows us to face adverse situations, avoid dangers, flee or avoid threat. Only sometimes, the levels of fear are very high and hinder our psychological, social, academic and/or work performance.	True
Fear of exams only appears if we haven't studied.	False
Anxiety is healthy when it allows us to perceive (hearing, seeing...), think and act more clearly	True
A good way to manage test anxiety is to set long-term goales.	False
Physical anxiety may be resolved unthought-out until the time of the test is done.	False
Sometimes, our thinking can cause us more anxiety than something that's really going on: I may be more eager to think about the test than to do the test	True
What happens when we get stuck on a test is that the anxiety is too high and doesn't let us do what we've learned.	True

History: “The recent Spain”

Study material

THE RECENT SPAIN

Objectives

- In this fortnight you will learn to.
- To know the meaning of the concept of transition.
- To value the importance of the 1978 Constitution.
- To situate in time the main events of the epoch.
- Relate changes in demography, society and culture.
- Identify the main features of the current Spanish economy.
- To know the role of Spain in international institutions.
- To highlight the importance of Spain’s integration in the process of European unity.

The Governments of Democracy

1. From Dictatorship to Democracy

- a. The Democratic Transition
- b. The 1978 Constitution
- c. The Governments of Democracy

2. The new Spanish company

- a. Demographics
- b. New social guidelines
- c. The culture

3. The economy of recent Spain

4. Spain opens up to the world

- a. Foreign policy
- b. Spain in Europe

Investigate

Ask someone close to you about a recent and important event in history of Spain (1975-2009) and how he experienced it personally.



Alfonso remembers with nostalgia the Transition

After Franco's death on November 20, 1975, Spain went through a transition period on which the foundations of democracy in our country were laid.

First name: Alfonso Muñoz Garrido

Origin: Almogía (Málaga)

Language: Español

Contained

1. From Dictation to Democracy

The Democratic Transition The "Transition" begins after Franco's death and the proclamation as King of Juan Carlos I in 1975 and can be terminated in 1982, with the coming to power of the first government from the Second Republic.

Juan Carlos I appoint Adolfo Suárez, a man with a firm interest in the country's economy, as president of the government. Commitment to the return to democracy. And let's not forget

that the role of civil society, which, through its mobilization and vote, marked the way forward, the implementation of a democratic system but without a radical rupture with the democratic system The past.

The word "Transition" means the transition from the Franco dictatorship to the current system democratic



Documento

"Freedom without Wrath", a hymn of the epoch

This song of the Andalusian band Jarcha was initially intended to promote The first street exit to Diario16 in 1976, but it was banned by the authorities. Soon, without However, it became a kind of anthem of this historical period of the Beginnings of the Transition.

Dicen los viejos que en este país Hubo una guerra Que hay dos Españas que guardan aún El rencor de viejas deudas

Pero yo sólo he visto gente Que sufre y calla, dolor y miedo Gente que sólo desea Su pan, su hembra y la fiesta en paz

Libertad, libertad Sin ira libertad Guárdate tu miedo y tu ira

Porque hay libertad Sin ira libertad Y si no la hay sin duda la habrá

Libertad, libertad Sin ira libertad Guárdate tu miedo y tu ira

Porque hay libertad Sin ira libertad Y si no la hay sin duda la habrá

Dicen los viejos que este país necesita Palo largo y mano dura Para evitar lo peor

Dicen los viejos que hacemos Lo que nos da la gana Y no es posible que así pueda haber Gobierno que gobierne nada

Dicen los viejos que no se nos dé rienda suelta Que todos aquí llevamos La violencia a flor de piel

Pero yo sólo he visto gente Muy obediente, hasta en la cama Gente que tan sólo pide Vivir su vida, sin más mentiras y en paz

Libertad, libertad Sin ira libertad Guárdate tu miedo y tu ira

Porque hay libertad Sin ira libertad Y si no la hay sin duda la habrá.

DEMOCRATIC TRANSITION

THE START OF CHANGE

The first government of the monarchy, led by Carlos Arias Navarro, is too continuist, but, since 1976, with the presidency of Adolfo Suárez - a young man from the Franco regime but eager for change - a series of important initiatives are taken: an amnesty is decreed for political prisoners and the return of the exiles is facilitated; political parties, including the Communist Party of Spain, are legalized.

THE 1977 ELECTIONS

On 15 June 1977, the first democratic elections to the Cortes were held since February 1936. They represent the victory of Adolfo Suarez's party, the Union of Democratic Center (UCD), while the Spanish Socialist Workers' Party (PSOE) became the main political leader in the country. Opposition party.

The fundamental task of these new courts will be the drafting of a Constitution, which later, it will be ratified by the Spanish people in the referendum of December 6, 2009. 1978.

DIFFICULT TIMES

The Transition, however, was not an easy period: there were fears of the memory of the Civil War, army posture, and weakness of political parties or inexperience politics of Spanish society. This political process must also be seen as a way of context of violence caused by terrorism (particularly ETA) and a situation of economic crisis and therefore of abundant labor conflicts. In spite of everything, the Transitions Spanish became a model to imitate in the process of peaceful change of a dictatorial government model to another democratic one.

1. From Dictatorship to Democracy

The Spanish Constitution of 1978

The Courts that emerged after the 1977 elections saw the need to create a new text Constitutional but shared by all, what is called a "consensus" policy. A presentation was thus created with seven representatives of different political parties ("the The Constitution ") which submitted a preliminary bill to the Courts in January 1978. The text was approved on 31 October 1978 by the Congress of Deputies (325 votes in favour, 6 against and 14 abstentions) and later by the Senate.

On 6 December 1978, the Spanish people approved the text in a referendum constitutional (87% of votes in favour). Finally, the king sanctions the new legal framework (27 December 1978).

In a referendum, special political decisions are subject to popular vote transcendence.

THE 1978 CONSTITUTION

WHAT IS A CONSTITUTION?

The Constitution is the fundamental law of a State (that's why it is called also the "Magna Carta"), and it is important because:

- It includes the rights and duties of the citizens.
- It fixes and regulates the power system.
- It defines the organs of the State and its functions, as well as the organization territorial.
- It is the basis of the legislative system later.

STRUCTURE

The Constitution consists of a Preamble (the declaration of intent), a Preliminary Title and ten more Titles (total 169 articles), as well as several additional provisions, and final (as on possible reform).

In the Preliminary Title, Spain is defined as a "social and democratic state of right ", in which national sovereignty resides in the people. The form of State is the Parliamentary monarchy. Political pluralism and the importance of political pluralism are recognized, as is the importance of Trade unions and business associations.

TITLE I. RIGHTS AND FUNDAMENTAL DUTIES

The Spaniards are guaranteed universal human rights and all freedoms the death penalty, recognizes freedom of education, freedom of religion and belief, freedom of religion or belief, freedom of religion or belief, freedom of religion or belief. And the market economy. It also proclaims that there is no official state religion. Among the duties, to defend Spain (although it acknowledges conscientious objection), the economic support of the State and knowledge of the Castilian language (although recognizes the official status of other languages in their respective territories).

TITLES II TO VII. THE AUTHORITIES OF POWER

Parliamentary monarchy is established as a form of state, with the role of arbitrator but not government.

Parliament is the guarantor of national sovereignty, with a bicameral composition (Congress and Parliament), and assumes legislative power. The president of government, the executive branch, is elected by Parliament and must to answer to him.

Liberties and rights are guaranteed by the Ombudsman, a judiciary which is independent and ultimately the Constitutional Court.

TITLE VIII. THE TERRITORIAL ORGANIZATION OF THE STATE

As stated in article 2, "the Constitution is based on the indissoluble unity of the Spanish Nation, a common and indivisible homeland of all Spaniards, and recognizes and guarantees the right to autonomy of the nationalities and regions that make up it and solidarity among all of them". Each autonomy will have its own government, a parliament, a statute and the corresponding powers. The role of local authorities, such as municipalities, is also highlighted.

1. From Dictatorship to Democracy

The Governments of Democracy

The different parties that have managed to gain access to government in recent Spain have developed their policy around a number of common themes:

- Development of the administrative and political decentralization process through the development of the autonomous community.
- The consolidation of a social state (pensions, education and health) universal) and legal rights (political and individual freedoms).
- Struggle for the challenge of modernization of the country (infrastructures, research...) etc.).

- The adaptation of the Spanish economy to a market economy more open and globalised (especially difficult in times of crisis)
- The fight against terrorism, in particular against ETA (but also against GRAPO, Islamist groups or the far right).
- A process of opening up to the outside world, especially integration into Europe.

THE GOVERNMENTS OF DEMOCRACY AND TRANSITION

THE GOVERNMENT OF ADOLFO SUÁREZ (1976-1981)

Adolfo Suarez, who has been in power since 1976, sees his position consolidated with the triumph of UCD in the 1977 and 1979 elections. The strong international economic crisis led to a policy of consensus on economic and social issues (the Moncloa Covenants, 1977).

Self-government is restored in the so-called "historical nationalities" (such as Catalonia or the Basque Country) and the process is opened to the rest of preautonomies.

Terrorism strikes very hard in this period, with the highest numbers of ETA and GRAPO victims throughout the democratic period.

THE END OF THE UCD (1981-1982)

The internal dissensions in the UCD force the resignation of Suarez, which is replaced by Leopoldo Calvo Sotelo. At the height of the inauguration of the new president of government (23 February 1981) there was an attempted military coup d' état that failed, highlighting the king's intervention and the role of the media. During Calvo Sotelo's brief government, he joined the Western NATO political-military organization, with an initial opposition from the PSOE. The strong economic crisis continues.

FIRST STAGE OF SOCIALISM (1982-1996)

The 1982 elections granted absolute majority to the PSOE, and Felipe González became president of the government. In domestic politics, it stands out for completing the autonomic map, an important social policy and a liberal economic policy, which confronts the unions on several occasions (general strikes). From an external point of view, the referendum for remaining in NATO in 1986 (with victory of the yes) and, in particular, integration into the European Communities (accession signed in June 1985). The social cost of its economic policy, the fight against terrorism and some cases of corruption were decisive for the end of the government.

THE PP GOVERNMENTS (1996-2004)

José M^a Aznar consolidates a strong centre-right party (Popular Party) that leads him to victory in the 1996 elections and, especially, in 2000 (absolute majority). It highlights the

success of its economic policy, which allows it to join the single currency (euro) in 2002. The compulsory military service is gone.

From the external point of view, it is clearly allied with the government's policy Bush, especially after the 9/11 attacks in the United States. (2001).

The political cost of government support for the Iraq war and the impact of the U. S. military on Iraq's people 11 March 2004, the attacks provoke the defeat of the PP in the elections of March 11, 2004.

SECOND STAGE OF SOCIALISM (2004-)

José Luis Rodríguez Zapatero becomes president in 2004. Your first effort is devoted to foreign policy issues (removal from Iraq) and social policy (Law on the Protection of the Rights of the Child). Marriage), although the strong economic crisis that began in the late 1990s, led to a growing 2007 has since then strongly conditioned government policy.

2. The new Spanish company

Demographics

From 1978 onwards, there were changes in the natural movement of the Spanish population: the strong economic crisis, the massive incorporation of women into the public sphere and the new family models meant that Spain came to have one of the lowest fertility rates in the world. This, coupled with one of the highest life expectancies, results in a rapid ageing of the population, which is still not very pronounced today because it was based on an initial model that was still young.

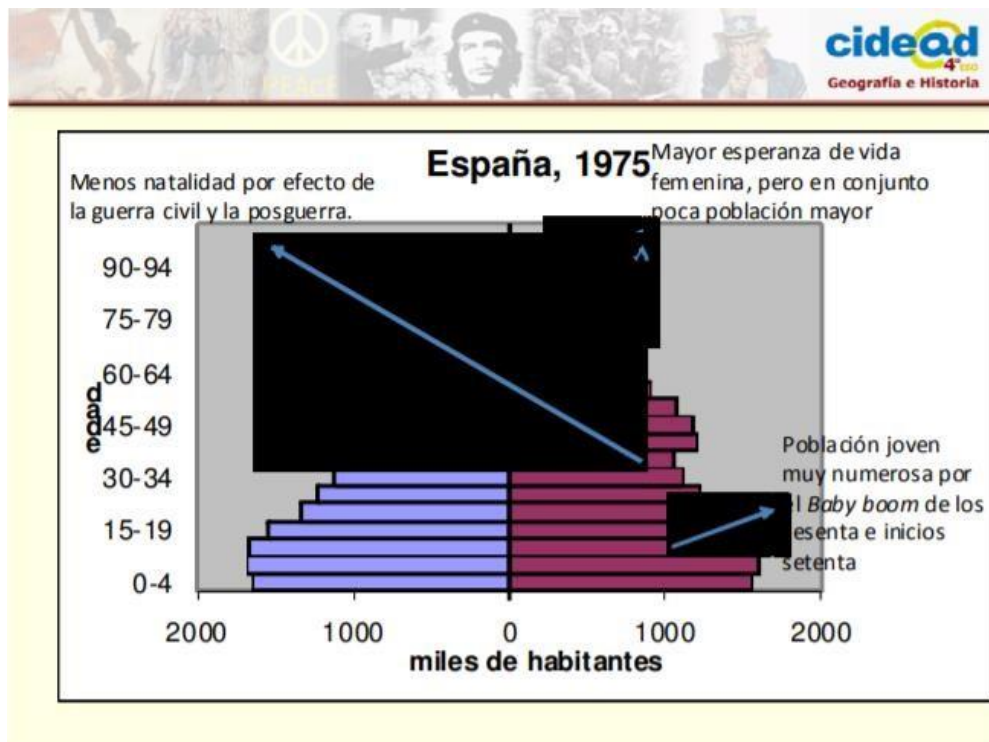
With regard to migratory movements, the number of inmates between Autonomous Communities is decreasing and in a few years it has gone from being a country that issues emigrants abroad to another where immigrants are already a statistically important part of the State's population.

THE SPANISH DEMOGRAPHIC STRUCTURE, A REFLECTION OF ITS CHANGES SOCIAL (1975-2009)

The Spanish population of 1975, a model of a young population

- At the beginning of the Transition the Spanish population was 35,824,000 inhabitants (1976), of which about 100,000 were immigrants. It was a young population, with the largest age group between 5 and 15 years old.
- Life expectancy was 70.4 years for men and 76.2 years for women.
- Fertility, 2.8 children per woman, and the average age of the mother on having her first child, 24.9 years.

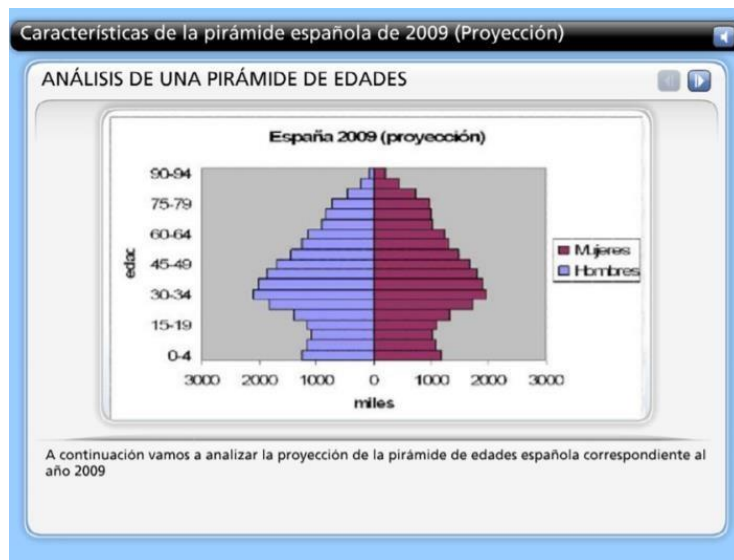
- The percentage of children born to unmarried women was only 2.16 %.
- The urban population at the beginning of the 1970s, 55%, the result of a strong previous rural exodus.
- The active population was fairly balanced between the secondary and tertiary sectors, but with a large population dedicated to the primary sector.



The Spanish population at the beginning of the 21st century, a new demographic model

- At the beginning of the 21st century the population is 46,157,822 inhabitants (2008), of which 11.41% are immigrants. It is an ageing population, with the largest age group between 30 and 44 years old.
- Life expectancy for women is 83 years and 77 for men (2005 data).
- Fertility has dropped to 1.45 children per woman, and the first child has an average age of 29.4 years.
- The percentage of children born to unmarried women is 30.6 per cent (2007).
- The urban population has risen to 67% (2005), concentrated in a few areas.
- The active population has left the primary sector and is concentrated in the services sector.

ANALYSIS OF AN AGE PYRAMID



Population ageing: the improvement of the economic and social situation in Spain facilitates an **increase in life expectancy**, one of the highest in the world. This fact, together with the low birth rate, means that a significant percentage of the Spanish population is located in the **highest areas of the pyramid**.

More women: Female life expectancy is higher than male life expectancy, so in the mature population **there is a significant gender imbalance** in favour of women.

The children of the "baby boom": the 1960s and early 1970s corresponded to so-called "developmentalism", a **favourable economic situation** that facilitated an increase in birth rates, although another cause was that the woman was still placed especially in the **domestic sphere**. At present the group that was born at **this time is the largest** of the pyramid

Low birth rate: From 1978 onwards, the strong **economic crisis** caused by the rise in oil prices **and the social and political changes** caused by the Transition (more women's freedom, free contraceptives, new family models) caused a significant **drop in the birth rate** to one of the lowest fertility rates in the world.

a new baby boom? In the beginning of the 21st century, there was a **slight upturn in the birth rate**, due to several factors, most notably the arrival of **young immigrants**.

with different demographic patterns - although they adapt quickly to the Spanish model - and, above all, given the late age at which Spanish women have their first child, the significant number of **women in their thirties**.

2. The new Spanish company

New social guidelines

The transformations that have affected Spanish society since the Transition have been spectacular:

- A model of post-industrial society has been created: domination of the services sector, importance of the middle classes, consumer society.
- The Welfare State (health, pensions, social policy) has been consolidated. In return, there are still pockets of poverty and almost structural unemployment. Transformation has also reached the family model (divorce, civil marriage, singleparent families).
- Spain has gone from being a country of emigration to one of immigration, becoming a multicultural country in a very short time.
- A secularized society, where the Church has lost importance.
- Changing the role of women: if formal equality is clear, the process towards real equality is taking place more slowly but firmly.

Document

THE VALUE OF EXPERIENCE

Oral history is a technique of historical science that uses oral sources as a fundamental basis for the reconstruction of the past. And in this fortnight, in which we try to learn more about our most recent history, it can be a very valid instrument to approach it in a different way.

In order to work on oral history we need three elements: firstly, to obtain sufficiently interesting testimonies; secondly, a methodology of our own, which in this case is the preliminary preparation of an interview; and finally, technical means, such as a tape recorder or a camera, to later make a faithful transcription of the content.

If we don't have it all, we can always call on the Archive of Experience (link at <http://www.archivodelaexperiencia.es>). This is a vast project, initiated in 2007, which seeks to recover the testimonies of Spaniards who have lived through different historical stages (from the Republic to Democracy) and which reflect their experiences on the most varied themes: cinema, social changes, the impact of tourism, sports celebrations, major political events, etc...

Although oral history is an attractive way of working with history - and also of relating to our elders - it also has its drawbacks, especially the great subjectivity of any kind of personal testimony, as well as the need to choose testimonies appropriate to the subjects dealt with. The type of interview and questions may also condition the respondent's response.

2. The new Spanish company

The culture

Two elements stand out when analyzing the culture of recent Spain. Firstly, the attempt to identify the signs of Spanish identity through the recovery of silenced voices (in exile or extinguished by the cultural monolithic Francoism) and to create a new model - always rooted in our common past - more in keeping with a modern and democratic Spain.

Secondly, the achievement of individual and collective freedoms led to a veritable cultural explosion, encompassing all spheres (music, film, painting, comics, etc.) and many territories of the State.

Madrid's "**Movida**" was a "pop" movement that emerged in the late seventies and 1980s. Related to the night, with a great interest in alternative culture.

THE CULTURE OF TRANSITION

THE RETURN OF THE GUERNICA



Picasso's painting "Guernica" is a symbol of our Civil War and an icon of 20th century art. First time hung in the Pavilion of the Spanish Republic in The 1937 International Exhibition in Paris as a tribute to the Basque city, victim of savage bombardments, was exhibited for decades at the Museum of Modern Art in New York, at the express request of the Malaga painter, who asked that the painting return to his country when democracy returned. Thus, after four years of intense negotiations, on 9 September 1981 the table returns to Spain. It was one of the most symbolic successes of the Spanish Transition and a great cultural event.

THE RECOVERED CULTURES

The return to democratic normality allows the return of many intellectuals who had lived in exile outside of Spain and who; therefore, their work had hardly had any repercussions in our country, or had even been forbidden.

On the other hand, the cultures in Catalan, Basque, Galician and other minority languages of the State, which had even been persecuted by Franco's regime, see a resurgence that is clearly observed in the world of education, literature or cinema and in everyday and official use in society in general.

THE "MOVIDA"

One of the most significant aspects of the beginnings of the Transition was the explosion that took place in all sorts of cultural fields: cinema, music, comics, painting, etc., which we reflect here with a Madrid expression, the "movida": a "pop" movement, fruit of the environment of freedom, so desired by many creators, which was established at the end of the seventies and beginning of the eighties and which spread throughout Spain.

THE ROLE OF ADMINISTRATIONS

To understand the increase in the "consumption" of cultural products produced in our country during this period (cinema, reading, attending shows or exhibitions), It is necessary to take into account the increase in the standard of living of the Spanish population and the significant role played by all types of administrations, both central (in 1977 the Ministry of Culture is created), and regional or local. In this way, important infrastructures (auditoriums, museums, libraries) appear and intense campaigns (reading, theatrical circuits or digital literacy, etc.) are carried out that decentralize and popularize culture.

3. The economy of recent Spain

The global economic crisis of the 1970s contributed to making the democratic transition process even more difficult. From the mid-1980s onwards, however, there was a strong economic development which, in the mid-1990s, led Spain to become the eighth country in the world in terms of Gross Domestic Product and was also among the first in terms of Human Development, since the economic prosperity achieved in recent years has made it possible to increase social spending, which has ultimately shaped the welfare state.

Next, we will analyze the different economic junctures of recent years and the strengths and weaknesses of the Spanish economy.

THE ECONOMY OF RECENT SPAIN

A DIFFICULT ECONOMIC TRANSITION



The global crisis caused by the sharp rise in oil prices seriously affected the fragile Spanish economy of the late 1970s: inflation, unemployment, state bankruptcy and trade deficit.

The policy of the centrist governments (Moncloa Covenants of 1977) and the first socialist governments was very similar: higher tax pressure, conversion of the most obsolete industrial sectors (such as mining, textiles or steel) and increased public spending. The crisis was only finally overcome by 1986, several years behind the overall recovery in the Western world.

THE IMPACT OF INTEGRATION ON EUROPE

Spain's entry into the European Communities in 1986 was undoubtedly a modernization factor for several reasons:

- Entry into the Single Market required many adaptations, both legislative and in specific economic sectors (such as agriculture). Facilitates international expansion of Spanish companies.
- The arrival of European aid funds was mainly used to improve infrastructure and to invest in the most disadvantaged regions of the country.
- Entry into the euro has made it necessary to implement a policy focused on economic stability.

A GLOBALIZED ECONOMY

From the mid-1990s onwards, Spain was able to face an increasingly globalized world economy.

- Part of the country's growth is already based on strong domestic consumption.
- Participation in the European Single Market, where our exports are concentrated, is essential.
- We have already talked about stability based on the control of inflation and a reduction in the public deficit.
- The opening of Spanish banks and companies abroad: Spain has become the leading European investor in Ibero-America.

WEAKNESSES OF THE SPANISH ECONOMIC MODEL

In times of economic crisis, such as the one that began in 2007, however, the weaknesses of the Spanish economic model are shown:

- Excessive dependence on the construction sector, which created a real "real estate bubble", especially in coastal areas.
- The chronic trade deficit, especially the heavy dependence on fossil fuels (gas, oil).
- Low productivity of Spanish companies and their low investment in research and development (R&D).

4. Spain opens up to the world

Foreign policy

The different governments of Democracy have maintained - despite their differences - the same broad lines of foreign policy, which can be defined as follows:

- Democracy's foreign policy, which began in the Cold War, places its membership in the western bloc (joining NATO in 1981). A policy that has been maintained more or less intensively (total support for US policy after 9/11, 2001; withdrawal from Iraq, 2004).
- The historical ties with Ibero-America and the reciprocal migratory movements mean that relations between both shores of the Atlantic are intense (Ibero-American Summits, Commemoration of the 5th Centenary in 1992).

- The historical ties with Ibero-America and the reciprocal migratory movements mean that relations between both shores of the Atlantic are intense (Ibero-American Summits, Commemoration of the 5th Centenary in 1992).

MISSIONS OF DEFENCE ABROAD

Since 1989, 100,000 Spanish military personnel have participated in more than 50 military and humanitarian aid operations on four continents. Whether under the banner of the United Nations, the European Union or NATO, the three armies have participated in all kinds of missions, some in highly conflict-ridden areas, and even at the expense of a significant tribute in human lives.

The most frequent have been peace missions. They send observers (unarmed officers to verify the maintenance of a ceasefire or to patrol borders) or armed troops (acting to ensure humanitarian aid and peace in an area).

In 2009, there are four ongoing missions:

ATALANTA. Somalia waters



Based on United Nations resolutions, its basic objective is to guarantee the safety of navigation in the area against the constant attack of Somali pirates. The European Security and Defence Policy decided in 2008 to send a multinational fleet to the Indian Ocean to contribute to deterrence, prevention and protection against pirate attacks.

Spain has sent several frigates and maritime patrol planes to this area, which is heavily frequented by the Spanish deep-sea fishing fleet.

EUFOR "Althea". Bosnia-Herzegovina

The European Union designed this operation in 2004, under the aegis of previous UN resolutions. Heir to previous missions following the Balkan wars that led to the disintegration of the former Yugoslavia in the 1990s, the current force is smaller (2,000 men and women, more than 10% of whom are Spanish), and above all has a police purpose.

It also collaborates with the International Criminal Tribunal in The Hague to prosecute and arrest those accused of war crimes in the aforementioned Balkan wars.

It is scheduled for completion - at least with respect to Spanish participation - throughout the year. Of 2010.

ISAF. Afganistán



The Spanish government authorized the participation of Spanish military units in the International Security Assistance Force (ISAF) in support of the Afghan interim government. The first Spanish units arrived in the country at the end of January 2002.

The activities of the Spanish contingent are directed in two ways: on the one hand, to facilitate reconstruction activities in the province of Badghis, and on the other hand, to provide support for the security of the rest of the international forces in western Afghanistan. They have also worked to guarantee the country's general elections.

FREE HYDALGO. Lebanon

The Palestinian-Israeli crisis of 2006 led the UN to increase its mediation forces along the Lebanese-Israeli border (USFIL). Spain committed itself from the outset to the mission and, after the mandatory parliamentary authorisation, which received close support for unanimity and no vote against, sent a contingent of 1,100 troops, who were assigned command of Sector East of the deployment.

The Spanish contingent carries out important mine clearance and explosives disposal activities, and also collaborates with the civilian authorities for the reconstruction of the area and other cultural and educational projects.

Observers in other missions

There are also currently Spanish observers who depend on the United Nations (so-called "blue berets") in different peace missions in Kosovo, the Democratic Republic of Congo, and Chad and also in the Republic of Congo. Central African

4. Spain opens up to the world

Spain in Europe

Although there were already some timid attempts during the Franco regime, it was not until the arrival of democracy in Spain that Spain's entry into what were then known as the European Communities (now the European Union) could be considered.

In July 1977, the formal application for membership was made and in February 1979, the talks began, but they were not concluded until 12 June 1985 with the signing of the Accession Treaty. Spain became a full member of the European Communities on 1 January 1986.

Spain and Portugal joined together in what was then called "The Europe of the Twelve".

Since its accession, the Spanish State has actively participated in the process of European construction. Its incorporation coincides with one of the stages in which the greatest impetus has been given to effective economic integration and greater political cooperation, as well as geographical expansion.

SPAIN IN EUROPE

SPAIN IN THE INSTITUTIONS

Spain is heavily involved in the policy of the Union and its three main institutions:

- The European Parliament oversees the work of the EU and participates in its legislation. Spain, depending on its The EU's population has 54 MEPs (58 from the Treaty of Lisbon).
- The European Council and the Councils of Ministers represent the voice of governments. Spain has already presided over the European Union four times in turn, and highlights its fight for a policy of Justice and Home Affairs and for the rapprochement to Ibero-America and the Caribbean. Mediterranean.
- The European Commission represents the common interest. That's 27 commissioners, one for each country.

A SINGLE MARKET

Spain's integration into the European Union in 1986 has been a decisive modernisation factor for the Spanish economy. The necessary opening up of the Spanish economy to a single European market has meant a spectacular increase in trade and capital exchanges. The impact of EU policies in Spain has also extended to all productive and service sectors, and has enabled Spanish companies to compete in a globalised economy.

Also noteworthy is Spain's entry into the leading group of the Economic and Monetary Union (the euro replaces the peseta in 2002).

A POLICY OF SOLIDARITY

The Cohesion Policy, through its various funds (Regional, Social and Cohesion), guarantees the reduction of inequality both between states and regions and between citizens of the Union.

Spain has received funds worth 0.8% of our GDP each year since 1987, although at present this has been reduced by exceeding our country's average GDP in the Union. EU aid has made it possible to modernise the country's infrastructure, create thousands of jobs over many years and benefit, through social policies, the unemployed, young people and women.

CITIZENS' EUROPE

One of the objectives of the Treaty on European Union (Maastrich, 1992) was the consolidation of a "Citizens' Europe": it thus creates a single European citizenship and fully guarantees the freedom to travel, live, work and study in any of the Member States. Like the Erasmus programme for university students: in the 2006-2007 academic year more than 27,000 Europeans studied at Spanish universities, while 22,300 Spaniards studied abroad.

Another example is the freedom of movement which, through the Schengen Agreement, has made it possible to remove most of the internal border controls of the Member States.

OTHER COMMUNITY POLICIES

Much of Spanish legislation has to comply with European legislation, so the impact of Europe in Spain is even greater. We can highlight policies The EU's policy on health, labour, environment, agriculture and fisheries.

There is also important European cooperation in areas such as security, foreign policy, and development aid or asylum and immigration policy.

Exam V. Configuration: Easy

Statement	Answer
The referendum by which the Spanish people approved the Constitution was held on 6th February 1976.	False
The leader of the winning party in the first democratic elections was Adolfo Suárez.	True
The leader of the Spanish Socialist Workers' Party in the electoral victory of 1982 was Felipe González.	True
The Popular Party won the elections of 1992 and 1996.	False
Before the emerge of Izquierda Unida (IU) in 1986, as an electoral coalition of left-wing parties, the main electoral asset of the Left in previous general elections to the courts was the Communist Party of Spain (PCE).	True
From around 1976 onwards, there was a marked decline in the Spanish birth rate.	True
The main causes of the fall in birth rates in Spain since 1976 are: problems in the fertility of Spanish men, the discovery of male contraceptive methods and the economic crisis.	False
In recent years there has been a rebound in birth rates thanks to the late motherhood of Spanish women in the large age of 30 years and the arrival of young immigrants with other demographic patterns.	True
The rebound in births and late motherhood will lead to a collapse in life expectancy due to collapse in hospitals and a heavy burden on pensions.	False
A combination of a low birth rate and high life expectancy, as is currently the case in Spain, can lead to a rapid ageing of the population, a crisis in the pension system and a decline in the system productive	True

Exam V. Configuration: Difficult

Statement	Answer
In 1983, during the government of the Union of Democratic Center (UCD) a group of civil guards took over the Congress of Deputies.	False
On 6 December 1978, the Spanish people approved the Constitution by referendum	True
The main characteristics of our electoral system since 1979 are: to elect our representatives to Congress and the Senate every 4 years (approximately), the electoral district is provincial and in the elections to the Senate, the person and not the party is chosen	True
The order of the presidents of Spanish democracy is: Suárez, Calvo-Sotelo, González, Aznar, Zapatero, Rajoy	True
The president of Spain during the 1978 coup d' état was Leopoldo Calvo - Sotelo Bustelo.	False
Spain joins the European Communities as a full member on 1 January 1982.	False
The Spanish economic model in times of global economic crisis, such as that of 2007, presents a series of weaknesses such as excessive dependence on tourism, low skilled labor and little capacity to attract immigration.	False
Spain joins the Treaty Organization of the United Nations North Atlantic in the early 1980s	True
One of the objectives of the Treaty on European Union (Maastrich, 1992) was the consolidation of a "Citizens' Europe": thus creating a single European citizenship.	True
The Euro replaced the peseta in 2000	False

5.2.3 Natural Science: “The cell, unity of life”

Study material

The Cell, Unity of Life

Objective

In this fortnight you will learn to:

- To know and evaluate cell theory.
- Know what a cell is like and how it works.
- Recognize the different types of cells according to their characteristics.
- Distinguish the phases of the cell cycle.
- Differentiate the different cell reproduction models.
- Using the Optical Microscope

Before you start

1. Organizational Levels
2. Cellular Theory
3. The cell
 - a. General information
 - b. Prokaryotic cell
 - c. The eukaryotic cell
4. Parts of the cell
 - a. Plasma membrane
 - b. Cytoplasm
 - c. Mitochondria and chloroplasts
 - d. Core

5. Cellular functions
6. The cell cycle
 - a. Mitosis
 - b. Meiosis
7. Differences between cells
 - a. Procariot and eukaryote
 - b. Animal and vegetable

1. Organizational Levels

All matter is organized. Starting from an element that is associated with others and increases the complexity of the structure.

In the same way, living matter is organized in different levels of complexity.

Atomic Level. Consisting of atoms. The atoms that form living matter are known as bioelements. The most important bioelements are carbon, hydrogen, oxygen, nitrogen, sulphur and phosphorus.

Molecular level. This level is made up of molecules that originate by binding two or more atoms. The molecules that make up living matter are called biomolecules. Biomolecules can be inorganic such as water, mineral salts or gases, or organic such as carbohydrates, lipids, proptides and nucleic acids.

Cellular Level. Cells are included. Every cell is made up of the lower levels, molecular and atomic. The complexity of this level is much greater, since the cell is an anatomical and functional unit, which means that it is the smallest structure that could survive on its own in the middle.

Pluricellular level. It involves the association of several cells that may form an organism complete. This level can be subdivided into the next sublevels:

- Tissues: formed by groups of cells that have the same look and function.
- Organs: structures formed by various tissues who together perform a specific function.
- Systems: set of structural organs similar functions that perform very similar functions. For example, the muscular system.

- Apparatus: set of organs that may have different coordinated structures to carry out the following tasks a certain function. For example, the digestive device.

The whole forms the pluricellular individual.

Population Level. It includes the group of individuals of the same species that live in a specific place and at a certain time, being able to relate to each other.

Ecosystem Level. It encompasses the relationships that are between populations living in a given country and the region. Place (biocenosis) and the place where it is located. Inhabitant (biotope). Large ecosystems are they call biomes. The set of biomes forms the BIOSPHERE.

2. Cellular Theory

Cells are the basis of all organisms, since all living beings are made up of cells. But the cell and its structure could not be known until the gadgets needed to see it were created. Those who gadgets are **the microscopes**.

In 1665, the scientist Robert Hooke described a sheet of cork he looked at under a microscope. Hooke saw a lot of cells he called cells.

Subsequently, many scientists have looked at the microscope and described the different cell structures.

All the observations made have led to the creation of **Cellular Theory**. It contains four main concepts:

- All living beings are made up of one or more cells.
- Every cell is the anatomical and physiological unity of living beings. It's the smallest unit of life.
- Every cell comes from the division of an earlier cell.
- Every cell contains hereditary material where the characteristics of the living being are found and which will be transmitted from a stem cell to their daughters.

This theory was developed by several researchers, including Schwann and Schleiden (1839), Virchow (1858) and Santiago Ramón y Cajal (1898).

3. The cell

Applying cell theory, we know that all organisms are composed of cells, but cells can be of different types. In addition, living beings can be made up of one or more cells.

The cells are classified according to the degree of complexity they present in their structure. This is how they distinguish themselves:

- Prokaryotic cell: All those whose genetic material is not protected by a membrane and the cytoplasm is not compartmentalized. It's the simplest cell type.
- Eukaryotic cell: All those whose genetic material is inside a structure, the nucleus, protected by a membrane. The cytoplasm is compartmentalized. It's the most complex cell type.

The organisms are made up of cells. Depending on the number of them they present, there are two types:

- Single-celled organisms:

They are those formed by a single cell. The cell performs all vital functions. They can be prokaryotes or eukaryotes. Examples of this type of organisms are bacteria, cyanophilic algae, protozoa and many eukaryotic algae.

Sometimes they live in stable groups, called colonies. In this case, some cells perform one type of function and other cells perform another. However, each cell can live independently of the colony, assuming all vital functions.

- Multi-cell organisms:

They are living beings, all eukaryotes, formed by many cells. All the cells of the body have emerged from a single cell that has formed the others. Therefore, all cells have the same genetic information, even if they do not express the same genetic information. Way.

Cells do not survive in isolation, as they lose some capacities in order to specialize in a particular function. This is how the various tissues that can form a pluricellular organism are formed.

Examples of pluricellular organisms are animals, including humans, plants, fungi and many eukaryotic algae.

The Prokaryotic cell

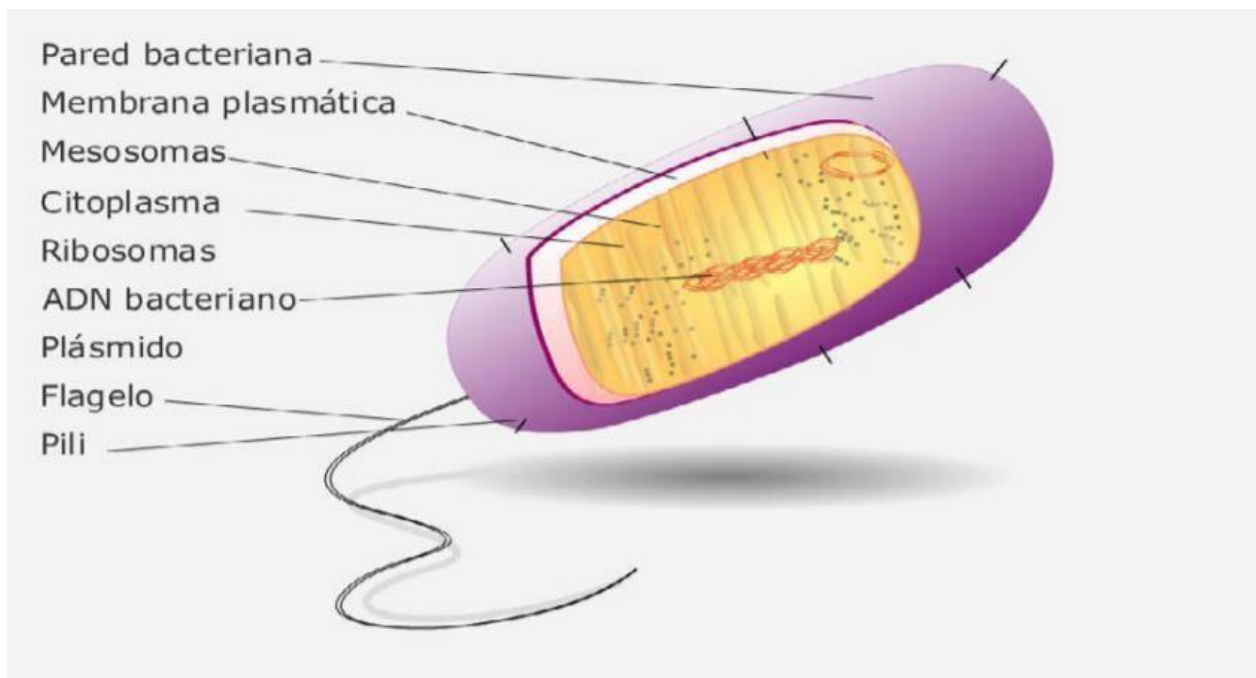
Prokaryotes do not contain a nucleus that protects the genetic material. Prokaryotes are bacteria and cyanophilic algae. They all belong to the Monas Kingdom.

They usually have the following parts:

- Rigid wall that gives it shape.
- Plasma membrane that separates them from their environment and controls the passage of substances. It has some wrinkles towards its interior that are called

mesosomes. They perform a lot of cellular activities, such as fixing DNA, performing cellular respiration, producing energy or controlling cell division.

- Cytoplasm, which is filled with water and contains a large quantity of dissolved substances, lipid droplets or inclusions of reserve substances such as starch. In the cytoplasm, the set of chemical reactions that allow the cell to survive will be performed. That is, cellular metabolism.
- Ribosomes, are the places where proteins are built.
- DNA, which is the genetic material that controls cell activity. The DNA is found forming a circular structure, constituting the only chromosome of the cell. Looks like an area of the cytoplasm called the nucleoid.
- Plasmids, small extrachromosomal circular DNA sequences that give the cell the ability to exchange genetic material with other cells or resistance to antibiotics.



Many bacteria have scourges, which are structures that allow the cell to move.

Other bacteria present Pili that are rigid structures that start from the cell membrane. They serve to connect the cells so that they can transmit information.

EXTENSION OF BACTERIA

Some bacteria have a viscous capsule. The capsule is a protective structure against bactericidal agents, although it also allows them to be associated with other bacteria.

Bacteria occur on their own or in colonies. In these colonies there is no specialization of any kind cell phone. Bacteria that are separated from the colony can live independently.

Bacteria can take different forms. They can be elongated (bacillus), round (coco), elongated with a flagellum (vibrio) or spring-like (spiryll).

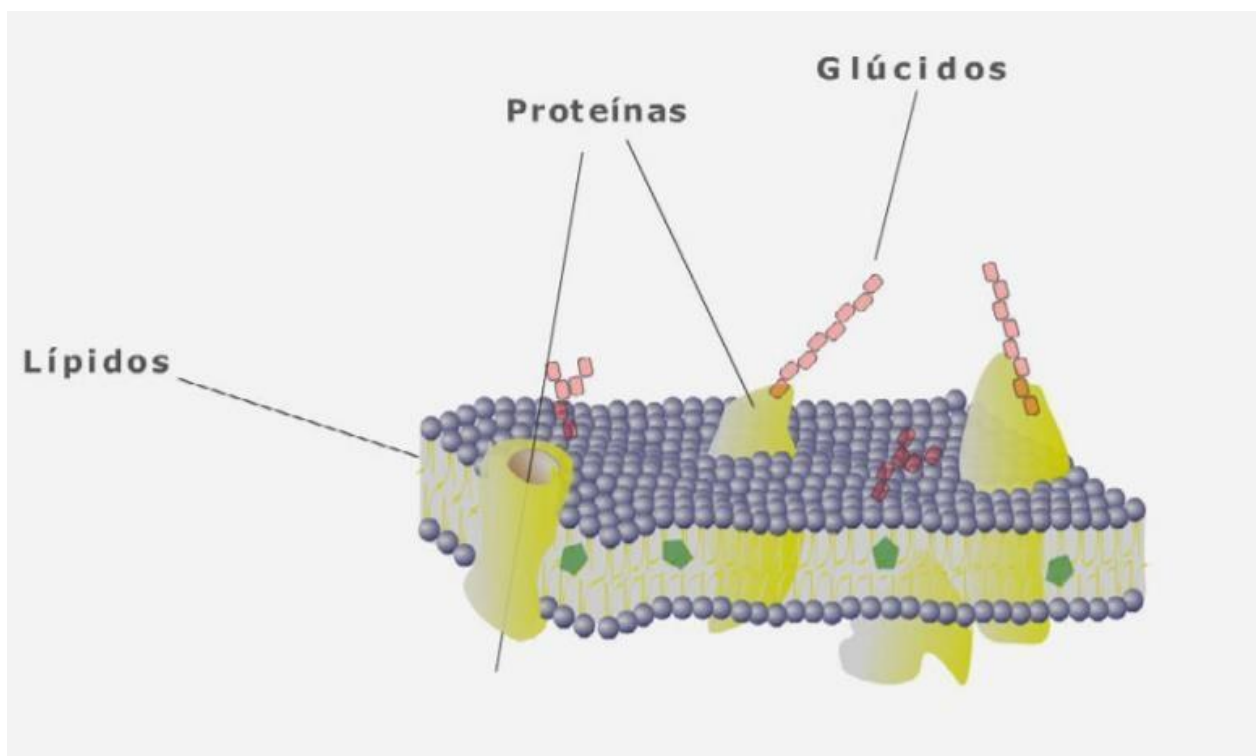
Cyanophilic algae, or cyanobacteria, are very large prokaryotes cells that contain tilacoids inside. These are membrane bags with chlorophyll in them. They do the photosynthesis with it

The eukaryotic cell

The eukaryote cell has the genetic material protected by a membrane forming the nucleus, In addition, in cytoplasm there are structures called cell organelles that perform different functions.

4. Eukaryotic Cell Parts

- Plasma membrane: formed by lipids, proteins and a small proportion of carbohydrates. The lipids are organized in two layers and prevent the passage of any polar substance. The proteins are usually located through the two layers of lipids creating channels through which the passage of substances is regulated. The carbohydrates are only found on the outside of the membrane forming a layer that can capture information from the outside. It is the cell limit, controls the passage of molecules and receives the stimuli produced in the medium.

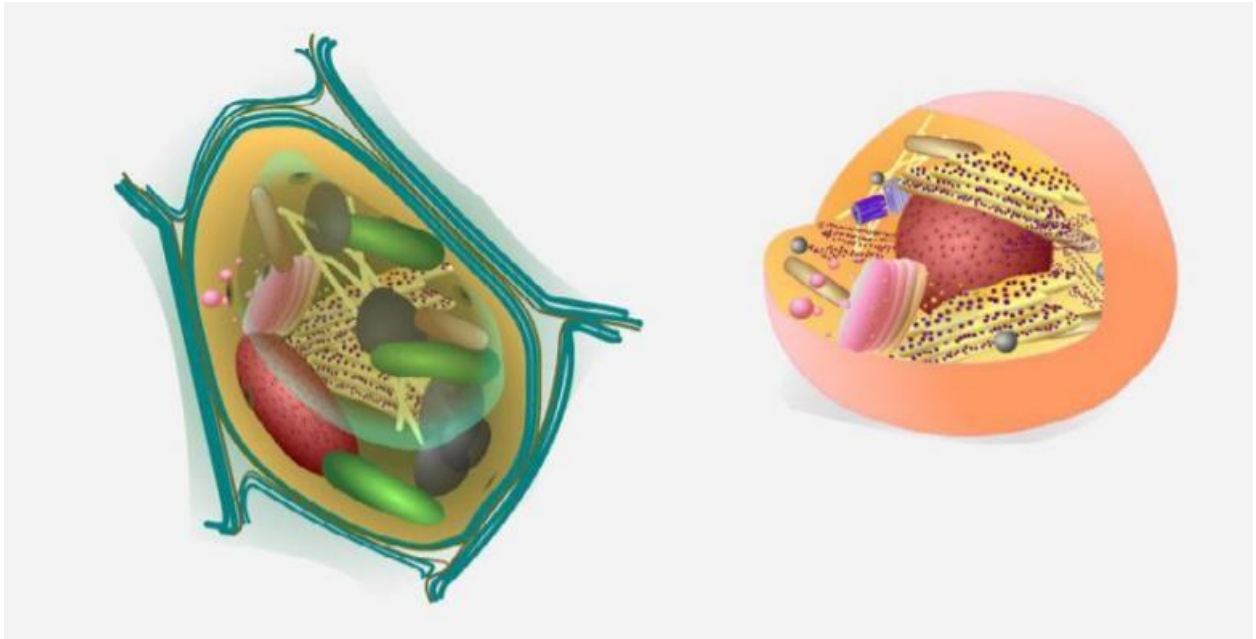


- Cell wall: it is a hard structure and in some cases very thick, formed by polysaccharide type carbohydrates, such as cellulose. It's an external skeleton that provides a defined and stable form to the cell. It also prevents the cell from breaking when it absorbs a lot of water. Small pores appear on the walls for water, nutrients and gases. It only appears in plant cells.
- Cytoplasm: is found between the plasma membrane and the nucleus. It contains the organelles and cytoskeleton included in the hyaloplasm.
- Cytoskeleton: structure formed by proteins. It's the cellular skeleton.
- Ribosomes: two subunits of RNA and protein. They are used for building proteins thanks to the information provided by the messenger RNA.
- Centrioles: are hollow cylindrical structures formed by microtubules. They organize the construction of the cytoskeleton, the achromatic spindle and the structures of the movement, cilia and flagella. They only appear in animal cells.
- Cillies and flagella: these are filamentous extensions formed by microtubules of protein surrounded by plasma membrane. The cilia are short and can be appear covering the entire cell surface or a certain area. The scourges are long and few in number. The function of these structures is related to cell movement or producing small currents to capture nearby nutrients.
- Endoplasmic reticulum: organelles formed by contoured tubules and flattened or rounded vesicles. They are found all over the cytoplasm interacting with each other. Its function is to synthesize, transform, accumulate and transport substances. It also forms vesicles that will give rise to other organelles of the cell.

There are two types of endoplasmic reticulum:

Rough endoplasmic reticulum, has a rough appearance due to the fact that it has ribosomes associated with the membrane of the organulus. Its function is to produce proteins that act inside a gallbladder or outside the cell.

Smooth endoplasmic reticulum without ribosomes. Its function is to synthesize lipids.



- Golgi apparatus: it consists of sacs and vesicles coming from the endoplasmic reticulum. Golgi's apparatus transforms substances produced in the endoplasmic reticulum. Vesicles are also generated that can bind to the membrane, releasing its contents to the outside, or give rise to other organelles.
- Lysosomes: are organelles formed by rounded vesicles filled with digestive enzymes, which carry out cellular digestion. Lysosomes come from Golgi's apparatus.
- Vacuoles: large, rounded vesicles. They accumulate all kinds of substances in their interior, such as pigments, reserve substances, waste and above all water.
- **Mitochondria:** These are large, oval organelles with double membrane. The external is smooth, the internal has folds called ridges. They are presented in the cell in variable number but they are very numerous if the cell needs to consume a lot of energy. The inside of the mitochondria is called the mitochondrial matrix. In the matrix we find circular DNA, RNA and ribosomes, like bacteria. They are able to form proteins and divide.

The function of the mitochondria is to produce most of the energy required by the cell through oxidation processes of organic matter. It uses organic matter and oxygen, releasing energy and carbon dioxide. This process is called **Cellular Breathing**.

Mitochondria



- **Chloroplasts:** These are the plant cell's own organelles. They are large, with varied shapes and double membrane. The external one is smooth and the internal one is associated with elongated vesicles called lamellae, on these are deposited discoidal vesicles of green color denominations tilacoides or granum that contain photosynthetic pigments.

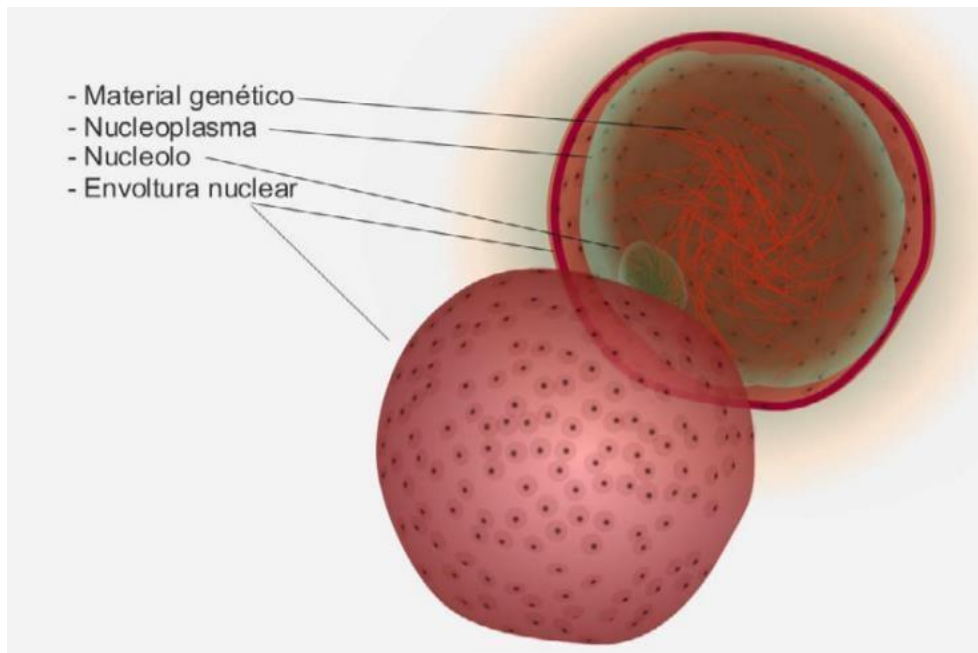
Tilacoids are grouped together into small piles called grana. Vesicle-free space is the stroma of chloroplast, where circular DNA, RNA and ribosomes, similar to bacteria, are found. Chloroplasts are organelles that use light and water to transform inorganic matter (CO₂) into organic matter (glucose). This process is known as Photosynthesis, there are other types of plastids in plant cells. These organelles usually accumulate reserve matter or colored substances.

Cloroplasto



- The nucleus is the characteristic structure of the eukaryotic cell. The following parts are distinguished:
 - Nuclear membrane, formed by two membranes coming from the endoplasmic reticulum. The entire surface is dotted with pores through which information enters and exits.
 - Nucleoplasma, a substance similar to hyaloplasma.
 - Nucleolus, is a very dense area formed by DNA, RNA and proteins. It's the place where ribosomes form.

- DNA or genetic material, is found condensed in the form of chromatin. DNA contains genetic information and controls cell activity.



When the cell enters division, chromatin spirals into chromosomes

The parts of a chromosome are as follows:

- Chromatids, they are identical parts, contain the same genetic information.
- Centromeric constricted area of the chromosome.
- Arm, areas above or below the centromer. The arms contain different genetic information.

Not all chromosomes are the same. Depending on the length of the chromosome arms, they are classified into metacentric, submetacentric, acrocentric and telocentric chromosomes.

5. Cellular Functions

Every organism performs a series of functions to keep alive and generate individuals like him.

The cell is the simplest living being, yet it also performs these functions.

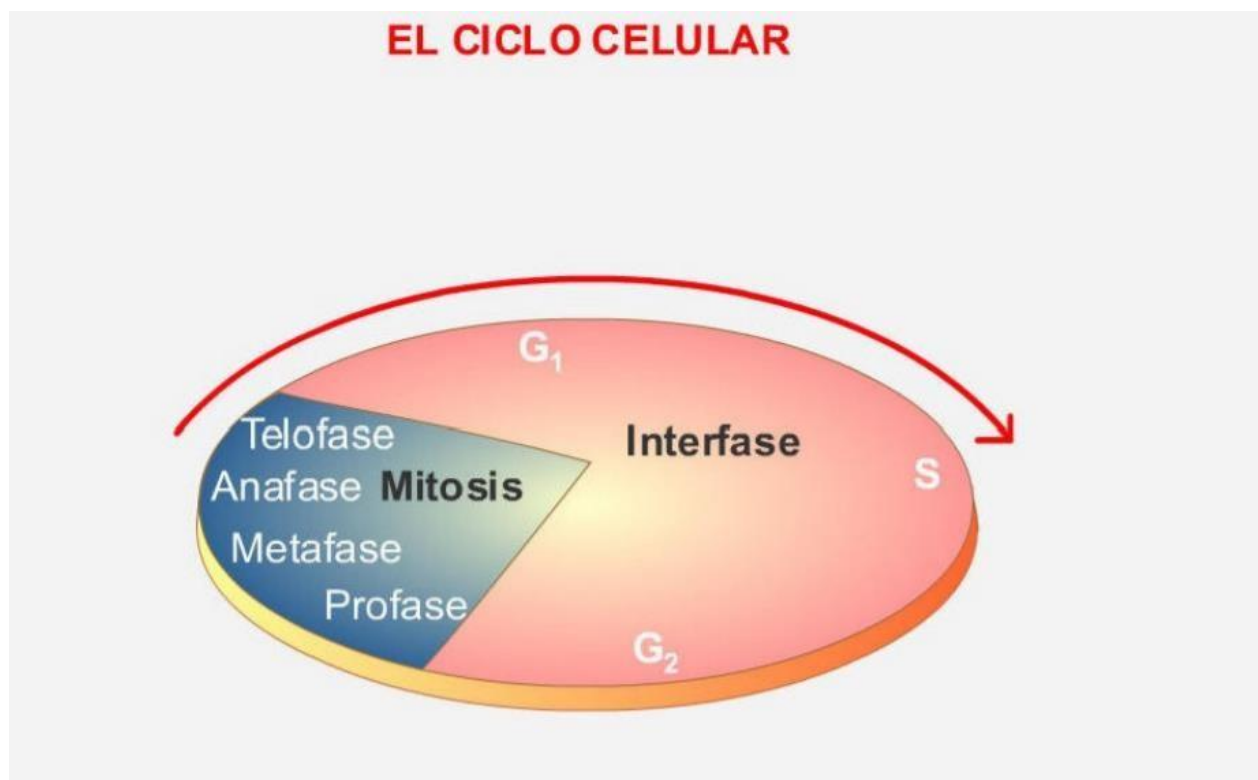
- Nutrition function. It consists of the uptake of nutrients and subsequent transformation to grow, relate or divide.
- Relationship function. It is the set of processes aimed at generating a response (tactism) to changes in the environment (stimuli).

- Playback function. It corresponds to the mechanisms that cells establish to divide themselves in order to increase their number of individuals of the species.

6. Cellular Functions

It is the set of changes that a cell undergoes from its formation from a cell division until it divides to form two new cells.

The cell cycle has a different duration between cells of different living beings, even between cells of the same living being. In any case, most of the cycle is occupied by the interface. After that, cell division occurs.



INTERFACE

This phase is the one that does not present great visible changes in the structure of chromatin. However, the cell is in full synthesis activity for all types of substances, including those needed to divide after the interface.

It is divided into periods called G₁, S and G₂. The first period appears after the division that originated the cell, so it must synthesize a large number of molecules and increase its size, increasing the number of organelles inherited from the cell that originated it.

- When the cell is to be divided again, it must duplicate DNA once all the substances necessary for this process have been synthesized in phase G₁. If the cell is not to divide, it does not need to duplicate its genetic information and the cycle is blocked in a phase called G₂. This blockage occurs in neurons, muscle cells, epidermis cells that are filled

with keratin and other cell types that differentiate to fulfill their specific function within the body, losing their ability to divide.

- DNA Synthesis Phase S consists of DNA duplication. In this process the cell spends a lot of energy to make an identical copy of the genetic information it contains.

The process is based on the addition of nucleotides of complementary bases to the existing strands. From each double helix thread a new thread is made

Once the process is complete, the cell contains the genetic information in duplicate on each chromosome. This way, it will be possible to divide into the two daughter cells formed by cell division.

- Before cell division occurs and after DNA duplication, the cell enters a phase called G2. In this phase, the cell synthesizes a large number of G2 cells. proteins involved in the creation of the achromatic spindle. New centrioles are synthesized in animal cells. From each of the pre-existing ones, a new one is formed, perpendicular to it.

MYTHOSIS

Mitosis is an asexual cell division that forms two genetically identical cells and stem cell clones. It consists of the equitable distribution of genetic information and the subsequent separation of cells when the cytoplasm is divided by cytokinesis. This latter process is not necessary for mitosis to occur.

Mitosis is divided into prophase, metaphase, anaphase and telophase.

- **Profase** At the cytoplasmic level, the centriolus pairs have been arranged as far apart as possible from each other. Among them, a cytoskeleton made up of microtubules has been built. This structure is called the achromatic spindle. It is generated from each pair of centrioles an aster of microtubules that grows towards the equatorial zone of the cell. The microtubules of one pole and the other contact each other. Chromatin condenses, forming chromosomes. The nucleolus is melted.
- **Metaphase** It is the longest phase. The placement of all chromosomes in the central area of the cell is the formation of a dark plaque called the equatorial plaque.
- **Anaphase** The chromatids of each chromosome are separated each to a pole. The chromatides are dragged to the cell poles, so that the same number of chromatides appears in each pole.
- **Telophase** The nuclear envelope is organized from the rough endoplasmic reticulum, on the chromatids that begin to become decondensed and the nucleolus is formed, necessary to synthesize ribosomes.

The process usually continues with a cytokinesis, in which the cytoplasms of the two new cells are separated.

EXTENSION OF CITOSINESIS

In animal cells, a contractile ring is produced that contracts in the area where the equatorial plaque used to be, strangling the cytoplasm of this region. At the end of the process, the space is so small that the membrane plasma melts and separates one daughter cell from the other.

In plant cells, cytokinesis is produced by the intervention of microtubules of the cytoskeleton arranged in the cell equator and vesicles of the Golgi apparatus containing the substances that form the cell wall. The Lasallian blisters fuse together, forming a disc filled with hemicellulose and pectin. Disc membrane fuses with the plasma membrane, so that the two daughter cells are separated and between them appears the middle film. This primordial wall is shared by the two cells and is crossed at many points by bridges cytoplasmic, which form plasmodesmos.

Cytokinesis involves a distribution of stem cell organelles to newly formed daughter cells. This distribution occurs equally when the divided cytoplasm is half. Once divided, the cell grows increasing the number of organelles. In the case of mitochondria and plastidios, these organelles have certain autonomy of division, increasing their number depending on the physiological needs of the cell.

Cytokinesis is not evenly distributed among cytoplasmic components. Twinning is an asexual mode of reproduction in which the stem cell duplicates and gives its genetic information to the daughter who receives the least amount of cytoplasm. This division model is produced in yeasts.

MEIOSIS

Meiosis is a model of cell division in which information is exchanged between homologous chromosomes and the number of chromosomes in the formed cells is reduced by half, so they are haploids.

Thus, when two haploid cells merge, the formed cell restores the number of chromosomes so that this number remains unchanged over time. On the contrary, the content of the genetic information that appears in that new cell has changed. This evolutionary advance allows genetically varied beings to appear, which may be better or worse adapted than their parents to the environment in which they develop.

Meiosis occurs in two stages of division, called the first Meiotic Division and the second Meiotic Division. Each one of them is divided in + phases that receive the name of prophase, metaphase, anaphase and telophase.

FIRST MESIOTIC DIVISION

Profase I

Chromatin condenses into chromosomes, visible under an optical microscope, which are attached at the ends to the nuclear sheath.

The homologous chromosomes (of the same couple) come together, producing a pair in which genetic information exchange (genetic combination) takes place, by means of an overcrossing of the chromatids.

At a cytoplasmic level, the achromatic spindle has been formed from microtubules that come from the Polar Regions, where the pairs of centrioles are located, one in each cell pole.

Metaphase I

The equatorial plaque is originated by the binding of the homologous chromosomes to the microtubules of the achromatic spindle.

Anaphase I

The homologous chromosomes are separated, each moving to an opposite pole of the cell. Half of the (n) chromosomes appear in each pole.

Telophase I

The chromosomes reach the cell poles. Around them the membrane is formed and the nucleolus appears. Energetically, a cytokinesis is produced, which involves a distribution of cytoplasm, which in many cases is inequitable.

SECOND MEIOTIC DIVISION

No DNA duplication occurs between the first and second divisions.

Prophase II

The chromosomes are condensed again, with their two different chromatids, the result of the genetic recombination caused by overcrossing. Disappears the nucleolus and the nuclear sheath and chromosomes attach to the microtubules of the new achromatic spindle.

Metaphase II

The chromosomes are arranged in the cellular equator, forming the equatorial plaque.

Anaphase II

The chromatids of each chromosome are separated, each to a pole.

Telophase II

A nuclear sheath is organized around the chromosomes that are gradually being discarded. The nucleolus appears and the cytoplasmic content is distributed by cytokinesis.

RESULT OF MEIOSIS

The result obtained is 4 cells (sometimes only one) with half the genetic information of the cell from which it originates. Each cell obtained is different from the other cells, since there has been a great variability due to the distribution of the homologous chromosomes and the distribution of the chromatids. Furthermore, chromatids are different from those that appeared in the stem cell, due to the exchanges generated by overcrossing.

The cells obtained in meiosis can fuse with others, producing a new cell that has the same genetic content as the initial cell. However, through this mechanism it is impossible to form a genetically identical cell.

Meiosis implies an evolutionary advance in the form of reproduction of organisms when there is an exchange of genetic materials from different cells, thus generating genetically new cells, different from the progenitors. This variability means that the possibility of adapting some organisms to the changing conditions in the environment where they live, surviving the best adapted ones.

7. DIFFERENCES BETWEEN CELLS

PROCARIOTE CELL AND EUCARIOT CELL

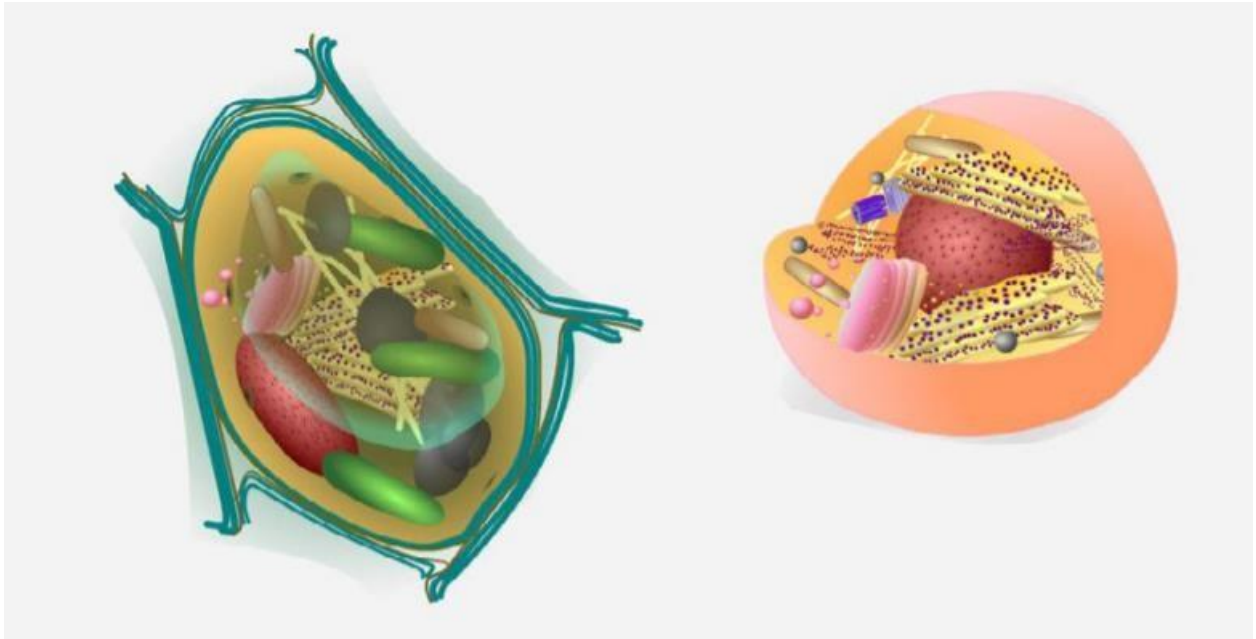
- The prokaryotic cell has no protective nucleus of the genetic material. The eukaryotic cell does have a nucleus limited by a membrane structure.
- The cytoplasm of the eukaryotic cell is compartmentalised, presenting organelles, whereas in prokaryote this compartmentalisation does not appear.
- The prokaryotic cell is protected by a bacterial wall other than that surrounding plant cells.
- Prokaryotes are more primitive organisms than eukaryotic cells.
- The DNA of prokaryotes cells is circular, while the DNA of eukaryotes is linear.
- When they present flagella, the structure is different in prokaryotes and eukaryotes.
- The plasma membrane of prokaryotes contains more protein than the membrane of eukaryotes.
- The prokaryotic cell has invaginations in its membrane, called mesosomes.



ANIMAL CELL AND PLANT CELL

Plants are made up of cells, just like animals. However, although most cell structures that function the same way, they have other structures than those of animal cells.

- The plant cell is usually larger than the animal and has an external, rigid wall made of cellulose. The cell wall gives the plant cell a constant, polyhedral-looking shape.
- In addition, the plant cell contains photosynthetic organelles, green in colour because of their chlorophyll content. These organelles are called chloroplasts. Cells with chloroplasts are autotrophic. However, animal cells are heterotrophic.
- Plant cells usually contain a storage bag of substances, mainly water. This organ is called a vacuole, which is sometimes so large that it occupies almost the entire cell interior.
- Plant cells do not have centrioles, although they have cytoskeleton and form achromatic spindle in their division.
- When the cell is divided in two by mitosis, the cytoplasm is divided by the formation of a wall that separates it into two parts, known as fragmoplasty. The result, as in the animal cell, is the formation of two daughter cells, identical to each other and identical to the stem cell.



Exam V. Configuración: Fácil

Statement	Answer
In mitosis, two cells are obtained genetically identical to the stem cell	True
Golgi's apparatus is associated with ribosomes	False
Microscopes were created after to state cellular theory	False
The cytoskeleton of animal cells is organized By centrioles	True
The eukaryotic cell contains genetic material in a compartment that we call core	True
A coconut bacteria has a round shape	True
Single-celled organs do not survive in isolation	False
The ecosystem level includes living beings that live in a place and relationships that are established among them	True

Plasma membrane only appears in cells animals, plant cells present cellular wall	False
Mitochondria has a smooth inner membrane	False

Exam V. Setting up: Difficult

Statement	Answer
The prokaryotic cell has the genetic material dispersed by the cytoplasm	True
In meiosis, two identical cells are produced in the meiosis genetic information that the stem cell	False
Some prokaryotes may present chloroplasts	False
Cellular theory says that the cell is the unit anatomical and functional of living beings	True
Chloroplast performs cellular respiration	False
The smooth endoplasmic reticulum serves to store lipids	True
Proteins form in ribosomes	True
The cilia and phagelos have the function of protecting the cell	False
Within the organizational levels of the subject matter, the Carbon would be found at the molecular level	False
Prokaryotic cell may have plasmids	True

5.3 Study material and exams for Univeristy/ Oppositions

5.3.1 Biology: "Genetics"

Study material

GENETICS

Lecture 1

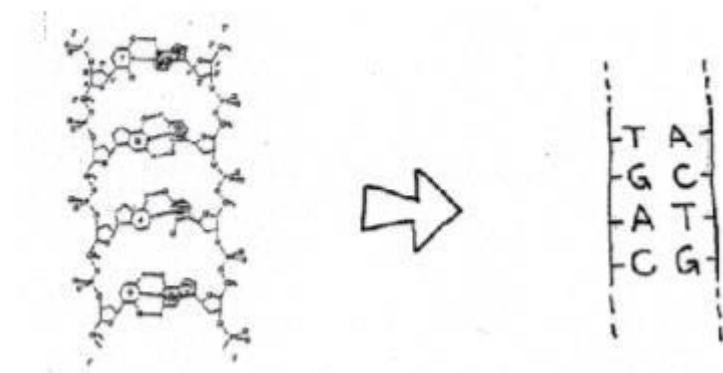
We will begin this course with the question: What is a gene?

This question will take us four lectures to answer because there are actually several different definitions that are appropriate in different contexts.

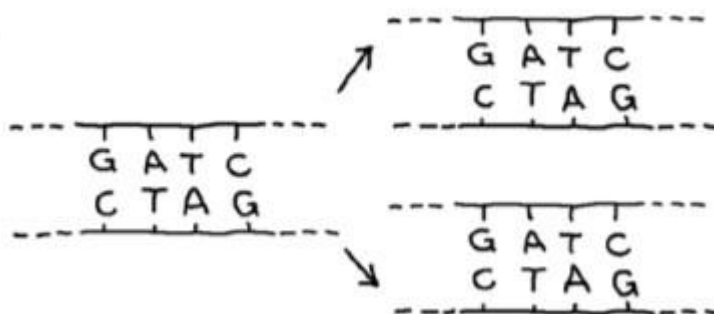
We will start with a physical definition of the gene. Conceptually this is the simplest and it will give me an excuse to briefly review some of the molecular biology that you probably already know.

Genes are made of DNA

For this course we will mostly think of DNA as an information molecule not as a chemical substance.



In 1953, Watson and Crick deduced that the structure of DNA was a double helix. It was not the helical structure per se, but the discovery of complementary base pairing that revealed how information could be encoded in a molecule and how this information could be exactly duplicated each cell division. **Replication.**

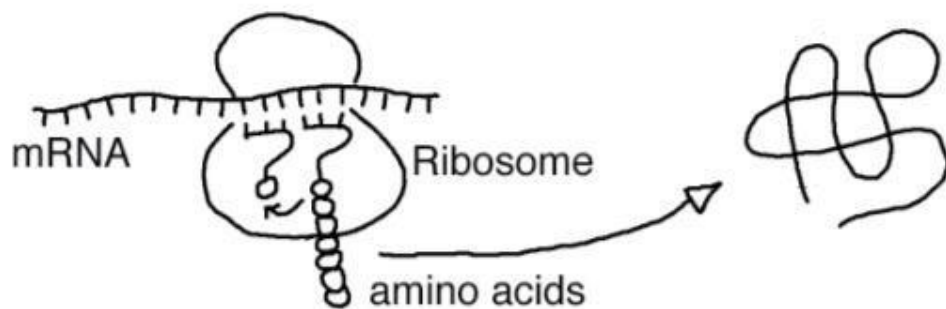


In order to extract information from the DNA, the cell again uses the complementary basepairing to make a copy of the information copied onto an RNA molecule. This is known as **Transcription**. RNA is chemically less stable than DNA and mRNA can be thought of as a temporary copy of DNA's information.

Transcription



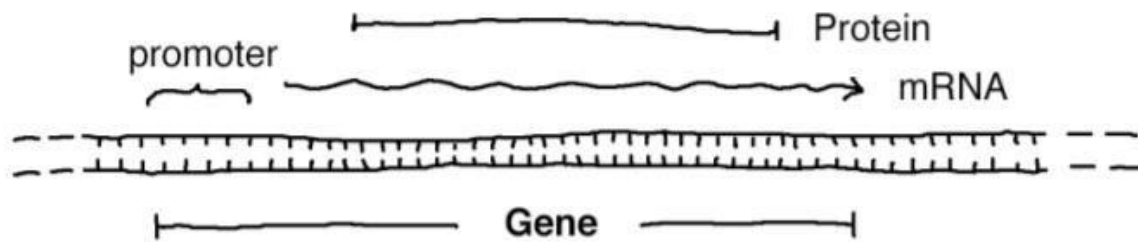
Translation



Folded proteins:

- Enzymes
- structural proteins
- membrane channels
- hormones

Gene: DNA segment needed to make a protein



Genes are typically 103 - 104 base pairs in size although they can be much larger. For example, the human dystrophin gene is 2×10^6 base pairs.

E. coli has about 4,200 genes which isn't very many considering that at least 1,000 different enzymes are needed carry out just the basic biochemical reactions in a cell. The smallest genome for a free-living organism (i.e. a cell, not a virus) is that of the bacterium *Mycoplasma genitalium* which encodes only 467 genes. Humans are at the other end of the spectrum of complexity and have about 35,000 genes.

In the demonstration in class you see how a mutation in the *Shibire* gene in the fly *Drosophila* gives a heat sensitive protein that is required for synaptic transmission. When the flies that carry this mutation are warmed by the projector lamp they become paralyzed.

Gene	—	Protein	—	Cell Process	—	Organism "disease"
(<i>Shibire</i>)		(Dynamin)		(Synaptic Signaling)		(Paralyzed Fly)

This example illustrates two powerful aspects of genetic analysis. First, we can follow microscopic changes in the DNA such as the *Shibire* mutation as they are revealed by the macroscopic consequences of the mutation such as a paralyzed fly. Second, we have a very precise way of studying the function of individual proteins by examining the consequences of eliminating just that one protein function in an otherwise normal organism.

Alleles: Alleles: Alleles: different versions of the same gene. Often alleles are referred to as mutants but actually this usage is often incorrect particularly when we discuss naturally occurring variants in a population.

Mutation: an altered version of a gene when we have "witnessed" the alteration but not when it is preexisting in the population.

Genotype: Genotype: Genotype: all alleles of an individual

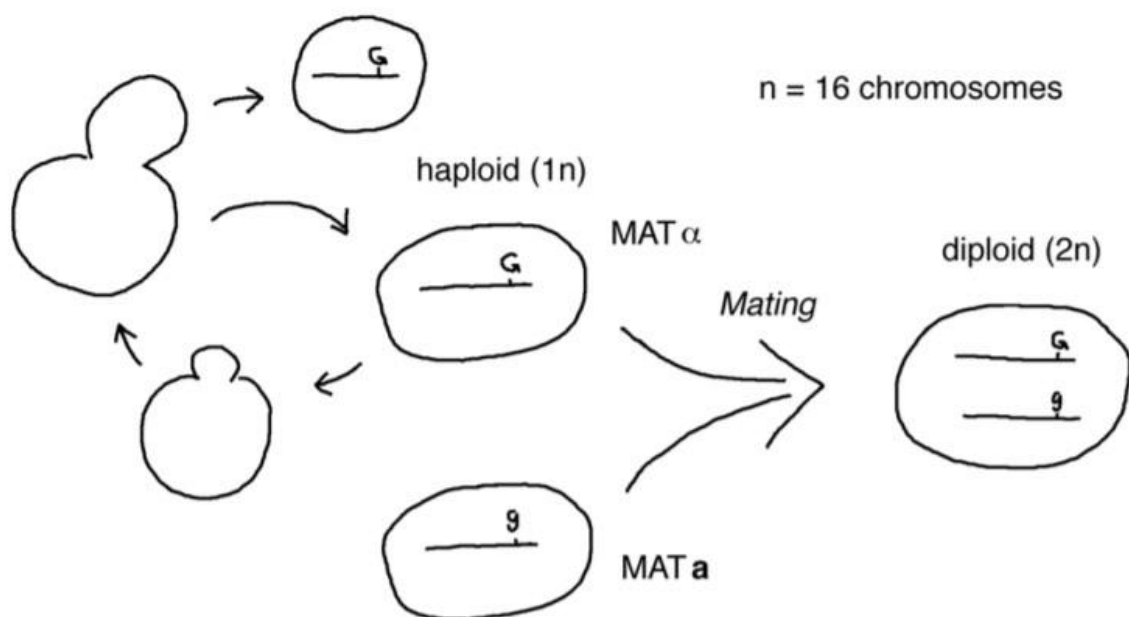
Wild type: defined standard genotype

The concept of wild-type is used as a defined reference for organisms where we can do breeding experiments. Of course there is no realistic way to define a standard genotype for humans, therefore “wild type” has no meaning when we discuss human genetics.

The physical definition of the gene is a very good one but there are many instances where we wish to study genes whose DNA sequences are not known. For example, say we have isolated a new mutant fly that is also paralyzed and we want to know whether this mutation is also in the Shibire gene. We will see in the next several lectures that we can answer this question without knowledge of the DNA sequence either by a test for gene function known as a complementation test or by a test of the chromosomal position of the mutation by recombinational mapping. In practice, these other ways of defining genes by function or by position are often much more useful than a definition based on the DNA sequence.

Lecture 2

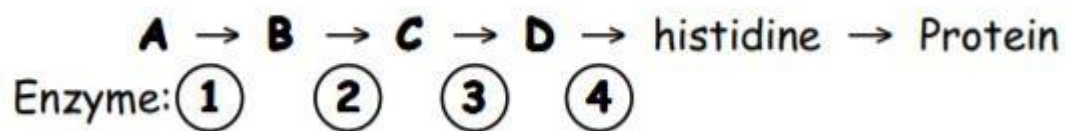
In this lecture we are going to consider experiments on yeast, a very useful organism for genetic study. Yeast is more properly known as *Saccharomyces cerevisiae*, which is the singlecelled microbe used to make bread and beer. Yeast can exist as haploids of either mating type α (MAT α) or mating type *a* (MAT*a*). Haploid cells of different mating type when mixed together will mate to make a diploid cell.



Haploids and diploids are isomorphic – meaning that a given mutation will cause essentially the same change in haploid and diploid cells. This allows us to look at the effect of having two different alleles in the same (diploid) cell.

All yeast needs to grow are salts, minerals, and glucose (minimal medium). From these compounds, yeast cells can synthesize all of the molecules such as amino acids and nucleotides that are needed to construct a cell. The synthesis of complicated molecules requires many enzymatic steps. When combined, these enzymatic reactions constitute a **biochemical pathway**.

Consider the pathway for the synthesis of the amino acid histidine.



Each intermediate compound in the pathway is converted to the next by an enzyme. For example, if there is a mutation in the gene for enzyme 3 then intermediate C can not be converted to D and the cell can not make histidine. Such a mutant will only grow if histidine is provided in the growth medium.

This type of mutation is known as an auxotrophic mutation and is very useful for genetic analysis.

	growth on minimal	growth on minimal + histidine
His ⁺ (wild type)	+	+
His ⁻	-	+

Phenotype: All traits of an organism (with an emphasis on trait under investigation).

Homozygote: Homozygote: diploid with two like alleles of same gene.

Heterozygote: diploid with two different alleles of same gene.

Recessive Allele: trait not expressed in heterozygote.

genotype	phenotype	Mate to :	diploid genotype	diploid phenotype
MATa His3 ⁻	His ⁻	MATα His3 ⁻	His3 ⁻ /His3 ⁻	His ⁻
MATa His3 ⁻	His ⁻	MATα His3 ⁺	His3 ⁻ /His3 ⁺	His ⁺

Based on the His⁻ phenotype of the His3⁻/His3⁺ heterozygote, we would say that His3⁻ is recessive to wild type.

Let's consider a different kind of mutation giving resistance to copper that occurs in a gene known as CUP1.

genotype	phenotype	Mate to :	diploid genotype	diploid phenotype
MATa Cup1r	copper resistant	MATα Cup1+	Cup1r/Cup1+	copper resistant

Dominant Allele: trait is expressed in heterozygote

Cup1r is dominant to wild type (Cup1+).

The terms dominant and recessive are simply shorthand expressions for the results of particular experiments. If someone says a particular allele is dominant that means that at some point they constructed a heterozygous diploid and found that the trait was expressed in that diploid.

Note: Sometimes an allele will have more than one phenotype and may be recessive for one and dominant for another. In such cases, the phenotype must be specified when one is making statements about whether the allele is dominant or recessive. Consider for example, the allele for sickle cell hemoglobin in humans designated Hbs. Heterozygous individuals (Hbs/Hba) are more resistant to malaria, thus Hbs is dominant for the trait of malaria resistance. On the other hand, Hbs/Hba heterozygotes do not have the debilitating sickle cell disease, but Hbs/Hbs homozygous individuals do. Therefore, Hbs is recessive for the trait of sickle cell disease.

Once we find out whether an allele is dominant or recessive, we can already infer important information about the nature of the allele. The following conclusions will usually be true.

Recessive alleles usually cause the loss of something that is made in wild type

Dominant alleles usually cause increased activity or new activity

It turns out that the Cupr allele actually carries more copies of the gene for a copper binding protein and therefore increases the activity of the gene.

Last lecture we defined the gene structurally as the DNA needed to encode a protein. We can now define a gene in a new way based on its function. Using the phenotypic difference between wild type and a recessive allele we can use a **Complementation test** to determine whether two different recessive alleles are in the same gene.

Say you isolate a new recessive histidine requiring mutation that we will call HisX⁻. In principle, this mutation could be in His3 or it could be in any of the other genes in the histidine biosynthetic pathway. In order to distinguish these possibilities we need a test to determine whether HisX is the same as His3.

To carry out a complementation test, one simply constructs a diploid carrying both the His3⁻ and HisX⁻ alleles.

An easy way to do this would be to mate a MAT α HisX $-$ strain to a MATa His3 $-$ strain.

possibility	genotype of diploid	phenotype of diploid	complementation
HisX= His3	His3 $-$ /His3 $-$	His $-$	No
HisX $\neq$ His3	His3 $-$ /His3 $+$, HisX $-$ /HisX $+$	His $+$	Yes

Having performed this test, if the two mutations don't complement we conclude that they are in the same gene. Conversely, if they do complement we conclude that they are in different genes.

This test only works for recessive mutations. Think about what the outcome would be if HisX $-$ were dominant.

The complementation test can be thought of in the following way. If I have an allele with an observable phenotype whose function can be provided by a wild type genotype (i.e., the allele is recessive) — I can ask whether the function that was lost because of the recessive allele can be provided by another mutant genotype. If not, the two alleles must be defective in the same gene. The beauty of this test is that the trait can serve as a read-out of gene function even without knowledge of what the gene is doing at a molecular level.

Definitions from the Language of Genetics

Gene: The fundamental unit of heredity, which can be defined in three ways: i) A gene can be defined in molecular terms as a segment of DNA carrying the information necessary to express a complete protein or RNA molecule, including the promoter and coding sequence. ii) A gene can be defined by function with a group of recessive mutations that do not complement each other. iii) A gene can be defined by position with a single-locus segregation pattern in a cross between lines with different alleles. Examples are a 1:3 phenotypic ratio in the F2 generation in a cross between diploid organisms or a 2:2 segregation pattern in yeast tetrad analysis.

Alleles: Distinguishable versions of the same gene.

Locus: The site on a chromosome where a gene is located. Usually defined by recombinational mapping relative to neighboring loci.

Genotype: The allelic constitution of an individual, usually with emphasis on the gene or genes under examination.

Phenotype: All of the traits or characteristics of an organism, usually with emphasis on traits controlled by the gene or genes under examination.

Wild type: A standard genotype that is used as a reference in breeding experiments. Note that for human crosses there is no standard genotype and the concept of wild-type is therefore not meaningful.

Haploid: A cell or organism with one set of chromosomes (1n).

Diploid: A cell or organism with two sets of chromosomes ($2n$).

Homozygous: The condition of having two like alleles in a diploid.

Heterozygous: The condition of having two different alleles in a diploid.

Dominant allele: An allele that expresses its phenotypic effect or trait in the heterozygous state.

Recessive allele: An allele whose phenotypic effect or trait is not expressed in a heterozygous state.

Incomplete dominance: The case where a heterozygote expresses a phenotype intermediate between the corresponding homozygote phenotypes.

Complementation test: A test of gene function where two genotypes with recessive alleles are combined by a cross to test whether the genotype of one parent can supply the function absent in the genotype of the other parent.

F1: First generation produced by interbreeding of two lines.

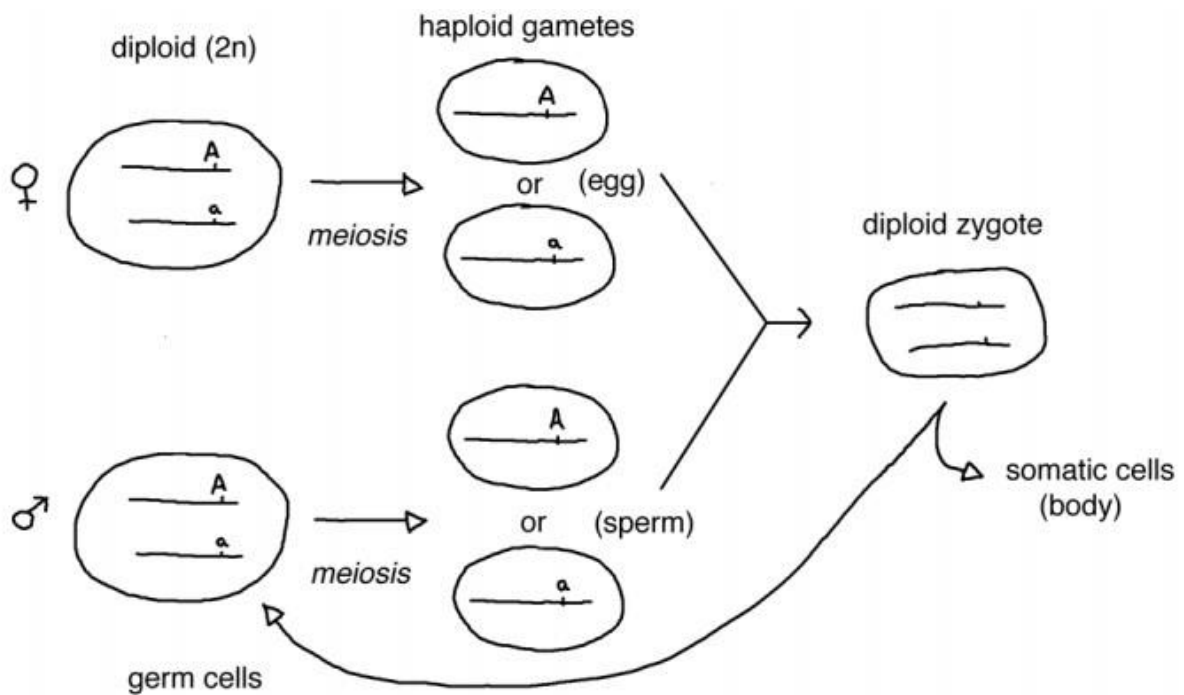
F2: Generation produced by interbreeding of F1 individuals.

Incomplete penetrance: Cases where certain alleles are not always expressed to give observable traits because of other environmental or genetic influences.

True-breeding: Refers to a line of individuals that on intercrossing always produce individuals of the same phenotype. This can almost always be taken to mean that the individuals are homozygous

Lecture 3

Now let's consider diploid organisms:



The genotype of the zygote will depend on which alleles are carried in the gametes.

Allele in gamete		sperm		
		A	a	
egg	A	A/A	A/a	Zygote
	a	a/A	a/a	

When heterozygotes mate their offspring will have different phenotypes: If A is dominant to a, the two possible phenotypes will be the phenotype of a/a or the phenotype of A/A and A/a.

When we do breeding experiments it is important to know the genotypes of the parents. But as you can see from the example above individuals with the dominant trait could be either A/A or A/a. A method to control this type of variation is to start with populations that we know to be homozygous. One way to do this is to keep inbreeding individuals until all crosses among related individuals always produce identical offspring. This is known as a true-breeding population and all individuals can be assumed to be homozygous.

True Breeding: homozygous for all genes

Say we have a true breeding line of shibire flies these flies are paralyzed and have genotype shi⁻/shi⁻.

First, we can test to see whether the shibire allele is dominant or recessive.

shi⁻/shi⁻ x (wild type) shi⁺/shi⁺ → all are shi⁻/shi⁺

(The offspring from a cross of two true breeding lines is known as the F1 or first filial generation). The F1 flies appear like wild type therefore **shi⁻** is recessive (not expressed in heterozygote)

Say we have isolated a new paralyzed mutant that we call **par**.

We start with a true breeding **par⁻** strain that we mate to wild type. We find that the mutation is not expressed in the F1 heterozygotes and therefore is recessive.

To find out whether **par⁻** is the same as **shi⁻** we can do a complementation test since both mutations are recessive. For this test, we cross a true breeding **par⁻** strain to a true breeding **shi⁻** strain.

par⁻/par⁻ x shi⁻/shi⁻ → F1 (these flies must inherit both shi⁻ and par⁻)

Possible outcome	Complementation?	Explanation	Inferred genotype
F1 not paralyzed	shi ⁻ and par ⁻ complement	par ⁻ genotype can supply function missing in shi ⁻ and vice versa	par ⁻ /par ⁺ shi ⁺ /shi ⁻
F1 paralyzed	shi ⁻ and par ⁻ do not complement	par ⁻ has lost function needed to restore shi	shi ⁻ /shi ⁻

Let's look more carefully at gene segregation in a cross between F1 flies

shi⁻/shi⁺ x shi⁻/shi⁺

What is the probability of a paralyzed fly in the next (F2) generation?

Definition:

$$p(a) = \frac{n_a}{N} \quad n_a = \text{number of outcomes that satisfy condition } a$$

$$N = \text{total number of outcomes (of equal probability)}$$

Probability problems can be solved by accounting for every outcome, but usually it is easier to combine probabilities.

p(paralyzed F2 fly) = p(inherit shi⁻ from mother and inherit shi⁻ from father)

Product rule: p(a and b) = p(a) x p(b)

(note the product rule only applies if a and b are independent which is the case here since the allele from mother does not affect the allele from the father)

$$p(\text{shi- from mother}) = \frac{1}{2}$$

$$p(\text{paralyzed}) = \frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$$

$$p(\text{not paralyzed}) = 1 - \frac{1}{4} = \frac{3}{4}$$

Thus in the F2 generation the phenotypic ratio will be, 1 paralyzed : 3 not paralyzed

A 1 : 3 phenotypic ratio among the F2 in a breeding experiment shows that alleles of a single gene are segregating.

This actually constitutes a third definition of a gene. Historically, this was the first definition of the gene developed by Gregor Mendel in the 1860s. Mendel was able to detect single genes segregating in pea plants because he looked at simple traits and started with true-breeding strains.

Let's see how these ideas can be applied to a very interesting problem in the evolution of corn. Domestic corn is derived from wild progenitor Teosinte. There is no historical record of how the breeding was done to produce Maize but there is a genetic record of the differences between Teosinte and Maize recorded the genomic differences between these two species. Maize and Teosinte can be crossed to give viable progeny.

Teosinte x Maize -> F1 all same and unlike either parent -> F2 50,000 plants ~1/500 look like Teosinte and ~1/500 look like Maize

How many genes contribute to the differences between the two kinds of plants?

Let's designate the genes that differ as A, B, C, D ...

For each gene there are two alleles: the allele present in Teosinte and the allele present in Maize.

For the A gene we will designate these alleles AT and AM respectively. For the B gene there will be alleles BT and BM and so on for all the genes that differ.

Let's follow the A gene through the cross between Maize and Teosinte

$$AT/AT \times AM/AM$$

$$F1 : AT/AM$$

Because the F1 don't look like either parent, let's assume that the alleles are codominant.

Codominant: heterozygote different than either homozygote.

Incomplete dominance: heterozygote expresses the traits of both homozygous parents. (Alternatively, the genes that differ could have a mixture of dominant and recessive alleles).

F₂: **A_T/A_T** **A_T/A_M** **A_M/A_M**
 1 : 2 : 1

1/4 will look like Teosinte.

For two genes that differ:

AT/AT BT/BT $1/4 \times 1/4 = 1/16$ will look like Teosinte.

Similarly, for three genes the probability will be $1/64$. For four genes it will be $1/256$, and for five genes it will be $1/1024$.

Since $\sim 1/500$ look like Teosinte the conclusion is that 4–5 genes differ between wild corn (Teosinte) and domestic corn (Maize). Using modern methods, it has been confirmed that there are about five significantly different alleles and several of these have been located using mapping methods.

4 Lecture

From the last lecture, we followed gene segregation in a cross of a true breeding shibire fly with a wild type fly.

Shibire x wild type $\rightarrow$ F₁: all not paralyzed $\rightarrow$ F₂: 3 not paralyzed : 1 paralyzed

This is the segregation pattern expected for a single gene. But in an actual experiment how do we know that the phenotypic ratio is really 3 : 1 ?

There is no logical way to prove that we have a 3 :1 ratio. Nevertheless, we can think of an alternative hypothesis then show that the alternative hypothesis does not fit the data. Usually, we then adopt the simplest hypothesis that still fits the data.

A possible alternative hypothesis is that recessive mutations in two different genes are needed to get a paralyzed fly.

In this case a true breeding paralyzed fly would have genotype: a/a , b/b

Whereas wild type would have genotype: A/A , B/B

F₁: A/a B/b not paralyzed

F2: $p(a/a \text{ and } b/b) = (1/4)^2 = 1/16$
 $p(a/a \text{ and } B/-) = 1/4 \times 3/4 = 3/16$
 $p(b/b \text{ and } A/-) = 3/16$ $p(A/- \text{ and } B/-) = \text{the rest} = 9/16$

This is the classic ratio for two gene segregation 9 : 3 : 3 : 1 (paralyzed)

For our hypothesis we should see a phenotypic ratio of 15 not paralyzed : 1 paralyzed.

Therefore, to distinguish one-gene segregation from two-gene segregation we need a statistical test to distinguish 3 : 1 from 15 : 1. Intuitively, we know that in order to get statistical significance, we need to look at a sufficient number of individuals.

For a **chi-square test** you start with a specific hypothesis that gives a precise expectation. The test is then applied to the actual experimental results and will give the probability of obtaining the results under the hypothesis. The test is useful for ruling out hypotheses that would be very unlikely to give the actual results.

Say we look at 16 flies in the F2 and observe 14 not paralyzed and 2 paralyzed flies.

Under the hypothesis of two genes we expect 15 not paralyzed flies and 1 paralyzed fly.

We calculate the value χ^2 using the formula below. Where O is the number of individuals observed in each class and E is the number of individuals expected for each class.

$$\chi^2 = \sum_{(\text{all classes})} \frac{(O-E)^2}{E} = \frac{1^2}{15} + \frac{1^2}{1} = 0.067 + 1 = 1.067$$

degrees of freedom (df) = number of classes – 1

From the table using 1 df, $0.05 < p < 0.5$

The convention we use is that $p \leq 0.05$ constitutes a deviation from expectation that is significant enough to reject the hypothesis. Therefore, on the basis of this sample of 16 flies we can't rule out the hypothesis that two genes are required. Say we look at 64 F2 flies and find that 12 are paralyzed. For the hypothesis of two genes the expectation is that 4 would be paralyzed. The χ^2 for this data:

$$\chi^2 = \frac{8^2}{60} + \frac{8^2}{4} = 1.07 + 16 = 17.1$$

From the table $p < 0.005$ so we reject the two-gene hypothesis.

Let's use this data to test the hypothesis of one gene segregation which would be expected to give 16 paralyzed flies from 64 F2 flies,

$$\chi^2 = \frac{4^2}{48} + \frac{4^2}{16} = 0.33 + 1 = 1.33$$

From the table using 1 df, $0.5 < p < 0.5$. Thus the data still fits the hypothesis of onegene segregation.

So far, the hypothesis that one gene is responsible for the paralyzed trait is the simplest explanation that fits the data.

The way to distinguish most easily between a heterozygote and a homozygote expressing a dominant trait is to cross to a homozygous recessive test strain.

Test cross: cross to homozygote recessive:

A/Ax a/a gives all A/a. i.e. all offspring will express the dominant trait.

A/a x a/a gives 1/2 A/a and 1/2 a/a. i.e. one half of the offspring will express the dominant trait.

Mendelian inheritance in humans

For humans we can't do test crosses, of course, but by following inheritance of a trait for several generations the modes of inheritance can usually be identified by applying basic principles of Mendel. The following are guidelines for identifying different modes of inheritance in pedigrees.

Autosomal dominant

- ☐ Affected individuals must have at least one affected parent

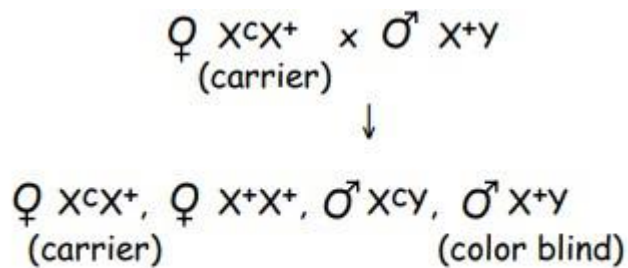
Exceptions to this rule will occur if a new mutation arises in one of the parents (in real life a more likely explanation is extramarital paternity). Another possibility is incomplete penetrance, where other genetic or environmental factors prevent the trait from being expressed in one of the parents.

Autosomal recessive

- When both parents are carriers, on average 1/4 of the children will be affected.
- When both parents are affected, then all of the children will be affected.

- If the trait is very rare then consanguinity is likely. That is, it is likely that parents of affected children are themselves related (e.g. cousins).

X-linked inheritance



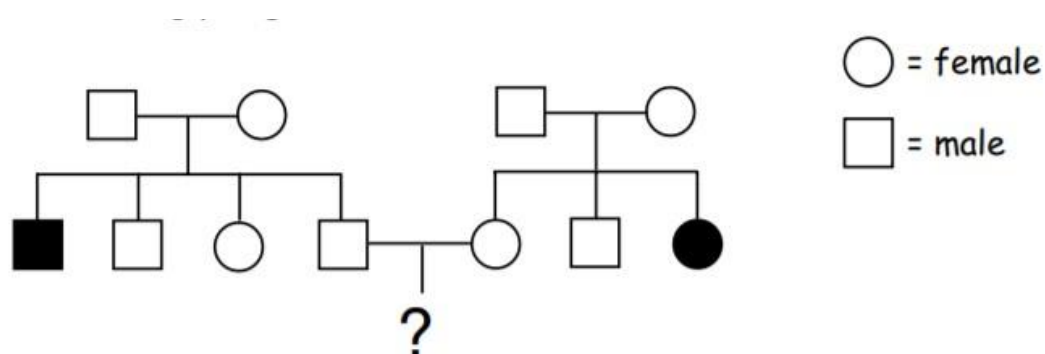
- When parents are a carrier O(F) and an unaffected O(M) , then on average, 1/2 of the daughters will be carriers and 1/2 of the sons will be affected.

If the trait is rare then the vast majority of affected individuals will be male which is the hallmark of X-linked traits.

- Affected sons inherit the allele from mother
 - o Maternal uncles often affected
 - o Since inherited only from mother, inbreeding doesn't increase the probability of an affected O(M) .

Conditional probabilities

Consider the following pedigree of a recessive trait.



$p(\text{affected child}) =$

- $p(\text{mother carrier and father carrier and affected child})$
- $2/3 \times 2/3 \times 1/4 = 1/9$

However, if they have a child that is affected we must reassess the probability that their next child will be affected.

$$p(\text{both parents carriers}) = 1. \text{ So, } p(\text{next child affected}) = \frac{1}{4}$$

This example shows how probability calculations are based on information. The probability changes not because the parents have changed but because our information about them has.

HANDBOOK for PROBABILITY CALCULATIONS

Many problems in diploid genetics rely on basic concepts of probability. This is because each individual inherits at random only one of two possible copies of a gene from each parent. Thus, breeding experiments or inheritance in human pedigrees have probabilistic rather than absolute outcomes. Everyone has an intuitive sense of probability but what we need is a precise definition that will allow probabilities to be manipulated quantitatively.

Probabilities are usually defined in terms of possible outcomes of a trial. A trial could be the toss of a coin, the roll of a die, or two parents having a child. If we define a specific event a , $p(a)$ or the probability of a , can be defined as follows: after a very large number of trials, $p(a)$ is simply the fraction of trials that give outcome a . In principle, we could determine $p(a)$ by actually performing a large number of trials and directly measuring the fraction of trials that produce event a . This is sometimes called the “Monte Carlo method” named after a famous European casino and works well for computer simulations of complicated phenomena. However, in many cases there is a much simpler way to calculate probabilities. To directly calculate classical probabilities one must know enough about a process to break down the possible outcomes of a trial into some number of equally probable events. In these cases the probability of event a is:

$$p(a) = n_a / N$$

where n_a is the number of outcomes that satisfy the criteria for a and N is the total number of equally probable outcomes. Note that since N includes all possible outcomes, $n_a \leq N$ and $0 \leq p(a) \leq 1$.

Example: A couple has two children, what is the probability that they are both girls? Assuming that the chances of having a boy or a girl are equal, there are 4 equally probable ways of having two children (boy, boy; girl, boy; boy, girl; girl, girl) and the probability of two girls is $1/4$ or 0.25.

For classical probability problems you will always be able to arrive at the correct answer by writing out all of the possible outcomes of a trial and counting the fraction of outcomes that satisfy the criteria for a given event. Often, enumerating all of the outcomes for a trial is timeconsuming and error-prone. It is usually faster and easier to break a problem down into simple parts and then to combine the probabilities for the individual parts. The following are useful ways that probabilities can be combined to speed probability calculations.

PRODUCT RULE

$p(a \text{ and } b) = p(a) \times p(b)$ if a and b are independent.

Two events are considered independent if they do not influence one another. The criterion of independence is very important — application of the product rule for events that are not independent will give an incorrect answer.

Examples: To find the probability that a couple with three children have three boys we first note that the sex of one child has no influence on the sex of another and therefore constitute independent events. For each child, $p(\text{boy}) = 1/2$ and by the product rule $p(3 \text{ boys}) = 1/2 \times 1/2 \times 1/2 = 1/8$.

First, for a recessive trait to be expressed the progeny must inherit the recessive allele from both the mother and the father. Since the probability of inheriting a given allele from a heterozygote is $1/2$, $p(\text{mutant from mother and mutant from father}) = 1/2 \times 1/2 = 1/4$. Second, since unlinked genes are inherited independently, we can use the product rule again to calculate $p(\text{recessives at gene A and recessives at gene B}) = 1/4 \times 1/4 = 1/16$.

SUM RULE

The probability that either a or b will occur can be written as $p(a \text{ or } b)$. If two events a and b cannot both occur they are mutually exclusive and the number of events that satisfy a or b is $n_a + n_b$. It should be apparent from our definition of probability that:

$$p(a \text{ or } b) = \frac{n_a + n_b}{N} = \frac{n_a}{N} + \frac{n_b}{N} = p(a) + p(b)$$

A useful special case of the sum rule arises when we consider $p(\text{not } a)$. By definition $p(a)$ and $p(\text{not } a)$ are mutually exclusive and they encompass all possible outcomes. Thus:

$$p(a \text{ or not } a) = 1 = p(a) + p(\text{not } a) \text{ and } p(\text{not } a) = 1 - p(a)$$

Examples: Find the probability that a family with three children has at least one girl. We begin by noting that instead of trying to count all possible families with at least one girl it is easier to realize that $p(\text{at least one girl})$ is the same as $p(\text{not all boys})$. Since $p(\text{all boys}) = 1/8$, $p(\text{not all boys}) = 1 - 1/8 = 7/8 = p(\text{at least one girl})$.

In a cross where both parents are heterozygous for recessive mutations in two unlinked genes, what is the probability that one of their progeny will express at least one of the dominant traits? $p(\text{at least one dominant}) = 1 - p(\text{both recessive})$, and from above, $p(\text{both recessive}) = 1/16$. Therefore $p(\text{at least one dominant}) = 1 - 1/16 = 15/16$.

In cases where two events a and b are independent but not mutually exclusive, we can still calculate $p(a \text{ or } b)$. In this case we note that the two events a and $(b \text{ and not } a)$ are mutually

exclusive and encompass all outcomes that satisfy a or b or both. For these mutually exclusive events we can apply the sum rule. Thus,

$$p(a \text{ or } b) = p(a \text{ or } [b \text{ and not } a]) = p(a) + p(b \text{ and not } a)$$

Since b and not a are independent:

$$p(a) + p(b \text{ and not } a) = p(a) + p(b) \times p(\text{not } a) = p(a) + p(b) \times [1 - p(a)] = p(a) + p(b) - [p(a) \times p(b)]$$

Note that in the case where a and b are mutually exclusive, $p(a) \times p(b) = 0$ giving the same formula as for the sum rule.

Example: We can use this formula as another way to solve the last example, which is a case in which the two events are independent but not mutually exclusive. $p(\text{at least one dominant}) = p(\text{dominant at gene A or dominant at gene B}) = p(\text{dominant at gene A}) + p(\text{dominant at gene B}) - [p(\text{dominant at gene A}) \times p(\text{dominant at gene B})] = 3/4 + 3/4 - [3/4 \times 3/4] = 6/4 - 9/16 = 15/16$.

Lecture 5

Until now our analysis of genes has focused on gene function as determined by phenotype differences brought about by different alleles or by a direct test of function – the complementation test.

For the next lectures our analysis will be concerned with the tests of gene position starting with the position of genes on chromosomes and finally mapping point mutations at the resolution of single nucleotide pairs.

We've taken it for granted that genes reside on chromosomes, but how do we know this? Let's review the properties of gene segregation.

Consider two different traits.

$$A/A, B/B \times a/a, b/b$$

The gametes from one parent will be A, B and from the other parent a, b

These gametes will then give an F1 generation of all A/a, B/b

Crosses between F1 individuals will give an F2 generation with a 9 : 3 : 3 : 1 phenotypic ratio as shown before.

A better way to look at segregation is by a test cross of the F1 heterozygote to a homozygous recessive individual.

$$A/a, B/b \times a/a, b/b$$

The possible gamete genotypes from the F1 will be:

A, b (recomb.) a, b (parental) A, B (parental) a, B (recomb.)

The corresponding genotypes of the offspring in the testcross will be:

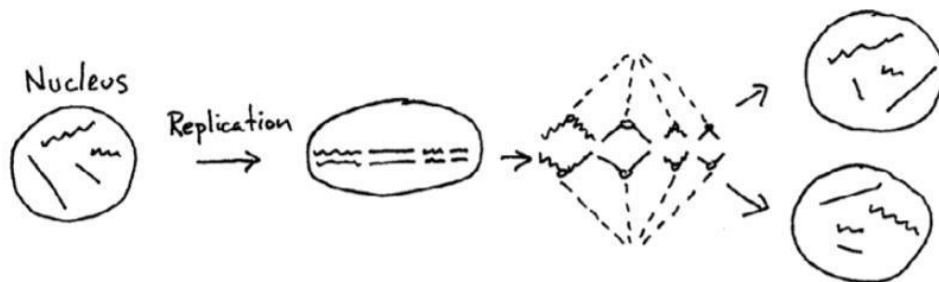
$A/a, b/b$ $a/a, b/b$ $A/a, B/b$ $a/a, B/b$

Each offspring receives either one or the other parental allele: **gene segregation**.

For most gene pairs, the frequency of each of the four classes of gametes is the same indicating that the two genes segregate independently: **independent assortment**.

At the turn of the century microscopes allowed people to watch chromosomes in the nuclei of dividing cells. (human cells, for example, contain 46 chromosomes).

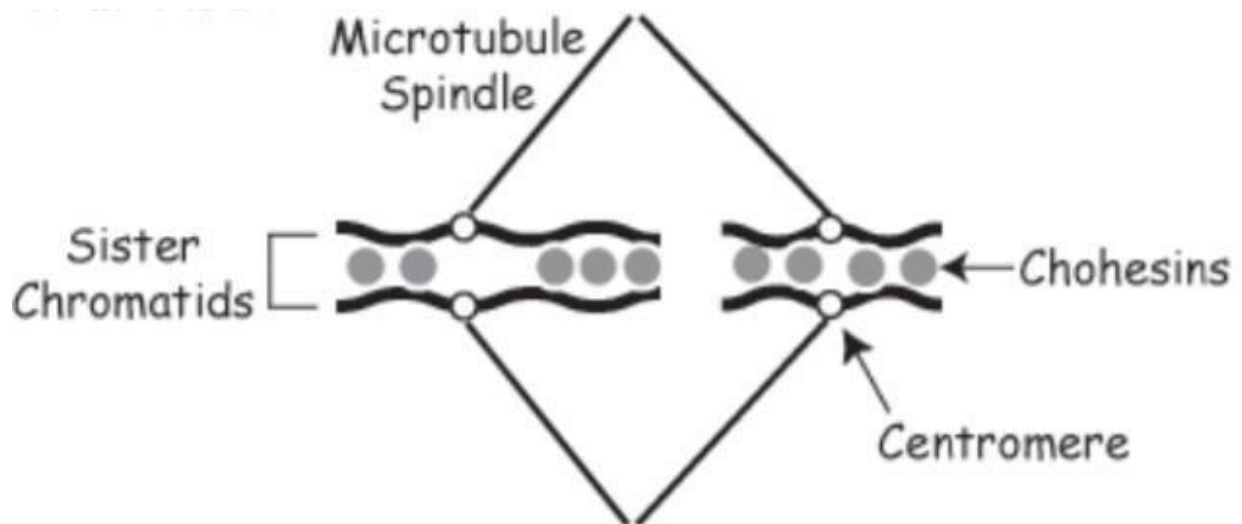
The chromosomes in dividing somatic cells go through **Mitosis**:



The net result of mitosis is to distribute a replica of each chromosome into the two daughter cells.

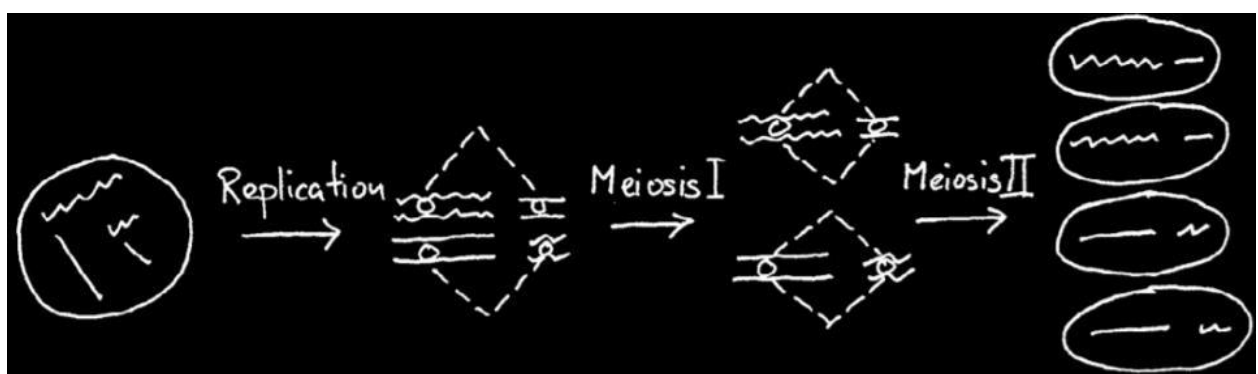
The stages of mitosis are as follows:

- Interphase. Interphase. DNA replication
- **Prophase**. Prophase. Chromosomes condense and centromeres attach to microtubule spindle
- **Metaphase**. Metaphase. Chromosomes align
- **Anaphase**. Anaphase. Sister chromatids move apart
- **Telophase**. Telophase. Nuclei reform



The cell has evolved a simple mechanical mechanism to insure that after mitosis each daughter cell has received exactly one copy of each chromosome. (Failure of proper chromosome segregation is known as **nondisjunction**). The steps in the mechanism are as follows: 1) After DNA replication two daughter chromosomes known as sister chromatids are held together by special proteins known as cohesins. 2) As chromosomes align in metaphase microtubule spindles attach to centromeres on each chromatid. 3) Once all of the chromatids are attached to spindles a protease known as separase becomes active (Actually unattached chromatids produce a signal to keep separase inactive and only when every chromatid pair is under tension generated by spindles pulling in opposite directions is the inhibitory signal turned off.) 4) Finally, active separase cleaves the cohesin proteins detaching sister chromatids and allowing them to be pulled apart by the spindle to be distributed to different daughter cells.

Cells in production of germ cells such as pollen undergo a very different kind of division, Meiosis **Meiosis**.



Meiosis differs from mitosis in two fundamental respects: 1) in meiosis there are two rounds of chromosome segregation for one round of synthesis so each germ cell receives only one of the two homologous chromosomes and 2) in meiosis the homologs pair with one another then move to opposite poles.

Chromosomes behave in meiosis the same way that Mendel showed genes to behave.

Each germ cell receives only one of the two homologs, a behavior that is analogous to gene segregation.

The relative alignment of chromosomes is arbitrary which is analogous to independent assortment of genes.

What was needed to show that genes are on chromosomes was a chromosome that could be identified in the microscope and that carried an allele for a trait that could also be followed. The proof for chromosome theory would then depend on correlating the segregation of the trait with segregation of the chromosome.

T.H. Morgan proved chromosome theory in 1910 using *Drosophila*.

Flies normally have brick-red eyes. The first white-eyed mutant was found by Morgan's wife, Lillian, who worked in the lab.

white O(M) x red O(F) (wild type) → F1: all red → F2: 3 red : 1 white (but only males)

Thus, the white mutation behaves like a recessive allele, but there was something unusual about the white mutation because only the male flies in the F2 have white eyes.

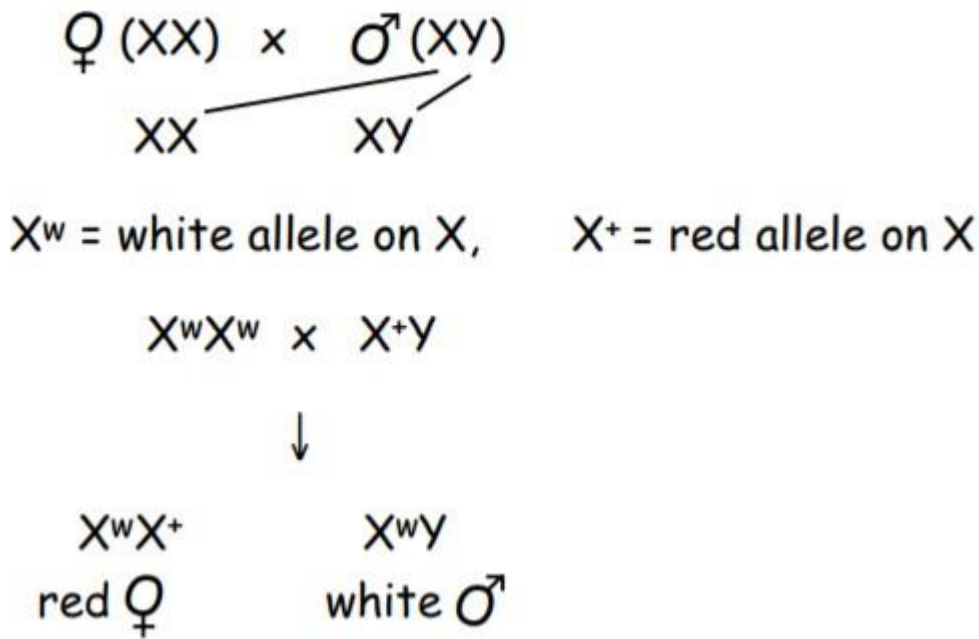
white O(M) x red O(F) (heterozygote from F1) → 1 red : 1 white

In this case equal numbers of males and females have white eyes. Again this is consistent with white being a recessive trait. The most informative cross is the reciprocal of the first cross.

white O(F) x red O(M) (wild type) ↓ red O(F) , white O(M)

Ignoring the sex of the flies, it looks as if a wild type is heterozygous: the wild type O allele is always passed on to the daughters and the white allele is passed on to sons.

The explanation is that eye color gene is on the sex determining chromosome X. Males only have one copy of the X chromosome and daughters always get one copy of the X from the mother and one copy from the father.



Thus, the trait for red eyes is always inherited along with the X chromosome from the father. The absence of red (giving white eyes) always goes with the Y chromosome.

6 Lecture

When we talk about gene position the term **locus** is used to designate the chromosomal location of a gene.

What we are going to do is to map genes relative to one another. To begin, we need two genes on the same chromosome. Last lecture we saw how you could tell whether a gene is on the X chromosome by how alleles of the gene are inherited differently by males and females.

Consider two mutations on the X chromosome of *Drosophila*; crossveinless and white eye.

Genotype	Phenotype
Xcv+w+Y	wild type
Xcv- w+Y	crossveinless wings
Xcv+w- Y	white eye

Xcv-w+Yx Xcv+w-Xcv+w- (true breeding)

All of the daughters from this cross will have two different X-chromosomes, which differ at two loci: Xcv+w-Xcv-w+

We want to follow these X chromosomes into the next generation so after a cross we look at male flies.

parental classes: Xcv+w-Y (crossveinless, white) and Xcv-w+Y (wild type)

crossover classes: Xcv-w-Y (crossveinless, white) and Xcv+w+Y (wild type)

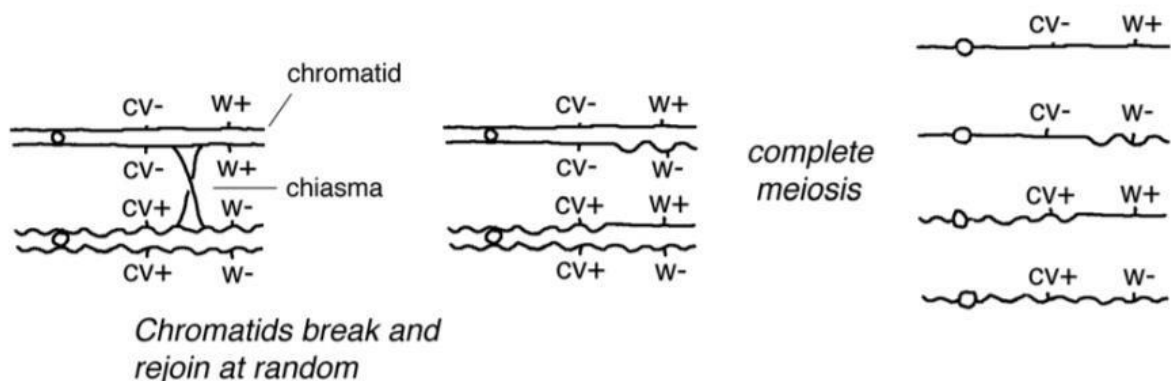
In the crossover classes the alleles appear to have separated and moved from one X to the other. Genes on the same chromosome often do not assort independently. Such behavior is known as Linkage **Linkage**.

unlinked — crossover classes appear at same frequency as parental classes. (Note that traits that show independent assortment are unlinked)

weakly linked — crossover classes appear often but less often than parental classes.

tightly linked — crossover classes appear rarely or never.

To see what's really going on we need to look at the chromatids in prophase of meiosis in the mother.



Crossovers between homologous chromosomes occur more or less at random during meiosis. To give you a rough idea of how frequent these crossovers are, in several different well studied organisms (Yeast, Drosophila, and humans) there is about one crossover per chromosome arm per meiosis. The geneticist uses these random crossovers as a tool to measure distance. Distance can be obtained because crossovers between two points that are close together will rarely occur whereas crossovers between points that are far apart will occur frequently.

Definition of genetic distance:

map distance (m.u. or cM) = $100 \times \text{crossover gametes} / \text{total gametes}$

$$\text{♀ } \frac{cv^- W^+}{CV^+ w^-} \times \text{♂} \quad (\text{Note new notation})$$

(In order to detect both dominant and recessive alleles, we look at males only)

cv- W+	430	CV+w-	450	cv- w-	52	
CV+W+						68

Number of crossover gametes = 120

Total gametes = 1,000

Distance = $100 \times \frac{120}{1000} = 12 \text{ cM}$

It is important to note that once a map distance between two genetic markers has been established this distance can be used to calculate the expected numbers of each type of progeny. For example, if you know that two mutations are 12 cM apart then you should expect that 6% of the progeny from a cross will be of each of recombinant class.

Things get interesting when we make several pairwise crosses between genes on the same chromosome.

We can use this data to construct a **Genetic Map**

Genetic maps have the following properties:

- ☐ Distance is proportional to frequency of crossover classes (this approximation actually only holds for short distances of <20 cM)
- Distances are approximately additive: mapped points fall on a line.
- Maps are internally consistent and concise.

(The first genetic map was constructed in 1911 by Alfred Sturtevant when he was a sophomore student in Morgan's lab)

It is important to remember that genetic distances are measured using a property of meiosis (genetic recombination) that varies from one organism to another. The relationship between genetic distance and actual physical distance can be summarized in this way:

Genetic distance = physical distance x recombination rate

The actual relationship between genetic distance in cM and physical distance in base pairs (bp) depends on the recombination rate and is different for different organisms

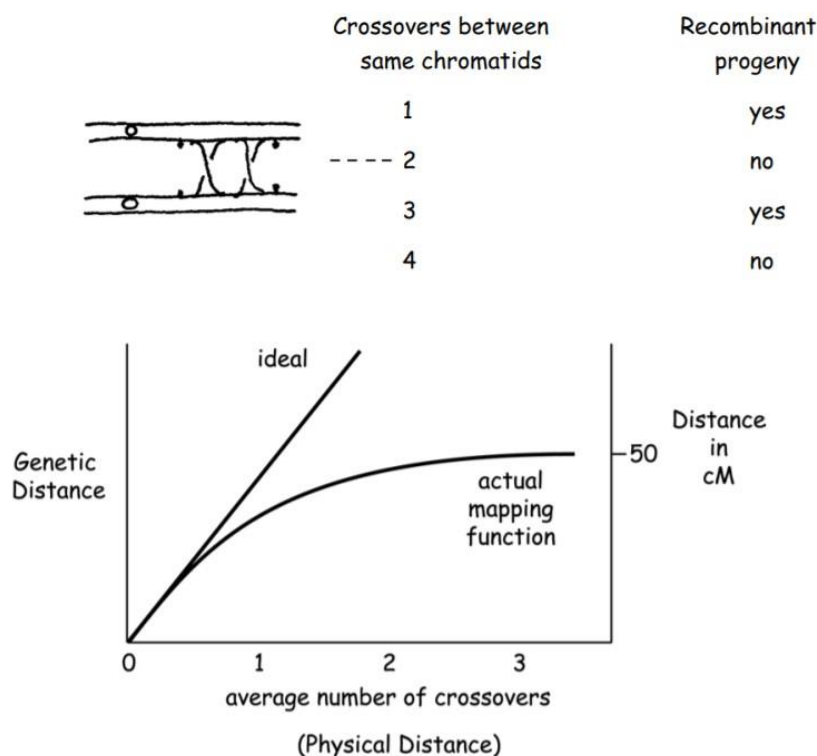
For example: Human: 1.3 cM/Mbp Yeast: 360 cM/Mbp

Sometimes recombination rates in the male and female of a species are different. In *Drosophila* there is no recombination in the male so the genetic distance between markers on the same chromosome are always zero when examined by meiosis in the male. In humans the recombination rate (and therefore map distances) in the female are twice that of the male.

Another issue that often causes confusion concerns the map distances of genes that are far apart on the same chromosome.

The physical length of a genetic interval is proportional to the frequency of crossovers that occur in that interval during meiosis but in a cross we are not actually counting crossovers rather we are counting the number of recombinant progeny that are produced.

The number of recombinants provide a good approximation of distance for short intervals but as the interval length increases, multiple crossovers are possible making the relationship between frequency of recombinants and crossovers not linear.



If the measured distance in a cross is statistically indistinguishable from 50 cM then we say that the genes are unlinked. But this doesn't mean that distances greater than 50 cM can not be obtained. By adding intervals, longer distances that are meaningful can be obtained. For example, if all the intervals between linked genes in the human genome are added together the total length of the genome (in males) is 2,500 cM.

Exam V. Configuration: Easy

Statement	Answer
In 1956, Watson and Crick deduced that the structure of DNA was a double helix.	False
Genes are typically 10 ³ – 10 ⁴ base pairs in size although they can be much larger.	True
A mutation is an altered version of a gene when we have “witnessed” the alteration but not when it is preexisting in the population.	True
Alleles refers to different versions of different genes	False
Yeast, a very useful organism for genetic study, is more properly known as “ <i>Saccharomyces cerevisiae</i> ”.	True
Homozygous is the condition of having two different alleles in a diploid.	False
The genotype of a zygote will depend on which alleles are carried in the gametes.	True
Breeding experiments or inheritance in human pedigrees have probabilistic rather than absolute outcomes	True
Genes on the same chromosome often do not assort independently. Such behavior is known as “incomplete dominance”.	False
When we talk about gene position the term “locus” is used to designate the chromosomal location of a gene.	True

Exam V. Configuration: Difficult

Statement	Answer
Regarding yeast, haploid cells of different mating type when mixed together will mate to make a diploid cell.	True
“Incomplete penetrance” refers to cases where certain alleles are not always expressed to give observable traits because of other environmental or genetic influences	True
The way to distinguish most easily between a heterozygote and a homozygote expressing a dominant trait is to cross to a homozygous dominant test strain.	False
“True-breeding” refers to a line of individuals that on intercrossing always produce individuals of the same phenotype	True
The modes of inheritance in humans can usually be identified by doing test crosses.	False
Using the phenotypic difference between wild type and a recessive allele we can use a “complementation test” to determine whether two different recessive alleles are in the same gene.	True
Regarding the autosomal dominant mode of inheritance of a trait, affected individuals must have at least one affected parent, except if a new mutation occurs in one of the parents, or if incomplete penetrance occur in one of the parents.	True
Regarding the autosomal recessive mode of inheritances, if a trait is very rare, it means that it is impossible that parents of affected individual are themselves related (e.g. cousins).	False
Failure of proper chromosome segregation during cell division is known as “independent assortment”.	False
One of the properties of genetic maps is that distances are approximately additive (mapped points fall on a line).	True