

## An ICT-based learning activity on the subject of "Pathogenomics"

The proposed activity, built as an internet site, will expose you to a new approach to research into pathogenic (disease-causing) organisms. This approach, called "Pathogenomics", is based on the recently acquired knowledge of the full genetic codes ("**genomes**") of Man and pathogenic microorganisms.

Infectious diseases are a worldwide problem. Living as we do, in a global village, the transmission of diseases from place to place occurs at great speed.

Recently, research on the classification and analysis of genetic components in human beings and in various microorganisms has contributed to a better understanding of the interaction between the host cell (Man) and microorganisms, as well as of the immune response, at both the molecular and physiological levels.

### **To the learner**

This activity will raise your awareness of the importance of current research on the genomics of pathogenic microorganisms:

**New means for diagnosing the causes** of diseases (or for identifying pathogens) are developed

**New vaccines** against pathogenic microorganisms are developed

**New strategies for the prevention and treatment** of infectious diseases are proposed and examined

### **The structure of the activity**

The home page offers you links to two types of knowledge. *In the upper section, links in yellow rectangles* refer to basic knowledge about the nature of diseases, pathogenic microorganisms and existing methods of defense against infectious diseases.

*Links in the bottom part* of the page will send you to the pathogenomic approach to the diagnosis, prevention and treatment of four infectious diseases.

For each disease, we offer you two main pathways through the activity:

#### **A short pathway,**

*which will give you a concise summary* of the main points of current knowledge concerning some infectious diseases. This summary includes the following topics:

- ✓ Why the disease represents a threatening "problem"
- ✓ The main symptoms of the disease
- ✓ What causes the disease
- ✓ The existing treatment(s)
- ✓ Why the existing treatment is not satisfactory
- ✓ The pathogenomic approach to the treatment of the disease

#### **The full pathway:**

To obtain more in-depth knowledge about any of the diseases or their treatment (explanations, animations, figures, articles, etc.), simply click on the blue links that you will find at all stages of the summary.

Even if you are not very interested in the detailed knowledge, it is worth taking a trip through the "full pathway", because you will find a variety of animations, internet simulations and virtual laboratories which may help you better understand some difficult scientific concepts.

At the end of the day, you will find that science provides Man with powerful tools in his fight against infectious diseases, and that in spite of the acute danger presented by such diseases, hope is constantly arising from new scientific research. Despite the many roadblocks, investing resources in scientific research could lead us to victory in our war against these diseases.

This activity allows you to learn alone, or in a group with a teacher. The teacher will find pedagogical considerations in this manual (see links "To the teacher").

To the teacher

The students are presented with a series of common diseases which are caused by various types of pathogens. Research into those microorganisms and the genetic means of coping with them will be discussed.

The following diseases were selected because each of them represents an authentic and current world health problem, with economic, social and environmental ramifications:

**Bacterial food poisoning**, caused by *Salmonella*, *Escherichia coli*

**Fungal epithelial diseases**, caused by the fungi *Candida albicans* and *Aspergillus fumigatus*

**Flesh-eating bacteria**, caused by group A *Streptococcus*

**Anthrax**, caused by *Bacillus anthracis*

With each disease studied, the activity emphasizes different aspects:

"Bacterial food poisoning" places emphasis on the development of new drugs based on pathogenomic research.

"Fungal epithelial diseases" also shows how new drugs are developed on the basis of genomic knowledge.

"Flesh-eating bacteria" highlights the development of vaccines based on genomic knowledge of the host.

"Anthrax", one step ahead, shows the development of genetic immunization against an infectious disease.

Each particular disease **brings to light different aspects** of Pathogenomics research. However, each subunit on a specific disease is modular, and all subunits deal with the main principles of Pathogenomics research. It is therefore not necessary to teach them all.

Objectives of the activity

The main objective of the proposed activity is to provide information about the diseases, and about efficient means of defending against them.

The key word is "Hope".

The objectives of the activity include scientific knowledge, the development of attitudes towards the relationships between science, technology and society, and the development of relevant cognitive skills.

Scientific Knowledge

- ✓ The clinical characteristics of diseases and their implications
- ✓ The connection between genetic code and the synthesis of specific proteins when disease is present
- ✓ The connection between the genomic sequencing of pathogens and the development of efficient means of defense
- ✓ The nature of research which will bring hope to Man in his battle against diseases

The relationships between Science, Technology and Society, and Students' Attitudes

- ✓ Political-social considerations in allocating resources for research, with an emphasis on factors that affect decision-making with respect to multidisciplinary public issues, such as economic, political and health considerations
- ✓ The power and limitations of Science in solving human problems

The main aim of the activity is to encourage the students to develop proper attitudes toward science. Young people should realize that in today's modern world, scientific knowledge must become public knowledge, as an essential tool for coping with public (social, political, economic) problems, and the *skills* needed to use that knowledge must become an essential part of the cultural baggage of citizens in the modern world.

Cognitive Skills

The activity will give the students an opportunity to gain experience in the use of cognitive skills related to inquiry and decision-making on public issues.

Objectives referring to information-management skills will depend on the tendency of the learner to use, or of the teacher to enhance the use of, the internet facilities which are built into the activity.

**Structure of the activity**

See the section "To the learner" above.

In addition, it should be stressed that the **basic scientific knowledge** needed to deal with the problems is accessible (by means of appropriate links) to the students, at all stages of the *entire* activity. The relevant menus appear on the screen during all parts of the activity.

This will allow the students, at every stage of the activity, to focus on topics which interest them, and to refresh, complete or improve their knowledge of scientific concepts.

Another important characteristic of the activity is the number of links to external sources of information. These sources may be used according to the learner's inclinations and learning style, or to the teacher's strategy.

**The recommended teaching-learning strategy**

Since this computerized activity is built as an internet site, with a great number of links, there is practically no limit to the time that an independent and motivated student can invest in his/her studies.

Nevertheless, this activity was designed as an enrichment program for 9<sup>th</sup>- or 10<sup>th</sup>-grade students, consisting, ideally, of about 10-12 teaching/learning hours. It is recommended that about 2-3 hours be dedicated to each disease and about 2-4 hours to the basic knowledge (yellow rectangles on the home page), depending on the desired level of knowledge (depth, and details). For students who have not been previously exposed to the subjects of genetics, microorganisms and the immune system, the amount of time necessary to learn about these topics may vary.

The activity is modular, which allows the teaching-learning process to be adapted to the personal preferences and teaching styles of the teachers and even the students.

However, it should be clear that the challenge of this activity is somewhat awkward: teaching abstract subjects to a population which may lack some or all of the necessary basic scientific knowledge. The activity therefore endeavors to make the scientific domain relevant to the students: internet links lead the students to authentic sources of information (e.g., newspaper articles), which refer to current "real-life" problems. It also illustrates abstract concepts, in order to make them tangible, concrete, by means of a variety of animations, simulations on the internet, and virtual laboratories.

However, it should be remembered that the learning of concepts is an active process. The students *must be actively involved* in building their own concepts. They must be given the opportunity to ask relevant questions, to check their answers to those questions, to clarify their perceptions of the meaning of new (to them) or existing concepts, to make actual use of their newly acquired knowledge. This approach should induce significant learning of scientific concepts, with the students building meaningful connections between new concepts and those that they are already familiar with (webs of meaning). The students should therefore work in pairs in front of the computer, so as to enable discussions and deliberations during the learning activity. In addition, if group discussions are possible in the classroom setting, the students are expected to interact with their peers by proposing clearly formulated—often written—ideas, opinions and perceptions, and in turn, responding to their peers' suggestions.

The best opportunities for the students to use scientific knowledge in relevant and meaningful contexts are found during discussions about *suggested decisions* concerning the solutions to authentic problems. This is why the teacher will find many ready-to-use decision-making exercises, based on scientific knowledge and referring to health, economic, or political considerations. These exercises also present opportunities to develop proper attitudes and cognitive skills.

Finally, it should be reiterated that the **teaching strategy needs to emphasize "hope"** rather than "dangers and fears".

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