Educational Biotechnology: teaching and developing for the future

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ABSTRACT

Biotechnology is an important area that hugely contributes to the society - from the transgenic plants that may feed millions (eg. Bt corn), to the engineered and/or cloned molecules to fight against people diseases (eg. recombinant insulin). Currently Biotechnology area is divided into subareas accordingly to topics (eg. Health) and colors (eg. red). However, most articles and homepages do not mention or recognize the importance of the educational approach of the biotechnological themes as well as the educational/orange biotechnology subarea. Due to the importance of Biotechnology, we need not only to recruit new brains to work on it but we also inform widely and correctly the society about it. In this work we reinforced the need of the recognition of the educational/orange biotechnology subarea by describing three different strategies to spread and teach about Biotechnology including: a) addition of educational/orange biotechnology definition in Wikipedia in different languages, b) organization of open events with sign language interpreters for deaf and blind-deaf people, and c) development of a strategy to catch young brains to biotechnology area in a Brazilian public schools stimulating their option for biotechnology careers.

Keywords: Educational Biotechnology, Teaching, Special needs, deaf

1. INTRODUCTION

Although biotechnological processes are used by humankind since 6,00 BC, the term "*Biotechnology*" was created only in 1919 by Karl Ereky to define the interaction between biology and human technology [1].

Classical biotechnology included the production of food (eg. wine, vinegar, bread and cheese) from living beings and was practiced by different ancient peoples such as Babylonians, Sumerians, Greeks and Egyptians . However, the discovery of DNA and transfer genetic material techniques using organisms initiated a new biotechnology stage known as "modern biotechnology". This event hugely stimulated the research in this area and helped society even more [1-2].

In the 21st century, biotechnology has become one of the key technologies multidisciplinary research areas involving the use of different contents from several sciences to develop a process and/or product. Due to the increased expansion and complexity of biotechnology research and products, in 2009 the Biotechnology Institute from Maryland University proposed the classification of biotechnology by colors to facilitate the identification of its research lines and subareas[3].

Among the biotechnology subareas, four are the most cited in scientific papers: (1) Green Biotechnology, also known as agricultural biotechnology, being an area with large data in recent years with the biotech development applied to the Agriculture (*e.g.* Transgenic crops) (2) Red Biotechnology that includes health-related products and applications, using organisms or molecules (*e.g.* antibodies and vaccines); (3) White Biotechnology, which is related with industrial applications and environment (eg. biofuels); (4) Blue biotechnology, involving aquatic resource applications, such as the use of marine or freshwater tissues, cells or molecular components [4].

Orange biotechnology or educational biotechnology is related to spreading the news and contents about this area to the society. It develops multi and interdisciplinary materials and educational strategies about these contents (eg. production of recombinant protein) accessible to the whole society [4-6]. This activity should include people with special needs such as those with hearing and/or visual impairment [6-8]. It also seeks to encourage, identify and attract people with scientific vocation and high abilities/ giftedness for biotechnological research and entrepreneurship [9-10].

In this work we reinforced the need of the recognition of the educational/orange biotechnology subarea by describing three different strategies to spread and teach about orange Biotechnology including: a) the addition of educational/orange biotechnology definition in Wikipedia, the free online encyclopedia that is extensively consulted by the whole world in different languages (Russian, Portuguese, Spanish, Greek, French, Arab, Chinese, Italian), b) the organization of public and free events with the presence of sign language interpreters to propagate the biotechnology concepts for deaf and blind-deaf people, and c) the development of a strategy to catch young brains to biotechnology area in a Brazilian public schools.

2. METHODOLOGY

We added the educational/orange biotechnology definition in Wikipedia, the free online encyclopedia that is extensively consulted by the whole world. We added the information in different languages (Russian, Portuguese, Spanish, Greek, French, Arab, Chinese, Italian) by opening an account and adding the concepts on it.

The events to spread Biotechnologies themes among other scientific contents to society, especially for deaf people, were performed annually by inviting different speakers. In order to increase their interest to these events we also included American (Dr. Donna Jo Napoli from Warthmore College) and Brazilian (Dr. Lodenir Karnopp) researchers from sign language linguistic area.

The advisory of a boy student from elementary education was performed by a specialized researcher in genetic and biotechnology contents. The Process of advisory has been closely followed by a psychology specialized in high skills/gifted children.

3. RESULTS AND DISCUSSION

The addition of educational/orange biotechnology definition in Wikipedia, the free online encyclopedia, in different languages (Russian, Portuguese, Spanish, Greek, French, Arab, Chinese, Italian) was performed as described in methodology section and will be useful to spread this important subarea. We also added the content in English and German languages but we are still waiting for the release of the information online (Figure 1).

Figure 1: Examples of the orange/educational Biotechnology definition added on Wikipedia in different languages that are now found in GOOGLE search.

PORTUGUESE

Biotecnologia laranja ou educacional: tem como objetivo disseminar a biotecnologia e a formação nesta área. Ela desenvolve materiais e estratégias educacionais para dar acesso as informações sobre temas de biotecnologia (ex: desenho de organismos produtores de antibióticos) para a sociedade como um todo, incluindo pessoas com deficiências (ex: visual e/ou auditiva). Ela ainda busca estimular, identificar e atrair pessoas com vocação científica e altas habilidades/ superdotação para a área de biotecnologia

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	A biolecnologia lam aplicações em grandes áreas industriais, incluir utilização de organismos para o desenvolvimento de produtos (Exer- relacionado muitos vezes ao tema abordado, como por exemplo:					
	Biotecnología vermelha: é a que tem relação com a cor do sangu antibióticos cumolóculas importantes como a insutina, e a engenhar			desenho de organismos o	apases de j	noduc
	Biotecnología acual ou marinha: tendría a cor do mar e tem sido us moléculas em algas marinhas para o tratamento de doenças como a		nhas e aquáticas da bioleco	nologia, como a busca e io	teraticação	d0
	Eleterología verde ou agrícola: tem a cor da maiona das planta creacem em ambientes específicos, na presença (ou auxilincia) de baixa agressão ao meio anteinte e ao ser-furnano, quando compa expressar um pesticola nátural, entando a necessadare os apricaçã	rodatos químicos tem como objetivo rada a agricultura industrial tradicioni	roduzir soluções para as q	uestões apricolas mais sa	dentiveis e	
	Outro exemplo é o uso de enzinas como catalisadores industriais p	Biotecnología branca ou industral: é a biotecnología aplicada a processo industriani. Um exemplo é a concepção de um organismo para producir um produla químico d Carlo exemplo é a suo de unitamia como calabilizadoras la biotantiana para productiva con destrute produtor químico de comunitor mesos mucrosos do que em processos materialmas al labelos para product have handantas.				£1.
	Biotecnelogía Guno ou Biointomática é um campo interdisciplinar dados biológicos em um cumo periódo de tempo. O campo pode tar organizar a informação associada a moléculas envolvendo a genôm termacéatico.	ibém ser referido como biología comp	utacional e pretende, aplica	ando técnicas informáticas	compreend	
	Biotecnologia latenția cu educacional tem como objetivo disemin acceso as intornações sobre temas de todecnologia (ez: desento- denicências (ex: visual e/ou auditiva). Ela alinda busca estimular, ide biotecnologia.	de organismos produtores de antibión	cos) para a sociedade com	o um todo, incluíndo pesso	las com	dar
	O investmento e produção econômica de todos esses tipos de bete	icnologia é denominado como "bioec	nona".			

FRENCH

« Biotechnologie oranges» (d'intérêt Pédagogique, vise à diffuser la biotechnologie et développe du matériel éducatif et des stratégies sur les questions de biotechnologie (par exemple production de protéine recombinante) pour la société y compris les personnes ayant des

besoins particuliers tels que ceux ayant une déficience auditive et/ou visuelle. I vise à encourager, identifier et attirer les gens à vocation scientifique et hautes compétences/capacités pour la biotechnologie.

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ErROS Kardi Latina Limburga	Depuis le milieu des années 1900, le domaine de la transgenèse est le plus médi dans les domaines des nanotechnologies et de la bio-informatique et des Nanobi composés, ou de biomoticules, avec de nouveaux risques sanitaires, environnen	rechnologies qui pour	at par exemple permettre une t	sbrication programmée de nano ou micro			
Linkwig	En Europe ³ , des industriels et certains laboratoires ont proposé de classer les bi	technologies en catég	ories "colonées" :				
Lahielio Mongowora Barstonio	« « Biotechnologies vertes » (climbrit agricole), « « Biotechnologies rouges » (climbrit middc al)						
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ulek Portugulis Románá Prozenil	Alleurs on classe les biotechs en catégories plus explicites : « neathcare biotech Les techniques basées sur la transgènèse sont devenues la base des biotechnol but premier la création de nouveaux procluis d'intérêt commerciaux, par :			de décryptage des génomes, avec pour			

GREEK

Βιοτεχνολογία πορτοκαλί (εκπαιδευτικά βιοτεχνολογία) εφαρμόζεται για τη διάδοση της βιοτεχνολογίας και της κατάρτισης στον τομέα αυτό. Αναπτύσσει πολυεπιστημονική και διεπιστημονική υλικών και εκπαιδευτικών στρατηγικών που αφορούν θέματα βιοτεχνολογίας (π.χ.. Παραγωγή ανασυνδυασμένης πρωτεΐνης) προσβάσιμα σε ολόκληρη την κοινωνία, συμπεριλαμβανομένων των ατόμων με ειδικές ανάγκες, όπως τα άτομα με προβλήματα ακοής ή/και διαταραχές της όρασης. Επιδιώκει επίσης να ενθαρρύνει, να εντοπίσει και να προσελκύσει ανθρώπους με επιστημονικό προσανατολισμό και υψηλές ικανότητες/χαρισματικότητα για τη βιοτεχνολογία.

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	εφοριόζητα για τη δάδοτα της βατηχολογίας και της κατάρτατης στον τομία κατό. Ακαπτώτετα πολικητοπημοικό και διαποτημοικό, είνωμα και ακποδιτοπικών στρατηγικών που αφοριό Κάματα βατηχολογίας (τ. β., Παργωγή ανασλυλοαμίνης τρωτιέλης) προφβατιρα οι ελλολογή τηι καινούε, συμπερλαφβασιφίων πων ατόμων με εδικές ανόριας, όπων τα άνταμα με αναθυλαίατα αυδιά (τ. αι διατορικάτι τό συστολογιαζίας)			

The event so called *International Meeting of Biological Biotechnological and Health Sciences* for all communities including deaf people (Figure 2) as well as the specialized Sign Language event named *Signs in Focus* (Foguren 3) are described on Facebook and in http://ndpisuff.wixsite.com/ sinaisemfoco, respectively.

Figure 2: Description of *International Meeting of Biological Biotechnological and Health Sciences* event on Facebook with specialists including in Sign language also using double interpreters (English to Portuguese and Portuguese to Sign language) to allow accessibility for deaf people to English lectures.



The spreading of Biotechnologies themes among other scientific and humanities contents for deaf people was performed by using Sign language interpreters including for deaf-blind people in the Sign in focus event (Figure 3).

Figure 3: Homepage of *Sign in Focus* event (http://ndpisuff.wixsite.com/sinaisemfoco) with specialists in Sign language and Biotechnology (Right) that offered interpreters for deaf blind people (Left).



The final strategy to catch young brains to biotechnology area in a Brazilian public schools was successful and a young kid of 9 years old is now enrolled in a scientific career in The Postgraduate program of Science and Biotechnology (PPBI) of Fluminense Federal University (Figure 4). Figure 4: Presentation of the young boy of 9 years old about his research work produced together with the geneticistbiotechnological specialized advisor in PPBI Workshop.



4. CONCLUSIONS

The recognition and incentive of the Biotechnology educational subarea mayl help to create new and better strategies to spread and teach biotechnology, such as those reported in this work. This subarea may, improve not only human resources formation but also products and processes production, which consequently might improve the future of our society

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