English in Digital Agriculture: A Textbook for Students of Digital Agriculture

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Tihomir Živić

Osijek, November, 2023

English in Digital Agriculture

A TEXTBOOK

for students

of Digital Agriculture

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English in Digital Agriculture

A Textbook for Students of Digital Agriculture

Published by
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English in Digital Agriculture

A TEXTBOOK FOR STUDENTS OF DIGITAL AGRICULTURE

[Published by the Faculty of Agrobiotechnical Sciences Osijek]

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Preface

This textbook is designed for students of English in Digital Agriculture, an English-language course in a field that explores the application of digital technologies to agricultural production and management. It is the first textbook of its kind in Croatia, and it covers the current developments and trends in digital agriculture in five interesting, authentic units.

The first unit introduces the pros and cons of the concept of virtual business communities and how they enable collaboration and innovation among various stakeholders in the agricultural sector. The second unit focuses on the communication between different actors who may have diverse values, interests, and perspectives on agricultural issues. The third unit examines the role of computer-mediated communication, or information and communications technology (ICT), in facilitating information exchange, decision-making, and problem-solving in digital agriculture. The fourth unit presents a vision of modern farming that is based on Agriculture 5.0, a paradigm that integrates artificial intelligence (AI), robotics, big data, cloud computing, and the Internet of Things (IoT) into smart and sustainable agricultural systems. The fifth unit explores the manipulation of living organisms, or agricultural biotechnology, and its implications for food security, quality, and safety.

The textbook adopts a modern approach to English for specific purposes (ESP) that aims to help students acquire both professional vocabulary and necessary grammar skills. It embraces modern "edtech" that enhances the learning experience and outcomes too. The textbook has thirty figures and three tables that illustrate key concepts and data; in addition, three of these photorealistic images are indeed created by OpenAI's *DALL-E*, version 2—that is, by a text-to-image model. Also, the textbook features bookmarks hyperlinked to a glossary that defines important terms and an ample bibliography that enables follow-up student research. Moreover, the textbook relies on embedded QR codes that link to video clips that provide a fuller situational insight and a realistic immersion in the professional American English contexts.

It is thus hoped that this textbook will inspire students to learn more about digital agriculture and its potential to transform the agricultural sector in Croatia and beyond.

Acknowledgments

This textbook is the result of many years of research, teaching, and collaboration in the field of English language learning and teaching and its applications to digital agriculture. I would like to express my sincere gratitude to all the people who have contributed to this project in various ways.

First and foremost, I would like to thank my associates, the faculty of the Graduate Study Program in Digital Agriculture, for their invaluable insights, feedback, and support throughout the writing process. They are not only excellent scholars and colleagues, but also great friends who have shared with me their passion and enthusiasm for digital agriculture and English education. They have also contributed to the development of the innovative pedagogical framework and the engaging activities that are presented in this book.

I am also deeply indebted to the reviewers of this textbook, who have provided constructive and helpful comments that have improved the quality and clarity of the manuscript. Their expertise and suggestions have been instrumental in shaping the final version of this book. I would like to especially thank Dr. Zdenko Lončarić and Dr. Antonija Šarić for their thorough and insightful reviews. I would like to express my sincere gratitude to Dr. Ivana Varga, who served as the Editor of this e-book. Her proficiency, guidance, and feedback were invaluable for shaping the content, structure, and quality of this work. I also appreciate the meticulous and professional work of Dr. Jadranka Zlomislić, who performed the copyediting of this e-book. She ensured that the language, style, and formatting were consistent and clear throughout the chapters. Without their contributions, this e-book would not have been possible.

I would also like to acknowledge the generous support of the Digital Research Infrastructure for the Arts and Humanities in the Republic of Croatia (DARIAH-HR). The DARIAH has been a key partner in advancing the research and innovation in digital humanities and its implications for language education. This project would not have been possible without their technical assistance.

Last but not least, I would like to thank my family and friends for their love, patience, and encouragement throughout this endeavor. They have been my source of inspiration and motivation, and I dedicate this book to them. They have always supported me in pursuing my academic goals and interests, and they have made many sacrifices along the way. I am truly grateful for having them in my life.

Lesson 1

Virtual Business Community

Weigh the pros and cons of working in a virtual environment.

PRE-READING ACTIVITY

Discussion

1. What is implied under the notion of a "virtual business community"?
2. Have you ever participated in a virtual meeting?
3. What team communications tools have you used?
4. Who was responsible for digital transformation (DX) in your company, an agile team, a chief executive officer (CEO), or a chief transformation officer (CTO)?
5. How do you actually function, being brought up short by a compulsory DX?
6. How are you getting on and how do you communicate in a virtual team?

COMPREHENSION

A Foci

digital communications platform — a software solution (e.g., *Google Workspace*, *Microsoft 365*, or *Zoom*) that facilitates external and internal messaging while offering customer communications functionality, file sharing, and project management and utilizing channels (e.g., phone, task management, team messaging and videoconferencing)

team communications tool — a proofing software or a tool used for document collaboration (e.g., *Office 365*), file sharing (e.g., *OneDrive*), project management, real-time chat (e.g., *Microsoft Teams*) and voice and videoconferencing (e.g., *Skype* or *Zoom*) operational on various platforms (e.g., on *Android* devices, *iOS*, *macOS*, web or *Windows*)

B Peruse the article, take a look at the new words and phrases, and then respond to the questions below it.

Fig. 1.1. Girts Ragelis. *Beautiful Young Woman* . . . . 4 Apr. 2020. *Shutterstock*, www.shutterstock.com/image-photo/riga-latvia-april-04-2020-beautiful-1702587238.

A Forced Digitalization

In recent years, **working from home** (WFH) has become an option selected by both employers and employees with increasing frequency. Research suggests that 1.87 billion people (i.e., more than forty percent of the working population in general or more than seventy-five percent of the working population in the developed countries) were working from home by the year 2022 (Luk). There are many advantages of such work and savings are sizeable, but solitude and isolation have been revealed as its basic deficiencies.

Consequently, *Amazon* sets up initial and occasional face-to-face meetings for its **global virtual team** (GVT) having more than 790,000 employees via videoconferences, high-quality communications technology (*Amazon Chime*), trainings and informal **virtual socializations** (virtual breakfast and virtual happy hour) to sustain group cohesion and encourage socialization. These problems have been intensified, and hence many individuals are looking for answers as to how to keep the business going and how to maintain communication.

The COVID-19 pandemic has brought a budgetary change and has packed us off to our own homes, so we have become yet another nation in a series of those working from home. We have moved our offices and working environment to new virtual premises. Those whose nature of the business permits it are online. Classes are taught online at all levels of education, employment is online, and the e-passes are issued online. In government service, different documentation circulates online, and entire processes have been digitalized and accelerated. This has happened at the time of digitalization, which made it possible for many things to occur more or less normally. Teamwork success is influenced by many factors, among which a prominent position is occupied by communication (i.e., by communication quality within the team).

Specificities of a Virtual Team

To achieve effective **virtual team communication**, the same rules apply as for the traditional teams, respecting certain specificities. These specificities are reflected in team members' preparedness (i.e., in their knowledge of work with selected tools and in their sense of connection and mutual trust). A sense of isolation and solitude is a common occurrence when working from home. Fear and anguish in these times of COVID-19 infection make the current situation even more stressful. Research by Sigal Barsade and colleagues (147) indicates that "employees' emotions affect not only their health and engagement but also business productivity of both small companies and large corporations as well" (Poropat Darrer). Therefore, it is important to arm oneself with patience, positive approach, and openness to the innovative technologies and the acquisition of new knowledge and skills.

April Reed and Linda Knight take the view that the risks of operation in a virtual team generally increase by comparison with traditional teams ("Project Risk Differences" 19). Peter Northouse points out that it is more important to first focus on team relationship building in

virtual teams because even the small troubles in that area may distort the conducting of the tasks (*Leadership* 3). The operation in virtual teams requires a clearer structure, definition of objectives, and division of roles.

Platforms and Tools

Multiple user-friendly **communications platforms and software** are available to virtual teams for the management of project tasks (e.g., *Microsoft Teams* and currently the most popular *Zoom*). The stock value of Zoom Video Communications, Inc., the company that launched the latter application, has climbed by 130% since the beginning of the corona crisis. As regards the choice of tools, the experts recommend that they be chosen according to the level of complexity of the tasks that lie ahead of virtual teams. The more complex a task is, the higher the need to communicate as similarly as possible to a live situation. Thus, the platforms having video call and screen sharing functions are chosen, and the choice of a specific tool depends on team needs. We should bear in mind, however, that effective communication does not depend on the sophistication of tools we use, but on the team's capacity to use the tool to its full potential (Kashyap; Pickell).

Virtual Coffee

Space distance and a lack of live interaction—all those encounters in the corridor, by the coffee machines, before and after the meetings, when we actually bond together in semiformal situations and maintain a bond—are major barriers to habitual social dynamics and cohesion within the teams. Jeremy Lurey and Mahesh Raisinghani analyzed the best virtual team solutions, on the basis of which they suggested an increase in the number of phone calls and videoconferences ("Empirical Study"). It is important to stay connected even following the completion of work, over virtual coffee, as the saying goes these days.

Rhetorical authenticity crystallized as a new element in confidence building between the teams. Research by Stanford lecturer Matt Abrahams indicates that it is in fact authenticity which is the crucial factor in ten percent of the best orators, and it makes them 1.3 times more authentic than the average. Authenticity is evident in the passion, energy, enthusiasm and cordiality an orator shows when conversing. Confidence is instilled upon empathy and appreciation of diversity. In order to encourage confidence building between the team members, the information requested

should be provided urgently, solutions to any problems run into by the team should be suggested, and an affirmative tone in communication should be maintained.

Nonverbal Messages

The absence of nonverbal communication in a confidence-building equation within the team impairs the performance of communication. Nonverbal cues accompany verbal messages and add power to them. A **verbal message** transmits content, and a **nonverbal message** conveys a view and attitude toward that content. It is therefore important to include precisely this dimension in a new paradigm of virtual team communication. Studies have shown that we intuitively trust nonverbal cues more than the very contents in the marginal situations. Of all the nonverbal cues, we highlight in particular the voice and the tone of voice as a tool that plays an important communication role.

The leaders of successful virtual teams take particular account of handling communication within a virtual team. Communication should be guided and transparent. Expectations should be clearly and unambiguously outlined to the team members regarding their roles in the team. **Road maps** featuring information and deadlines may be elaborated, as appropriate. The team members should preferably keep written records about the progress they make in a project task. For a team leader to ensure optimal efficiency, the team should be educated on how to use the selected virtual tools and procedures and on how to observe communications protocol in a timely manner.

Enhancing Connectivity

According to Mara Banović and Irena Miljković Krečar ("Analiza"), managers should pay most attention to ensuring high-quality communication in order to increase team productivity. This implies planning and construction of a clear communications network, whereby the network represents an information flow within a virtual team. Furthermore, all team members should be made duly aware of mandatory channels of communication and improve relations of members within a team in order to make the information circulate in an undisturbed manner.

Banović and Miljković Krečar add that the teams in which the information travels faster, in an undisturbed manner, and according to the clearly established rules are also estimated to be much more effective than

the teams in which this aspect is problematic since the way of information flow in them is not clearly defined. The authors continue as follows:

> Nemogućnost da pravovremeno provjere važne elemente svojega posla, zatraže savjet ili dobiju povratnu informaciju produljuje vrijeme rada na zadatku i/ili potencira veći broj propusta i pogrešaka u radu.
>
> An inability to check the essential elements of their job, seek advice, or receive feedback in good time prolongs the period of work on an assignment and/or potentiates an increasing number of failures and errors in operation. ("Analiza" 203; my trans.)

Likewise, it is appropriate to set out rules on communication in a team, set the feedback time, and provide assistance, which helps to strengthen confidence and affiliation to the team. As noted, this plays a key role in achieving effective communication. Although we operate using various **information technologies** (ITs), we are not robots, so let us retain the characteristics that make us human and maintain interconnectivity.

Note: The examples are adapted from Jagoda Poropat Darrer's "Virtualni timovi — Nisam robot, moram komunicirati s ljudima" (*Lider*, 22 Apr. 2020, lider.media/sto-i-kako/virtualni-timovi-nisam-robot-moram-komunicirati-s-ljudima-131052).

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Lesson 2

icebreaker game	an exercise that prompts conversations from participants
road map	a detailed plan guiding progress toward a goal
virtual breakfast	a free, live online meeting that usually runs 7:00 a.m.–7:30 a.m. via digital communications platform, with presentations on timely topics
virtual happy hour	an online social event held over video meeting platforms that includes drinks and icebreaker games and usually runs 5:00 p.m.–7:00 p.m.

Note: The definitions are adapted from "Virtual Happy Hour Ideas, Games, and Activities for Coworkers" (*TeamBuilding*, 1 Aug. 2022, teambuilding.com/blog/virtual-happy-hour) and "Virtual Breakfast" (*Michigan State University*, www.canr.msu.edu/field_crops/virtual-breakfast. Accessed 12 Dec. 2021).

1. How many people were working from home by the year 2022?
2. What team communications tools does *Amazon* use for its GVT?
3. What negative side effects may occur when working from home?
4. Why is it significant to understand employees' emotions in a virtual team?
5. What may distort the conducting of the tasks in a virtual team and how can this be prevented?
6. What user-friendly communications platforms are placed at disposal of a virtual team?
7. Which features of digital communications platforms are valued most highly?
8. What might set up a barrier to habitual social dynamics and cohesion within the teams?

9. Explain the notion of "rhetorical authenticity."

10. What is nonverbal communication?

VOCABULARY

A Gap-Fill Exercise

Find the words and phrases in the text of the article, then fill the gaps.

1. Research suggests that 1.87 b_____ people (i.e., more than forty percent of the working population in general or more than seventy-five percent of the working population in the developed countries) were working from home by the year 2022. (par. 1, line 3)

2. These problems have been intensified, and hence many individuals are looking for answers as to how to keep the business going and how to m_____ c_____. (par. 2, line 8)

3. The C_____ pandemic has brought a budgetary change and has packed us off to our own homes, so we have become yet another nation in a series of those working from home. (par. 3, line 1)

4. To achieve effective v_____ t_____ c_____, the same rules apply as for the traditional teams, respecting certain specificities. (par. 4, line 1)

5. April Reed and Linda Knight take the view that the risks of operation in a virtual team generally increase by comparison with t_____ teams ("Project Risk Differences"). (par. 5, line 3)

6. Multiple user-friendly c_____ p_____ and software are available to virtual teams for the management of project tasks (e.g., *Microsoft Teams* and currently the most popular *Zoom*). (par. 6, line 1)

7. Space distance and a lack of l_____ interaction—all those encounters in the corridor, by the coffee machines, before and after the meetings, when we actually bond together in semiformal situations and maintain a bond—are major barriers to habitual social dynamics and cohesion within the teams. (par. 7, line 1)

8. In order to encourage c_____ b_____ between the team members, the information requested should be provided urgently, solutions to any problems run into by the team should be suggested, and an affirmative tone in communication should be maintained. (par. 8, line 8)

9. A verbal message transmits c_____, and a nonverbal message conveys a view and attitude toward that content. (par. 9, line 4)

10. Likewise, it is appropriate to set out rules on communication in a team, set the f_____ t_____, and provide assistance, which helps to strengthen confidence and affiliation to the team. (par. 13, line 2)

B Matching Exercise

Form lexical collocations, based on the examples identified in the article.

1. budgetary	a) authenticity
2. communication	b) change
3. COVID-19	c) country
4. developed	d) frequency
5. face-to-face	e) infection
6. increase	f) interaction
7. live	g) interconnectivity
8. maintain	h) meeting
9. nonverbal	i) message
10. rhetorical	j) platform
11. virtual	k) population
12. working	l) team

C Antonymy Exercise

Write a contrastive, or opposite, meaning on the line. Use the suggestions on the right to guide your responses.

1. authentic _____
2. high fidelity _____
3. increasing frequency _____
4. online _____
5. openness _____
6. recent years _____
7. sizeable _____
8. solitude _____
9. transparent _____
10. verbal message _____
11. virtual meeting _____
12. working population _____

a) decreasing frequency
b) face-to-face meeting
c) indiscernible
d) low fidelity
e) miniature
f) nonverbal message
g) obstruction
h) offline
i) past years
j) retired population
k) unauthentic

D Phrasal Verbs Exercise

Form phrasal verbs while matching the verbs (1–6) with the prepositions (a–f), then combine each coinage with a definition (i–vi).

1. to bring
2. to come
3. to lock
4. to send; to put
5. to walk
6. to work

a) across; out
b) after
c) on
d) out
e) out
f) through

i) convey; transmit
ii) elaborate
iii) ensure
iv) follow
v) guide
vi) highlight

E Sentence Completion Exercise

Use the phrasal verbs from Exercise D to complete the sentences below.

1. Nonverbal cues _____ verbal messages and add power to them.

2. A verbal message _____ content, and a nonverbal message _____ a view and attitude toward that content.

3. Of all the nonverbal cues, we _____ in particular the voice and the tone of voice as a tool that plays an important communication role.

4. Communication should be _____ and transparent.

5. Road maps featuring information and deadlines may be _____, as appropriate.

6. In order that a team leader _____ optimal efficiency, the team should be educated on how to use the selected virtual tools and procedures and on how to observe communications protocol in a timely manner.

F Video Clip Exercise

1. Scan the Quick Response Code (QR Code) embedded below with your smartphone, then watch the video clip in its entirety.

"Setting Communication Standards for Virtual Teams." *YouTube*, uploaded by Skillsoft, 16 Mar. 2020, www.youtube.com/watch?v=eisfFx20FdI.

Imagine yourself as a member of a multinational virtual team divided into four equal groups at the team's inaugural meeting, and subsequently perform the following, in the form of a self-interview, within a ten-minute timeslot:

- analyze what kindles your enthusiasm about working in such a team (Group 1)
- analyze what could help you relieve your anxiety, practically and psychologically (Group 2)
- analyze what problems might be posed due to an alien culture, spatial distance, or foreign language (Group 3)
- analyze how could you minimize these problems (Group 4)

Discuss your key findings, ideas, and inputs within your group. Summarize the group responses, appoint a group reporter, and make a short oral presentation thereof once the team is reassembled.

2. Based on the results, draft a virtual team's communications road map.

Lesson 1

Communication between Different Actors

Consider how a manager would treat the values that are different from those he or she is used to in his or her own business environment (Radošević 12).

PRE-READING ACTIVITY

Discussion

1. What are intercultural communication and intercultural management occupied with?

2. What influence does culture exert on customer behavior and communications styles, management styles, and professional styles at the international level?

3. Explain the role of development of engineering and technology, globalization, and the media.

4. How does globalization intensify people-to-people contacts and the relations between the countries?

5. Why is it necessary to know and upgrade communications skills to communicate effectively?

6. How does culture govern dynamics and means of intercultural persuasion, marketing communication, and reactions to products and commercial proposals and promotion?

COMPREHENSION

A Foci

intercultural management — management based on the understanding of interaction between diverse cultural elements in order to create a successful business cooperation and successful business relationships

interpersonal communication — a transmission of certain content to the interlocutor and an opinion on the content, interlocutor, and on oneself

B Peruse the article, take a look at the new words and phrases, and then respond to the questions below it.

Fig. 2.1. *Photo-Gallery-16*. 2022. *Cross-Cultural Management*, crossculmgmt.com/wp-content/gallery/ccm-gallery/photo-gallery-16.jpg.

Concept and Definition of Intercultural Communication

Courtland Bovée and John Thill define **intercultural communication** as a process of sending and receiving messages between people who may interpret verbal and nonverbal signals differently. The authors argue that culture influences any attempt to send and receive a message and that one should have a basic knowledge of cultural diversities that are likely to be encountered, and the ways one is supposed to deal with them to communicate effectively (*Suvremena poslovna komunikacija* 65). Communication is a complex process, and circumstances such as different languages, different values, different customs, and the like should be added to the process of intercultural communication. It also includes new challenges (i.e., new knowledge, skills, and attitudes needed for communication to be successful).

The cultures of both interlocutors affect the way we communicate, in particular the verbal and nonverbal communication. It is impossible to separate culture from communication. The meaning of words, the symbolism of gestures, the use of the space and time, the rules of human behavior, along with many other aspects of communication, are defined by culture (Bovée and Thill 64). Intercultural communication relates to establishing communication with the members of other cultures who should agree among each other, despite them not having the same cultural experiences. Today, in an increasingly multicultural society in which we live, intercultural communication is very important. Vesna Bedeković interprets that perception and verbal and nonverbal communication are fundamental aspects of intercultural communication (144n15). **Perception** is construed in the sense of a complex process which allows for a choice and evaluation of those stimuli that affect human senses, whereby beliefs, weltanschauung, and social organization play an important part ("Interkulturalna kompetencija").

Verbal communication is the one which is based upon speech, a language that sets cultures apart most frequently, but particular characteristics of culture are also demonstrated by nonverbal messages, gestures, body movements and mimes, which are very important and by which most messages are relayed too. If nonverbal messages which are characteristic of a respective culture are recognized and interpreted correctly, intercultural communication is considerably facilitated. Intercultural communication is substantial because of integration and openness in society, promotion of democracy, empowerment of civil society and promotion of fundamental human rights.

The Communications Process

Human communication is a complex process, and a message could get lost or misinterpreted. By means of the definition of communication as a process, one may recognize which skills are needed and which skills need to be improved for the success of the business process. Figure 2.2 exemplarily illustrates a process of communication, divided into eight steps.

The book *Business Communication Today*, which in Croatian has been rendered as *Suvremena poslovna komunikacija*, deals with modern **communications tools** preparatory to actual practice of business communication. The contents cover a wide range of topics that are of concern to effective communication and communications in the context of cultural diversities. The authors Bovée and Thill continuously offer practical advice and deal with relevant topics in modern communication, such as use of social networks, blogs, *Twitter,* and other contemporary communications tools in the business environment. Each chapter concludes with exercises and activities that support a particular topic.

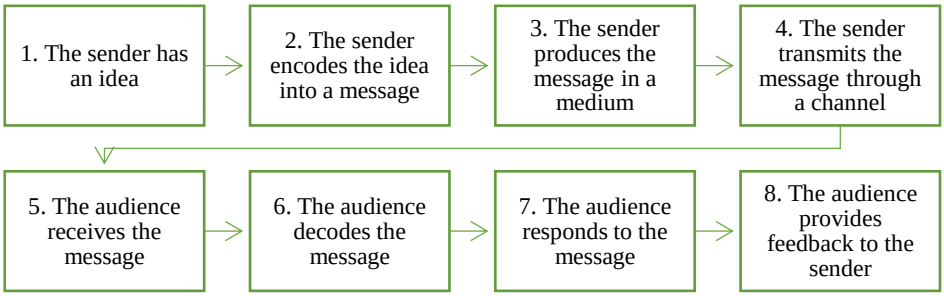

Fig. 2.2. Adapted from: "Slika 1: Komunikacijski proces." *Suvremena poslovna komunikacija*, by Courtland L. Bovée and John V. Thill., Mate, 2013, p. 11.

Communication is getting off to a good start if an idea is clear and concise. The final outcome of communication substantially depends on this step. After an idea is formed, it is encoded into a **message** (i.e., into words, images, or a combination of words and images). Successful encoding of an idea into an effective message is an important communications skill. The selection of the best **transmission medium** for each message (e.g., a written, oral, visual or electronic one) is also an important communication skill to present a message to the **target audience**. In view of an increasing number of media used, new **communications channels** are also made that

may be used for the communication of messages (i.e., for the transmission thereof). The message reaches the intended audience by communications channels, but the arrival at the place of destination does not guarantee a proper understanding of the message because it can be ignored or misinterpreted as noise. The audience needs to get an idea from the message received. If the message is fashioned in a way that shows the advantages of responding to it, the chances of the audience responding are higher. Except for responding or failing to respond to the message, the recipients may also provide **feedback**, facilitating an evaluation of the effectiveness of communication.

Communication is also the process by which a message is transferred from one person to the next via a medium of communication. Communications skills can be represented as cognitive skills. That includes **empathy**, which is the ability to understand another person's feelings while maintaining one's own view, the adoption of social perspectives, cognitive complexity, the number of terms used to describe a situation, a sensitivity to the levels of treatment, the knowledge of the situation and self-monitoring, along with the behavioral skills such as the involvement in interaction, interaction management, the flexibility of behavior, listening and social style. For fruitful communication, particular importance is placed on the following communications skills: nonverbal communication, successful listening, the ability to control stress in crisis situations and the recognition and understanding of one's own emotions.

Types of Communication

There are multiple breakdowns of the types of communication (e.g., verbal, paraverbal, and nonverbal communication; voice or oral communication; written communication; intentional and unintentional communication; and direct and indirect communication). **Verbal communication** is a transmission of information by words (i.e., by speech). The feelings, views, ideas, convictions, and instructions are conveyed by verbal communication, consisting of speaking and listening. The performance of verbal communication depends on the entity which transmits the information and on the entity which receives the information. **Nonverbal communication** is "a way in which people communicate without using words, intentionally or unintentionally" (Radošević 16). In nonverbal communication, the nonverbal cues such as facial expression, tone of voice, movement, body position, look, gesture and touch are used. Appearance, apparel, odor, and the distance of the place we occupy in

space also come under nonverbal communication. A verbal message is primarily sent by voice, but the voice also serves as a means of nonverbal communication. In **paraverbal communication**, the tone of voice, accelerated speech and a slow-moving flow of words, the accentuation of certain words, the inserted pauses and the raising of the pitch of voice are used for performing the functions of nonverbal communication.

Having pioneered research in **body language**, Albert Mehrabian discovered in the 1950s that "an overall impression of a message is seven percent verbal (i.e., just words), thirty-eight percent vocal, including the voice timber, voice modulation, and other sounds, and fifty-five percent nonverbal" ("Neverbalna komunikacija"). Mehrabian found evidence that our emotions, sympathies, or dislikes directed at the people with whom we come in contact are formed on the basis of uttered words, on the basis of voice or the way they were said, whereby intonation and rhythm are essential, or on the basis of our facial expressions (Tomašević Lišanin 118–19).

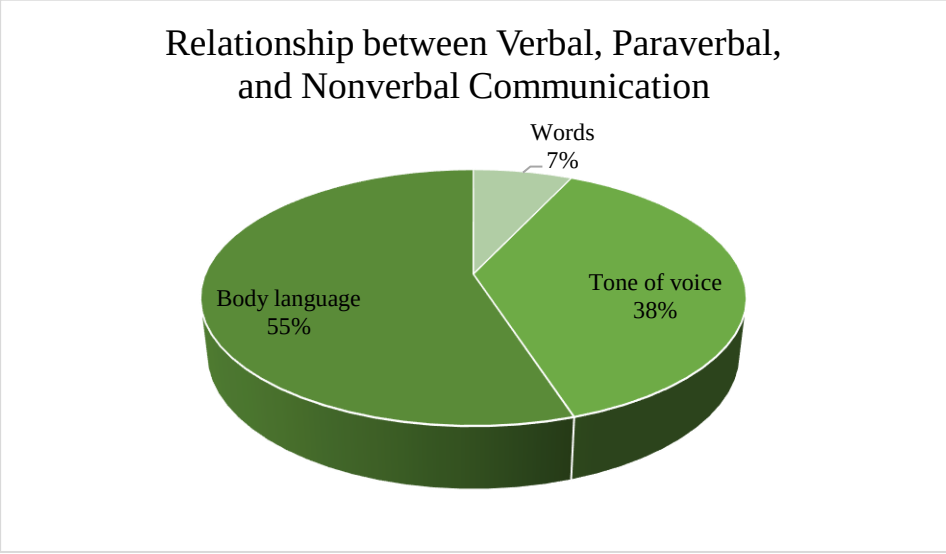

Fig. 2.3. Adapted from: "The Double-Edged Message." *Silent Messages*, by Albert Mehrabian, Wadsworth Publishing, 1971, p. 43.

Verbal communication is considered to better represent the thoughts, emotions, and states, but nonverbal communication is by no means to be undervalued, because it is equal to ninety-three percent of total communication. Nonverbal communication is a discrete but also an immensely powerful way of communicating for those who know to detect and read that kind of message. Alexander Lowen says that no language is

as clear-cut as body language once we learn to read it (99). For that type of communication, body language is particularly significant because it provides an opportunity to learn a lot more about people than they would want us to know. Usually, the persons who succeed in communicating owe their success to the fact that they are able to "read" other people. All people subconsciously read the body language of the person with whom they communicate. Nonverbal communication commonly conveys the emotional components of a message with greater power.

Barriers to Mutual Communication

Because of a host of **communications barriers**, the messages in the channel of communication can be distorted. Noise is all that distorts a message, interferes with communication, or prevents the recipient from receiving the message. It can happen that the message is incomprehensible at the beginning (e.g., when the message is being formed), or a part of the message may be lost during transmission or receiving owing to an incorrect interpretation, insufficient attention, or information overload. All communication contains noise—that is, it is almost impossible to eliminate it altogether—but it can be reduced. Barriers to communication may be grouped as follows:

Noise and disturbances are distracting, and the sources may be personal impediments such as thoughts and feelings, which may prevent focusing on the messages, or a multitasking attempt, which also creates **communications interference**.

It is difficult to get exclusive attention of the audience because it is about competing with other competitive messages which make it to the audience simultaneously, and only the most attractive message can get the attention of the audience.

Messages can be stopped or filtered as a result of human or technical intervention between the sender and the receiver.

> Channel outages may happen, and so a message fails to be conveyed (Bovée and Thill, *Suvremena poslovna komunikacija* 12).

Once a message reaches the target audience by a communications channel, its interpreting depends on how the audience receives and decodes the message. An audience member must sense that the message has come, select it from many messages, and perceive it as a real message. To succeed, the message should be tailored to the audience's expectations as well as to the channels by which the audience expects the messages to come. One of the most important skills in communication is an ability to identify different types of noises and develop ways in which to handle them. Certain types of behavior also raise obstacles to the output from an efficient communications process, particularly with regard to the response and feedback to the originator. In **passive conduct**, an avoidance of expressing one's own opinion and an avoidance of expressing emotion occur in communication (i.e., the auditors do not uphold their interests, advocate their needs, nor represent their rights). Passive conduct will usually be the case because of low self-esteem. In **aggressive behavior**, individuals seek to dominate communication, impose their own opinions, uphold their own interests and advocate their own needs. Aggressive communication is often a symptom of unhealed emotional wounds, a sense of helplessness, and low self-esteem.

According to Larry Samovar and colleagues, the most commonly identified barriers in effective communication are **prejudices** and **stereotypes** (*Komunikacija* 209). Stereotypes occur by generalizing the description of people (e.g., members of a culture). They entail conducts targeted at particular groups of people that are different, little known to the mind of the observer, or similar to what has already been categorized as unacceptable. Stereotypes, however, may not necessarily have negative connotations and can ascribe positive traits to a group of people too.

Frequently, stereotypes are defined as the specific characteristics attributable to people on the basis of their allegiance to a certain group ("Što su to stereotipi"). Stereotypes tell us that there is a common perception of certain groups of people that can be true or false. If we willfully accept a certain stereotype, we may control it, but research suggests that stereotypes are most often inadvertent or automatic. A stereotype may assess the group members positively or negatively. Everyone is predisposed to stereotypes, irrespective of whether they have learned about them during their studies or have accepted them from

examples of everyday life, family's values, media, and positive and negative gossip about a specific group of people. As soon as we meet a member of another culture, the first thing we judge about him or her are the stereotypes, whether positive or negative, which exist and which we have adopted about his or her culture, but when the stereotypes are incorrect, they can be counterproductive, especially in a work environment.

The concept of prejudice is intricately connected with stereotypes. Prejudices relate to a judgment made in advance about people and things that the person does not know enough. Prejudices and stereotypes may be intricately linked, so differences are worth pointing out. Prejudices are a hostile or negative attitude toward an identifiable group of people based exclusively on their membership in the group. Thus, prejudices against individual characteristics or a victim's behavior may go unnoticed, and these biases may be ignored. When, on the other hand, stereotypes, or generalizations, are perpetuated about a group of people, identical characteristics may be attributable to them, irrespective of the actual differences between the members. Prejudices may affect the person's self-esteem, almost always defame racial and sex characteristics, religious qualifications, political features and many other characteristics of an individual, and are a very common source of confrontation.

Except for prejudices and stereotypes, concepts which define relations and attitudes of individuals toward different persons may also pose an obstacle to intercultural communication, as follows:

- **ethnocentrism** or aggrandizement of one's own ethnic identity
- **racism** involving marginalization and discrimination
- **xenophobia** indicating fear of the alien and the unknown
- **language**, as well as phrases, jargons, and dialects, that often have different meanings in various cultures
- **religion** as a cultural fact
- disregard of and noncompliance with **social norms**
- attitude toward **time** and **space**

- **nonlexical communication**, which often leads to negative impressions

These barriers, however, often represent a source of confusion, conflict, tension, and intolerance. The causes of impediments to varied cultures necessitate intercultural interaction therewith (i.e., familiarization, respect, mutual recognition and understanding) regardless of prejudices, stereotypes, or any other forms of **communications blockade** (Drandić 50).

Cultural Differences in Business Communication

"Doing business with other cultures" can be said to be both a necessity and challenge (Kraljević et al. 318), so an understanding of **cultural differences** in international business transactions is particularly important and assists in problem-solving and remedying inconveniences in business communication and business cooperation. It is possible to improve skills of communication with people of distinct cultures through experience. Every person is a unique result of a range of factors (i.e., not only cultural but also those linked to the environment in which the person lived and in which the person was educated). Therefore, the diversity of people and the diversity of cultures they come from are shaping their way of thinking, modus operandi, behavior pattern, etiquette, and interaction with others, all of which may have an impact on business success or business failure.

Nowadays, business is characterized by a **global economy** and extends beyond the boundaries within which we live, since businesspeople communicate with members of the most diverse cultures. There are increasingly more organizations operating globally, and the markets are open to all the states in the world. The organizations direct their business development toward the expansion of markets across national boundaries. As a result of such expansion to global markets, business communication becomes intercultural, be it between business partners or between employees within the organization itself who are the members of diverse cultures. Ignoring cultural differences in business may prove to be a grave mistake for the organizations intending to grow within the framework of a global economy. To this end, intercultural communication is the intrinsic link to a better understanding of individuals, modus vivendi, communication and the perception of the world.

Customs and **anticipated conducts** in certain situations are also a very important element of communication. The better the expectations are

known and understood, the more easily the communication will flow and there will be fewer errors and misunderstandings. Bovée and Thill consider that the different perception and the **disparate value systems** (i.e., an idea which someone has found worthy enough to share with others, right up to the habits and the awaiting of feedback) may affect every phase of the communications process ("Communicating Interculturally" 48, 50, 54, 56, 60).

Nobody would want to hear the unwelcome news, but they are inevitable in business dealings, because, unfortunately, the endeavors do not always run smoothly, without difficulty. Business communication above all demands a businesslike and ethical manner and access to the business partners, but this manner differs from culture to culture. Examples are cited of the **French business communication**, which is author-oriented and breaks bad news directly, relating to the prior correspondence only, in contrast to the **Japanese business communication**, which uses explanations, apologies, and the recitals as a cushioning device and breaks bad news (i.e., those that may even be misinterpreted because of the lack of knowledge regarding that cultural difference) only at the very end of the account (Bovée and Thill, *Suvremena poslovna komunikacija* 253).

It is known that punctuality is requested in the first place in Western European countries, as well as on the North American continent, and the "time is money" phrase holds (Franklin 375), as it is not the case in the Middle East. Also, the Americans in Asia often experience anxiety at dinner meetings, because they think discussing business is the purpose of dinner. Nataša Šalamun perceives the following contrasts between cultures:

> Since **eye contact during communication** (i.e., looking the other person in the eye) is common during business negotiations in Western cultures (e.g., in Europe and in the United States), gaze avoidance can be interpreted as incredulity and lack of interest. Among Americans, Caribbeans, and Latin Americans, however, avoiding eye contact, looking down, or gazing past a person is not uncommon when communicating, as a sign of respect. In Africa, looking a person of higher status in the eye is considered as irreverence. In India, eye contact is avoided between persons of different socioeconomic status, whereas eye contact is avoided between men and women in Egypt.

It is a well-known fact that the tone of voice (i.e., **articulation in pronunciation**) can tell a lot more than the spoken word. Loud speech linked to power is typical of Arab countries, while such a loud voice is construed as the person's involvement and interest in Brazil. In Germany, a loud utterance is interpreted as authority and self-confidence, whereas in Thailand such a loud utterance means that the person is upset or nervous. A soft and quieter manner of speaking is preferred by the Filipinos, for it is believed among them that soft speech is a result of good breathing (i.e., eupnea) and education. The Japanese also prefer the hushed tone and soft articulation.

In the United States, **touching while greeting** is permitted to the persons having higher hierarchical positions (i.e., they may touch a lower-ranking individual during the conversation, but not the other way round). Touch is allowed when greeting Brazilians, and they share a kiss on both cheeks on the occasion of the greeting. Mexicans would also hug when greeting, while the women in Costa Rica would share a kiss on one cheek and would have a hand on the other person's shoulder. In the countries in Southeast Asia, touch when greeting is avoided altogether.

Gestures and motions are liable to be interpreted in different ways in various cultures. A beckoning motion, while the fingers face up, will be construed as a *come here* message in America and Europe, and the exact same message will be relayed by the fingers facing down in Korea. Filipinos will frequently beckon each other by nodding their heads quickly, but beckoning takes place, more often than not, by reaching out the right hand, straightening the thumb (pollex), and opening and closing the hand in Arab countries. In the Western world, if the thumb (pollex) and forefinger (index) are brought together so that they form the letter *o*, they will pass the message that everything is alright, but in some Latin American countries it would be interpreted as an obnoxious gesture. Cultural differences also exist in the intensity of use of gestures. Italians, South Americans, Africans, and the majority of inhabitants of

Latin American countries use nonverbal communication and gestures in communication more frequently and more intensely, while gestures are significantly less used in Scandinavian countries, Japan, Germany and China.

Unlike the United States, a slightly lesser **physical distancing** between the persons during communication is permitted in Mexico, whereas a slightly larger **personal space** is required in England, Germany, or Australia. The Swiss may even slightly move backward if a person gets too close to them during communication and invades their personal space. In some Asian countries, neither would the students sit close to their professors, nor would the employees sit close to their directors, because it is a token of respect.

Posture is frequently associated with obeisance, and it is important in this connection to reflect on various courtesies among the Japanese, Thais, and Indians. Though their greeting bows may at first seem to be identical, they differ, and a bow is far more than just a salutation among them. A bow manifests and implies a social status and ranking. In Japan, a deep bow is interpreted as a token of respect, and a person of an inferior hierarchical level initiates a bow first. Also, a bow taken by a person on an inferior hierarchical level needs to be deeper than a bow taken by a person on a superior hierarchical level, who will take a decision on when the bow ends. When bowing, the Thais clasp hands (as Roman Catholics do when praying), and the closer the clasped hands are to the head, the higher reflection of reverence they express. In India, the hands are clasped too, but the hand fingertips touch the chin when bowing. Sitting positions will also be interpreted differently in cultures. While, on the one hand, a more casual, relaxed sitting position is also permitted in the United States, on the other, it will be interpreted as professional misconduct in Germany and Sweden. In addition, in countries like Saudi Arabia, Egypt, Singapore and Thailand, the male, cross-legged way of sitting is not permitted, since showing the bottom of one's feet is considered offensive in these nations. In Thailand, people believe that the feet have a

> special meaning and avoid stepping on them and showing them to others. Communication is important in every segment of social life, profession, and activity. An individual affects the interlocutors, be it family members, friends, acquaintances or associates, business partners, inferiors, or superiors, via communication. On the basis of a means of communication, the impressions about a person and a company are given ("Kulturološke razlike").

The Impact of Cultural Differences on Management

In communication with members of the various states, **language problems** come before all else; however, there are also difficulties in communication associated with the application of the different nonverbal communication tools. In a globalized context, "to know the language, reference sector, or the economic situation of a potential partner" is no longer enough, but it is all the more necessary to also "know the way of **cultural communication**, comprised of gestures, attitudes, and behaviors of members of the various cultures and states" (Radošević 28). Culture governs how we perceive and construe reality around us, our verbal communication phrases, and nonverbal communication expressions. In a multicultural society like the one we have today, "**interaction between culture and business** is often neglected" (Radošević 28). Globalization and the development of trade at the international level have resulted in an increase of contacts between varied cultures, highlighting difficulties and issues which might arise concerning their interaction. The negotiations are often complicated by **cultural distances**, which stem from different patterns of behavior rooted in commercial practices.

Occasionally, acceptance and consideration of the existence of multiculturalism may constitute a change to a global strategy or can call into question the governance models which so far have been regarded as universally valid, but the new context does not any longer provide pleasure by applying a standard governance model. The identification of cultural distance and **cultural distance management** "allow companies to secure the important competitive advantages, while shortening the communications time and avoiding misunderstandings" (Radošević 28). Even "contact with a new business culture," argues Goran Radošević, "enables familiarization with novel practices, novel ideas, different perspectives, and alternative solutions" (28) and as such "contributes to the development of a new corporate vision" (28; Tizzano; Dupriez and Simons

13). To achieve this, different cultures have to been seen as a resource and a new way of acquiring knowledge, not as an obstacle thereto.

Culture also shapes the human views of the world. The understanding of what is right and what is wrong, and the meaning of certain colors and flowers, are not identical. Bovée and Thill give an example of the American glorification of youth and the Japanese great respect for the elderly. The interpretation of a valiant gesture by a junior colleague (i.e., the manager who advocates a radical transformation of business strategy) could namely be construed in a different manner between members of the two cultures (*Suvremena poslovna komunikacija* 13). Then there is a **divergent interpretation of the nonverbal cues**: the Canadian listeners nod to express their agreement, the Japanese listeners nod to show they understood, whereas the British listeners look at the speaker blinking to convey their understanding. In the United States, however, men have been taught that staring at someone is insolent (Bovée and Thill, *Suvremena poslovna komunikacija* 52).

Another characteristic feature of culture is language. Language allows information and ideas to be exchanged and culture to be propagated. It is a feature common to all cultures (Samovar et al., *Komunikacija* 47). **Competence in foreign languages** (i.e., the ability to communicate in other languages) opens up a variety of worldviews. According to author Alvino Fantini, this aspect is often neglected by the interculturalists, who do not always attach sufficient importance to the **tight relationship existing between culture and language**, whereas the ability to communicate and conceptualize in the other language affects intercultural consciousness (26, 27, 30).

Character is also important for communications competence. In case the communication partner does not consider a collocutor to be a person of different character from that of his or her own, he or she is less likely to succeed (Samovar et al., *Communication* 374–78).

An Intercultural Manager

The tone, organization, and other cultural specificities that the collocutor expects should be used in communication with members of other cultures. In this way, an inadequate and offensive approach that may jeopardize a business relationship is avoided. To determine and meet the needs of participants in intercultural communication, **cultural expectations** should certainly be taken into account in order not to send the wrong message to the collocutors.

If he or she is to be successful, an **intercultural manager** must gain awareness of and sensitivity to distinct rules and cultural differences in communication in force in the cultures of the interlocutors. By doing this, he or she can more easily predict, avoid, and resolve the conflicts which have arisen. A successful business communication between cultures requires many skills, such as knowledge of other cultures, competency in foreign languages, appreciation of others' communications styles in written communication, attentive listening, helping others to adjust to our culture and identifying when translators and interpreters are necessary (Bovée and Thill, *Business Communication* 83–92).

According to Samovar and others, an effective communicator should be motivated—that is, he should want to interact, or in case of a manager, enter into a business relationship and negotiations with a member of another culture (*Communication* 374–78). He or she must have knowledge (i.e., he or she must have information and understand the culture of the person he or she is conversing with).

A diverse workforce may offer a significant competitive advantage by the adoption of new ideas and new communications skills. The more diverse a workforce is, the more attention should be devoted to communication.

Intercultural Communications Competence

Certainly, one of the most important competencies that a modern manager must master is **intercultural communications competence** (ICC). In the simplest terms, intercultural communications competence is a behavior that is appropriate and efficient in a given context (Spitzberg 379–80). It is important to stress that an interculturally competent individual should have the following competences:

- the ability to **mediate**, **interpret**, and **critically and analytically understand** his or her own and other culture
- the ability to **appreciate**, **understand**, and **accept** the relationship between varied cultures
- the possession of **cognitive**, **emotional**, and **behavioral** dimensions

Such qualities are essential to the managers nowadays in order to overcome cultural and intercultural communications barriers, understand and acknowledge their business associates and clients regardless of their culture and identity, and conduct business successfully (Caroselli 61, 72–91, 93–111, 172–73; Samovar, *Communication* 61–67). If a manager is able to manage stress, be in control of his or her time, command energy and direct his or her emotions, then he or she will definitely govern other people better too.

Elvi Piršl states that to be interculturally competent means having knowledge and holding positive attitudes as well as being capable of facilitating efficient interaction with others—that is, being capable of establishing good intercultural communication (203–04).

Finally, Raquel Baptista conveys the view of Geert Hofstede and colleagues, who emphasized that for the purpose of communicating, the **interlocutor's cultural background** must be borne in mind (*Cultures* 388), and culture in business management may have a dominant influence over **decision-making** and **human resources management** (HRM).

Note: The examples are adapted from Goran Radošević's *Interkulturalna komunikacija i menadžment* (2020. Istarsko veleučilište, MA thesis. *Digitalni repozitorij Istarskog veleučilišta*, urn.nsk.hr/urn:nbn:hr:212:972066).

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Lesson 2

VOCABULARY

A Word Search

In the article, find the words and phrases corresponding to the connotations indicated below.

1. communication pertaining to two or more cultures (par. 1)
2. the act of apprehending by means of the senses (par. 2)
3. anything used as a means of accomplishing a purpose (par. 5)
4. a communication containing some information (par. 6)
5. an intervening instrument by which transmission is conveyed (par. 6)
6. a regular public that manifests interest (par. 6)
7. a path for the transfer of data (par. 6)
8. a reaction to a particular activity (par. 6)
9. the psychological identification with the attitudes of another (par. 7)
10. nonverbal, unconscious communication through the use of gestures (par. 9)

Note: The definitions are adapted from "Audience, *N.* (3)" (*Random House*, p. 135); "Body Language" (*Random House*, p. 233); "Channel, *N.* (13) and *V.*" (*Random House*, p. 345); "Empathy, *N.* (1)" (*Random House*, p. 638); "Feedback, *N.* (3)" (*Random House*, p. 706); "Intercultural, *Adj.*" (*Random House*, p. 993); "Medium, *N.* (6)" (*Random House*, p. 1195); "Message, *N.* (1)" (*Random House*, p. 1206); "Perception, *N.* (1)" (*Random House*, p. 1437); *Random House Compact Unabridged Dictionary*, special 2nd ed. (Random House, 1996); and "Tool, *N.* (5)" (*Random House*, p. 1995).

B Sentence Completion Exercise

Refer to the text and complete the sentences.

1. Verbal communication is considered to better represent the thoughts, emotions, and states, but _____ communication is by no means to be undervalued, because it is equal to ninety-three percent of total communication.

2. _____ is all that distorts a message, interferes with communication, or prevents the recipient from receiving the message.

3. In _____ conduct, an avoidance of expressing one's own opinion and an avoidance of expressing emotion occur in communication (i.e., the auditor does not uphold his or her interests, advocate his or her needs, or represents his or her rights).

4. _____ communication is often a symptom of unhealed emotional wounds, a sense of helplessness, and low self-esteem.

5. Nowadays, business is characterized by a _____ economy and extends beyond the boundaries within which we live, since businesspeople communicate with members of the most diverse cultures.

6. Bovée and Thill consider that a different perception and the _____ value systems (i.e., an idea which someone has found worthy enough to share with others, right up to the habits and the awaiting of feedback) may affect every phase of the communications process.

7. Examples are cited of the _____ business communication, which is author-oriented and breaks bad news directly, relating to the prior correspondence only, and of the _____ business communication, which uses explanations, apologies, and the recitals as a cushioning device and breaks bad news (i.e., those that may even be misinterpreted because of the lack of knowledge regarding that cultural difference) only at the very end of the account.

8. Since _____ contact during communication (i.e., looking the other person in the eye) is common during business negotiations in Western cultures (e.g., in Europe and in the United States), gaze avoidance can be interpreted as incredulity and lack of interest.

9. It is a well-known fact that the tone of voice (i.e., _____ in pronunciation) can tell a lot more than the spoken word.

10. The identification of cultural distance and cultural distance _____ allow companies to secure the important competitive advantages, while shortening the communications time and avoiding misunderstandings.

C Word Derivation Exercise

1. Deverbative substantives. Write the nouns derived from these verbs.

a) adopt
b) appreciate
c) communicate
d) converse
e) devote
f) exist
g) expect
h) identify
i) interact
j) interpret
k) manage
l) understand

2. Denominal verbs. Write the verbs derived from these substantives.

a) addition
b) association
c) behavior
d) decision
e) definition
f) difference
g) expect
h) identify
i) interact
j) interpret
k) manage
l) understand

D Prepositions Exercise

Form grammatical collocations and complete the sentences. Use the prepositions suggested in the box.

at between by for from in into of over to up with

1. Globalization and the development of trade _____ international level have resulted in an increase of contacts between varied cultures, highlighting difficulties and issues which might arise concerning their interaction.

2. The negotiations are often complicated by cultural distances, which stem _____ different patterns of behavior rooted in commercial practices.

3. Competence in foreign languages (i.e., the ability to communicate in other languages) opens _____ a variety of worldviews.

4. Character is also important _____ communications competence.

5. To determine and meet the needs of participants in intercultural communication, cultural expectations should certainly be taken _____ account in order not to send the wrong message to the collocutors.

6. _____ doing this, he or she can more easily predict, avoid, and resolve the conflicts which have arisen.

7. A successful business communication _____ cultures requires many skills, such as knowledge of other cultures, competency in foreign languages, appreciation of others' communications styles in written communication, attentive listening, helping others to adjust to our culture and identifying when translators and interpreters are necessary.

8. An effective communicator must have knowledge (i.e., he or she must have information and understand the culture of the person he or she is conversing _____).

9. In the simplest terms, intercultural communications competence is a behavior that is appropriate and efficient _____ a given context.

10. Elvi Piršl states that to be interculturally competent means having knowledge and holding positive attitudes as well as being capable of facilitating efficient interaction with others (i.e., being capable _____ establishing good intercultural communication).

11. Such qualities are essential _____ the managers nowadays in order to overcome cultural and intercultural communications barriers, understand and acknowledge their business associates and clients regardless of their culture and identity, and conduct business successfully.

12. Culture in business management may have a dominant influence _____ decision-making and human resources management (HRM).

E Argumentation Exercise

Examine the contentions below, then express solid agreement or a serious disagreement while, at the same time, transcending the usual clichés with a cogent argument.

1. Is there a "national character" and do you make generalizations about other nationalities?

2. What are prejudicial stereotypes about a group of people and how dangerous are they?

3. Do people who are afraid of diversity perpetuate a stereotype because they adhere to a familiar arrangement and simplified classifications?

4. Can a stereotype be true? Do the British really make excellent police officers, are the French really the best chefs, are the best mechanics really German, are the Italians the greatest lovers and do the Swiss really excel at certain organizational skills, as argued by Christopher Hackley (*Advertising* 196) with respect to stereotypes anchored in European society?

WORK CONSULTED

Hackley, Christopher E. [*published as* Chris Hackley]. *Advertising and Promotion: An Integrated Marketing Communications Approach*. 2nd ed., SAGE Publications, 2010.

Lesson 1

Computer-Mediated Communication

Evaluate whether the arrival of major corporations as clients is information and communications technology's (ICT's) trump card relative to other industries and how important an extremely coherent relationship between universities and local communities is, like the one in California's Silicon Valley.

PRE-READING ACTIVITY

Discussion

1. Is the software industry, as something that can get into action quite rapidly, also something that offers young people hope of being employable and making their own ideas real straight out of high school and graduate school?

2. Can university curricula and syllabi in the English language, mobile and web application development, and information technology (IT) and robotics prevent a brain drain?

3. Are the concept of online store and the perception of value for money in Croatia different than in the West?

4. Since the economy in which we operate is based on knowledge-sharing and people are looking for and getting information, does pursuing such a course increase knowledge worldwide and is it the only way for us to be able to move forward as a society?

5. As regards to an educational vertical and the fact that Croatian ICT specialists also require more higher-quality experts, should the primary mission of these specialists be cooperation with graduate schools and the descent to elementary schools and high schools to show the students how interesting programming is and thereby cast the seeds of future engineers?

6. Is software developer exclusively a "men's occupation"?

Note: The examples are adapted from Suzana Lepan Štefančić's "Hrvatska Silicijska dolina: U 150 IT tvrtki radi tisuću ljudi, a plaća je — europska" (*Večernji list*, 24 Nov. 2018, www.vecernji.hr/techsci/hrvatska-silicijska-dolina-u-150-it-tvrtki-radi-tisucu-ljudi-a-placa-je-europska-1284574).

COMPREHENSION

A Foci

brain drain	the departure of intellectuals or experienced personnel (i.e., of educated or professional people) "from one country, economic sector, or field" for another, usually for better pay or living conditions ("Brain Drain")
curriculum	the subjects comprising a course of study in a college, or "the whole body of courses offered by an educational institution or one of its branches" ("Curriculum")
information technology	information processing via computers
mobile application development	the creation of software applications running on a mobile device and utilizing a network connection to operate with remote computing resources
online store	a website navigated to in order to download applications, or apps, to a computer or smartphone and to perform retail sales
robotics	the science of the creation and use of robotic devices
software developer	a software-designing and software-writing person or organization

software industry	the development, distribution, and maintenance of application software, database and analytics software, operating systems, software as a service (SaaS) and system infrastructure software
syllabus	an outline of the subjects in a course of study
web application development	the creation of web apps (i.e., nontransferable, server-residing and Internet-deliverable application programs), accessible to the end user through a web browser

Note: The definitions are adapted from "Brain Drain, *N.*" (*Merriam-Webster's Unabridged Dictionary*, Merriam-Webster, 2022, unabridged.merriam-webster.com/unabridged/brain%20drain); "Curriculum, *N.*" (*New Oxford American Dictionary*, p. 425; *Merriam-Webster's Unabridged Dictionary*, Merriam-Webster, 2023, unabridged.merriam-webster.com/unabridged/curriculum); "Developer" (*PCMag Encyclopedia*, Ziff Davis, 2022, www.pcmag.com/encyclopedia/term/developer); "IT" (*PCMag Encyclopedia*, Ziff Davis, 2022, www.pcmag.com/encyclopedia/term/it); *New Oxford American Dictionary*, 3rd ed. (Oxford UP, 2010); "Online Store" (*PCMag Encyclopedia*, Ziff Davis, 2022, www.pcmag.com/encyclopedia/term/online-store); "Robotics" (*PCMag Encyclopedia*, Ziff Davis, 2002, www.pcmag.com/encyclopedia/term/robotics); "Software" (*Statista*, www.statista.com/markets/418/topic/484/software/#overview. Accessed 10 Feb. 2022); "Syllabus, *N.* (1)" (*New Oxford American Dictionary*, p. 1759); TechTarget Contributor's "Web Application Development" (*TechTarget*, Jan. 2019, www.techtarget.com/searchcloudcomputing/definition/web-application-development); and "What Is Mobile Application Development?" (*AWS*, Amazon Web Services, 2022, aws.amazon.com/mobile/mobile-application-development).

B **Peruse the article, take a look at the new words and phrases, and then respond to the questions below it.**

Fig. 3.1. Ra2 Studio. *Hand Using Laptop . . . .* 2022. *Shutterstock*, www.shutterstock.com.

Information and Communications Technology

INFORMATION AND COMMUNICATIONS TECHNOLOGY (ICT) REFERS TO products and practices used for the **storage and recording of information** and for other types of **information processing**. In modern times, ICT predominantly concerns technologies that evolved from the **telecommunications industry** and the **computer industry**. ICT is the fastest-moving domain and has experienced the most rapid growth at the end of the 20th and the beginning of the 21st century, having transformed the society totally. Nowadays, ICT is found in all spheres of life (Silverstone et al. 204) and falls within the fields of **computer science** and telecommunications that grow even more combined, since very expeditious progress is being made. ICT has currently taken center stage in all technological systems and is at the heart of human activity in all sectors.

The concept of ICT also encompasses a wide range of products in the field of **telephony**, **library science**, and other practices in respect of

motion pictures, **facsimiles**, **magazines**, **articles**, and so forth. **Technological achievements**, without which modern living is unthinkable, dominate the realm of ICT—namely, **radio**, **television**, the **Internet**, and **fixed and mobile telephony**. ICT therefore includes **data storage and processing** and the **transfer of information** over **wired and wireless connections**, comprising **copper infrastructure** and **fiber optical infrastructure**. New developments in this area radically change work, studying, and entertainment in contemporary society. **Virtual and augmented reality**, **cognitive radio**, the **Internet of Things** (IoT), **machine-to-machine communication** (M2M) and **5G mobile networks** constitute just a few examples of technologies which require **new engineering knowledge**.

ICT is included in all segments of modern-day society and its activities (Stare and Bučar 13). When communications fail, the world comes to a stop, so to speak. Thus, the needs for experts in the field of ICT have steadily increased. They are required across all sectors of the economy, and there is a great shortage of them throughout the European Union (EU). The development of ICT is key to Europe's competitive edge in today's increasingly digital **global economy**. The principal tasks of Europe are as follows: expansion of **broadband rollout** and **high-speed networks**, development of **ICT products and services**, development of **e-commerce** and enhancement of **ICT applications** for **e-government**, **e-learning**, **e-inclusion**, **e-culture**, and **e-health** ("Information and Communication Technologies").

The ICT sector includes the knowledge required for the transfer, processing, and storage of information and the knowledge required for **access to information** in electronic form. The great names of computer science and telecommunications are not the only ones that provide employment for ICT specialists. At the present time, all cutting-edge companies need independent experts in information and communications support, whatever their core activity.

Mass production has made conventional **information and communications devices** inexpensive and reliable for the transmission of information signals of highest quality, with **minimal power consumption** and **minimal bandwidth utilization**. Henceforth, we will witness the development and construction of new **radio systems** and the development and construction of new **optical systems**, which will deliver more **gigabits per second** (Gbps) to the user and will cover the whole planet.

The Historical Evolution of the Term *ICT*

The term originates from the 1980s (Melody and Mansell 9), when the **digitization of telephone networks** was started, while information technology was already employed in **digital terminal networks** in the early 1960s, as in **local transmission networks** and **public transmission networks** ("Timeline"). Services have emerged such as **teletext**, **videotex**, and **dedicated data networks** (e.g., Datex-L and Datex-P). Ideas that originally belonged to completely different sectors would develop side by side—that is, information technology, on the one hand, which was primarily concerned with **mainframes** and **office computers**, and communications technology, on the other, which dealt mainly with telephone networks.

Since the 1990s, a rapidly growing **diversification**, whose end is not yet in sight, has developed in both areas. **Elementary technologies** have not only covered these sectors but have also continued to grow in a number of other branches as well, from vehicles to construction technology.

Due to the widespread use of the Internet and the central role of services, which in the IT industry are based on the **Internet protocol** (IP) (e.g., IP networks) and which are all the more based on communications technology (e.g., IP telephony), the term *ICT* has spread to politics, administration, and especially to the eponymous industry since the year 2000.

ICT is thus defined as a **generic term** that includes any **communications instrument** or **communications application**—that is, **cell phones**, **computer hardware and software**, **networking hardware and software**, **satellite systems**, and the like in addition to radio and television, as specified by William Melody, Robin Mansell, and Barbara Richards in *A Report by the ESRC Programme on Information and Communication Technologies* (1: 9; 2: xii).

The Development of Technological Capacity

In 2014, writes Martin Hilbert (2), the world's **technological capacity** to store information increased to five **zettabytes** (ZBs), which is the **information equivalent** of 4,500 bookstacks from Earth to the Sun, whereas an efficient technological capacity to exchange information via **two-way telecommunications networks** reached a total of approximately 100 **exabytes** (EBs).

Funds allocated to the IT sector on a global scale were estimated at US$3.8 trillion in 2017 (i.e., they have increased less than five percent per annum since 2009), and, in the aggregate, **monetization** of ICT data and services was assessed at five percent in 2018. The strongest, sixteen percent growth was expected in the field of emerging technologies—for example, in **artificial intelligence** (AI), **augmented reality** (AR), **mixed reality** (MR), and **virtual reality** (VR) as the forms of **extended reality** (XR)—alongside IoT and robotics ("IDC"; Goode).

The budget of the United States federal government for the year 2014 amounted to approximately eighty-two billion dollars. Since the year 2002, **IT expenses**, as a percentage of corporate revenue, have increased by fifty percent, which has burdened the IT budgets. When examining the IT of the current companies, one should note that seventy-five percent are represented by the recurrent costs, utilized to continue the operation of the IT department, while twenty-five percent are represented by the costs of new technology development initiatives.

The average IT budget has the following breakdown:

- internal **personnel expenditures** in the amount of thirty-one percent
- **software expenditures** in the amount of twenty-nine percent, being an external (i.e., purchasing) category
- **hardware expenditures** in the amount of twenty-six percent, also being an external (i.e., purchasing) category
- **external service provider expenditures** in the amount of fourteen percent (Luxembourg and Sommer)

An anticipated assessment of money destined for the IT industry in the year 2022 amounted to slightly over six trillion United States dollars.

The ICT Development Index

In various countries around the world, the **ICT Development Index** (IDI) compares the level of use and access to ICTs and considers the **digital divide** (Executive summary). The International Telecommunication Union (ITU) publishes the latest IDI ranking, placing most high-income countries (HICs) and administrative regions with an above-average quality of life (QOL)—for example, European nations (1: 35) and other bodies politic,

such as Australia, Bahrain, Canada, Japan, Macao, New Zealand, Singapore, and the United States—along the scale (2: 1–204).

ICT in Education

The **United Nations Educational, Scientific and Cultural Organization** (UNESCO) has integrated ICT as part of its endeavors to ensure equity and **access to education**. UNESCO communicates the know-how associated with the numerous ways in which technology could facilitate general access to education, support teachers' development, increase the caliber and adequacy of learning, strengthen the involvement of students and improve education management ("ICT in Education").

University environments play an essential role in the facilitation of language learning. Occasionally, however, **linguistic-literacy barriers** may deny access to university and impede university attendance, especially off campus.

Language-learning applications for mobile devices are essential tools, because mobile solutions can give a reply to the challenges of language and literacy in three principal areas: literacy development, foreign language learning, and interpretation and translation ("Information and Communications Technology"). Mobile technology is relevant, since a communication exercise is of vital importance for those who join a new society and new language community. The well-designed activities of **mobile language learning** connect the students with customary cultures and assist the students to learn in a real-life environment.

ICT has been employed since the 1960s ("Information and Communications Technology"). The inception of radio and television broadcasting has expanded the scope of education from university auditoria to living rooms and to the geographic regions that were beyond reach of the traditional lecture rooms. As technology matured and was more widely used, the efforts were expanded too. In the 1990s, major efforts were invested in providing the universities with computer hardware and software, to the effect that the students and teachers become familiarized with computers in the lecture halls. From then on, the majority of projects endeavored to achieve a continued expansion of ICT outreach in various regions, including the distribution of several million **laptops** to several million students and teachers ("Information and Communications Technology").

ICT in E-Agriculture

Since 2008, the United Nations (UN) has anticipated that the scope of **e-agriculture** will be developed and modified as our understanding of that art, practice, or nascent science grows (Mangstl 5). As per the United Nations Food and Agriculture Organization (FAO), ICT is thus innovatively employed to support the eradication of poverty in rural areas and to support the assurance of food supply, for e-agriculture implies a **concept** being formulated, a **design** being pursued, and an **evaluation** being made ("E-Agriculture"). In addition to the aforementioned e-commerce, these are the aspects of ICT application in e-agriculture:

1. a **geographic information system** (GIS) in **precision farming**, as instructed by the United States Department of the Interior's Geological Survey ("What Is"), Kang-Tsung Chang (2), and Alex McBratney et al. (7);

2. **agricultural robots**—for example, **automatic milking systems** (AMSs), as discussed by Nigel Cook and Robert Smith (52, 96);

3. **radio-frequency identification** (RFID), which can also be utilized to implant a **transponder**, or tag, so that it collects data on **animal physiology** (United States, Dept. of Agriculture; Rundio et al. 1);

4. **sensing technologies** (Chaerle et al. 1152, 1153, 1154);

5. **smartphone apps**;

6. the **Global Positioning System** (GPS), which is used for cartography, or mapmaking, "geo-fencing," and surveying (United States, Dept. of Transportation B-3; United States, Federal Communications Commission 2381); and

7. **wireless technologies** ("AgriCamera").

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Lesson 2

VOCABULARY

A Sentence Completion Exercise

Complete the sentences with the words from the box.

digestible listen opportunities personnel jobs rate recruitment workplaces careers consistency intellectual salary databases expertise lucrative support qualifications requirements résumé vacancy coding competencies professions proficiency companies cybersecurity gateway network array pitfalls reference sophisticated

1. Almost any company is in need of IT-oriented _____, providing excellent _____ for the industry's professionals who are able to actively _____ and communicate complex information in a _____ manner.

2. _____ in the IT industry are among the fastest-growing occupations, and it is predicted that employment in computer-related _____ will grow by twelve percent to the year 2028 (i.e., it will proceed at a considerably more rapid _____ in terms of _____ in other sectors).

3. Based on universal _____ values (e.g., relevance, perspicuity, _____, accuracy, and profundity), IT is one of the best-paid _____, with an average annual _____ of US$88,240 as of May 2019.

4. The IT positions can be _____, and there are roles for persons having distinct interests, with multiple levels of _____: from programming to the creation of _____ and the provision of technical _____.

5. When applying for a _____, emphasize in your _____ the IT skills that are the closest to the preferred _____ indicated in the job posting, and thus you will be able to prove that the _____ have been satisfied.

6. A wide variety of _____ available signifies that the employers require diverse technical _____, so some companies might request _____ in a specific programming language—namely, in the hypertext markup language (HTML) or in the Java _____ language.

7. Other _____, on the other hand, might request more general computer skills—for example, those of user experience (UX) design, cloud computing, and the Internet protocol (IP) setup—to architect a _____ and verify _____ functionality, to administer a system and provide _____, and to optimize the schedule and assure quality.

8. Thus, in an _____ of emerging integrated technologies, critical thinking—that is, a varied range of _____ capabilities pertaining to self-indulgent deliberation of a superior rank—implies a _____ to the learning process experiences and effective decision-making, conceives a novel idea, and addresses a problem while avoiding the common _____ of illogical reasoning, unilaterality, and unsubstantiated claims.

Note: The definitions are adapted from Alison Doyle's "Important Skills for Information Technology (IT) Jobs" (*The Balance Careers*, 4 July 2021, www.thebalancecareers.com/list-of-information-technology-it-skills-2062410); "HTML" (*Merriam-Webster's Collegiate Encyclopedia*, p. 772); "IP Address" (*Merriam-Webster's Collegiate Encyclopedia*, p. 817); "Java" (*Merriam-Webster's Collegiate Encyclopedia*, p. 840); *Merriam-Webster's Collegiate Encyclopedia*, edited by Mark A. Stevens (Merriam-Webster, 2000); Bryan Pfaffenberger's "HTML" (*Webster's New World Computer Dictionary*, p. 177) and "Java" (*Webster's New World Computer Dictionary*, p. 201); Bernadette Schell and Clemens Martin's "Gateway" (*Webster's New World Hacker Dictionary*, Wiley Publishing, 2006, p. 134); Aaron Schmidt and Amanda Etches' *User Experience (UX) Design for Libraries* (American Library Association, 2012. The Tech Set 18); the United States Bureau of Labor Statistics, Office of Occupational Statistics and Employment Projections' "Computer and Information Technology Occupations" (*U.S. Bureau of Labor Statistics*, 18 Apr. 2022, www.bls.gov/ooh/computer-and-information-technology/home.htm#); and *Webster's New World Computer Dictionary*, 10th ed. (Wiley Publishing, 2003).

B Video Clip Exercise

1. Scan the QR Code embedded below with your smartphone, then watch the video clip in its entirety.

Fig. 3.2. Chat Karen Studio. *Two Farmers Shaking Hands . . . .* 2022. *Shutterstock*, www.shutterstock.com/image-photo/two-farmer-shaking-hands-on-potato-597047855.

Adapted from: "ResyBuild.io." *Cultivated Culture*, 2021, cultivatedculture.com/resume-templates; "How to Introduce Yourself—American English Pronunciation." *YouTube*, uploaded by Rachel's English, 5 Sept. 2013, www.youtube.com/watch?v=oWP9Riq-ZBg.

In American English, when you introduce yourself, you can use an interjection, formulate a clause, or use a phrase of a more colloquial style. Your expressions should include the following:

- salutation (e.g., "Hey"; "Hi")
- an appellative construction, whereby contractions (e.g., "I'm . . ."; "My name's . . .") are permissible
- provenience data (i.e., the current address, hometown, and job), frequently worded as "I'm from . . ."
- conclusive statements (e.g., "Nice to meet you"; "Well, it was good to meet you, . . .")

2. As a follow-up to this exercise, adhere to a set of clear guidelines established in the bulleted list in numbered paragraph 1 and fill out the editable résumé template, available at the website *Cultivated Culture* (cultivatedculture.com/resume-builder/?template=1).

   Furnish personal details, download the preformatted document, and carry on a conversation about biographical information you provided in the sections of your profile.

C Recontextualization Exercise

Solve each part of this exercise:

On page 55, convert charts (figs. 3.3, 3.4) into narrative.

Textualize the content of the infographic on page 56 (fig. 3.5), illustrating the cost-benefit ratio in 5G network usage of the five eastern Croatian counties (i.e., Brod-Posavina County, Osijek-Baranya County, Požega-Slavonia County, Virovitica-Podravina County and Vukovar-Syrmia County). Post data values on the contour map.

Extract data from the text about the fifth generation of mobile communications networks that is printed on pages 57–59, and then compile the table 3.1 on page 60 on the basis of the information provided.

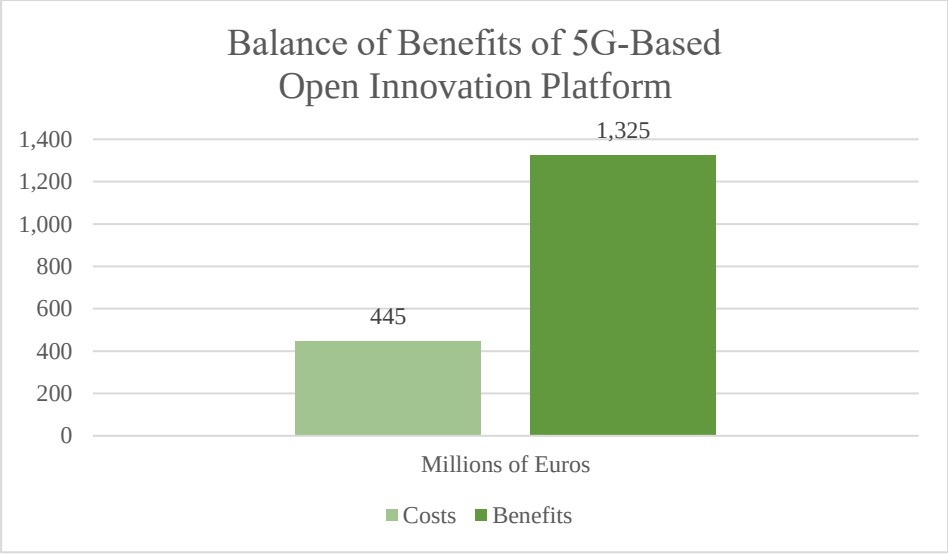


Fig. 3.3. Adapted from: "Troškovi ulaganja i koristi . . . ." *Ekonomski učinci* . . . , Ekonomski institut, Zagreb, 2021, p. 84. *HT*, www.t.ht.hr/webresources/tht/pdf/HT_5G_atlas.pdf. The figures are expressed in terms of present net value (PNV) in the overall Croatian economy.

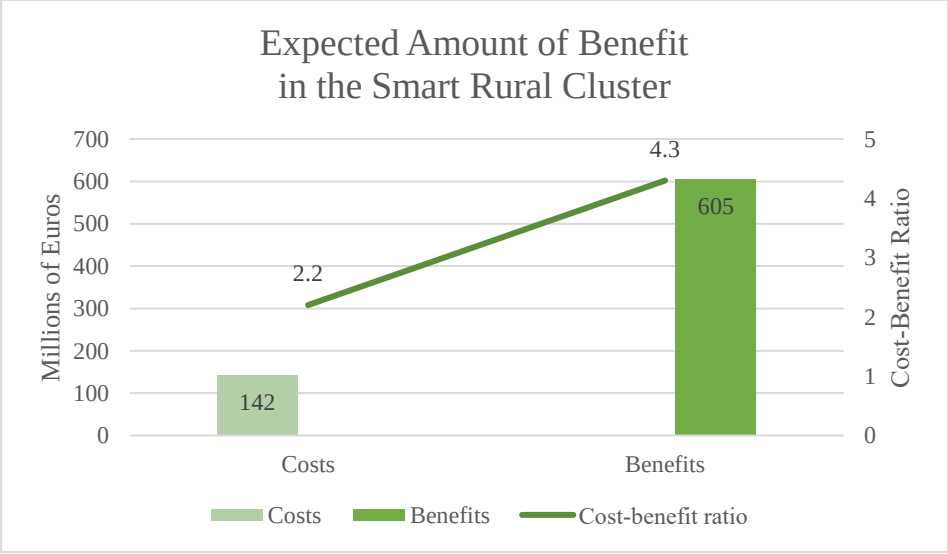


Fig. 3.4. Adapted from: "Troškovi i koristi . . . ." *Ekonomski učinci* . . . , Ekonomski institut, Zagreb, 2021, p. 84. *HT*, www.t.ht.hr/webresources/tht/pdf/HT_5G_atlas.pdf.

Brod-Posavina County	2.8
Osijek-Baranya County	3.7
Požega-Slavonia County	3.0
Virovitica-Podravina County	3.1
Vukovar-Syrmia County	3.2

Fig. 3.5. Adapted from: "Omjer koristi i troškova . . . ." *Ekonomski učinci* . . . , Ekonomski institut, Zagreb, 2021, p. 94. *HT*, www.t.ht.hr/webresources/tht/pdf/HT_5G_atlas.pdf.

Launched in 2019 in South Korea, the 5G is the fifth generation of mobile communications networks comprised of 469 mobile network operators (MNOs) in 140 countries or territories, representing a new standard in global mobile communications networks based on the method of orthogonal frequency-division multiplexing (OFDM) and modulating the digital signal via several different channels to minimize the interference and connect the trillions of devices. The 5G increases the download speed up to 10 Gbps, provides Industry 4.0, and extends an IoT device's battery life ten times, whereas the users should enjoy higher levels of reliability and a maximum ten-millisecond latency between the moment of performing the activity and the moment of receiving network response. In addition to enhanced mobile broadband (eMBB) and mission-critical services (MCS), Industry 4.0 entails a combination of cyber-physical systems (CPSs), massive IoT (MIoT), and the Internet of Systems (IoS). Leading economic experts have found that the Croatian economy will realize a profit of €1,325,000,000 on the development of 5G networks, and the number of people employed in the ICT industry will grow by more than forty percent. Operating expenses (OpEx) will be reduced by ten percent, while the expected sales revenue in the ICT sector will be raised by fifty percent (*Ekonomski učinci* 27, 30; Lider).

Relying on the methodology and the basic results presented in Analysis Mason's *5G Action Plan Review for Europe: Final Report*, the evaluation of capital expenditures (CapEx) for the development of 5G infrastructure in the Smart Rural cluster involves agriculture and fixed wireless access (FWA) as use cases. As a matter of fact, the highest amount of benefit, with the most favorable cost-benefit ratio, is expected in the Smart Rural cluster—namely, 4.3 times the amount of benefit, or €605 million, for each euro of investment. The net benefits of 5G infrastructure in the Smart Rural cluster are, writes Lider, among the nation's highest in Vukovar-Syrmia County and in Virovitica-Podravina County, amounting to 2.5% of gross domestic product (GDP).

The benefits in the Smart Rural cluster include additional gross value added (GVA), which can potentially be acquired by increasing productivity in agriculture and by employing the technology of 5G-based FWA, affording an opportunity for a growth in economic activity in many areas. Thus, export sophistication in the agricultural sector—that is, the technological

complexity of export products and services—should be increased by twenty-five percent at mobile speeds that can be considered as a minimum threshold of a 5G network. Virovitica-Podravina County and Požega-Slavonia County are among those that have the greatest potential for the technological sophistication of export commodities due to the introduction of the 5G network (*5G budućnost*).

The operating expense index is calculated by assessing the impacts on the operating expense share in the total operating income. Hence the benefits with a view to reducing the operating expenses may be expected in the sectors of ICT, agriculture, and transportation, whereby a reduction in the operating expense share ranges from 0.2 in the ICT sector to 0.3 in the sector of agriculture. The greatest potential for an increase in business cost-effectiveness—that is, up to thirty percent—is established in the sectors of ICT, agriculture, and transportation, this being in conformity with Accenture Strategy's report entitled *The Impact of 5G on the United States Economy* and its assessments of the European economy (53, 69). The cost-benefit ratio in 5G network usage amounts to 3.7 in Osijek-Baranya County, 3.1 in Virovitica-Podravina County, 3.2 in Vukovar-Syrmia County, 2.8 in Brod-Posavina County and 3.0 in Požega-Slavonia County, while the European Union average amounts to 4.3. An annual net benefit per inhabitant—that is, a potential for productivity growth based on 5G infrastructure—amounts to fifteen to twenty euros for Osijek-Baranya County and ten to fifteen euros for Brod-Posavina County, Požega-Slavonia County, Virovitica-Podravina County and Vukovar-Syrmia County, whereby the average rank of the more developed countries of the European Union is twenty-one euros (*5G budućnost*).

In the future, the mobile networks of new generation—for example, the 5G network—will also enable the collection of considerably more data and data tracking, even in real time. It will thus be possible to operate a vineyard and exercise control over it from a single command center, and the flight of a drone will be able to be remote-controlled, which will permit the determination of the flight path significant for the quality of the drone footage of the vineyard. In this way, radio communication in the field is set to control the flight of the drone and capture video footage of the vineyard in conformity with a prearranged flight path.

Business modernization often involves the carrying out of projects which deploy a drone—for instance, for the purpose of monitoring of the viticultural production at lower costs—in order to control the variabilities affecting the actual quality of grapes as efficiently as possible. Such projects collect data about the vineyards' verdure and variability by means of an imagery of drone-mounted multispectral cameras. Since multispectral imagery is processed by using adequate tools with the aim of providing support to decision-making in viticultural production, the existence of potential problems—for instance, the occurrence of diseases or pests, lack of fertilizers, or irrigation demand—can thereby be identified (*5G budućnost*).

These images are also used for vineyard mapping, which is a precondition for future targeted application of agrotechnical measures and other ampelotechnical procedures in the vineyard itself, and refers to the use of protective agents, fertilizers, and irrigation, as well as to the selective grape harvest according to the determined quality zones in the vineyard. Furthermore, these procedures allow for a reduction in production costs, an increase in and a regulation of the yield and quality of the grapes, and the monitoring of the whole viticultural industry, which will facilitate better planning and better assessment of future needs and revenues.

Likewise, the images will be utilized for the development and training of neural networks in AI systems, which will ultimately be able to replace certain time-consuming and capital-intensive operations when managing production. The objective of this model of digitalization is the aggregation of relevant data with the purpose of better decision-making in viticultural production (*5G budućnost*).

Note: The examples are adapted from Analysis Mason's *5G Action Plan Review for Europe: Final Report* (Ericsson / Qualcomm, 24 Sept. 2020, www.qualcomm.com/content/dam/qcomm-martech/dm-assets/documents/5g_cost_benefit_analysis_for_europe_final_report_290121.pdf); *Ekonomski učinci* . . . . (Ekonomski institut, Zagreb, 2021. *HT*, www.t.ht.hr/webresources/tht/pdf/HT_5G_atlas.pdf); *The Impact of 5G on the United States Economy* (Accenture Strategy, Feb. 2021, www.accenture.com/_acnmedia/PDF-146/Accenture-5G-WP-US.pdf); Lider's "5G mijenja Hrvatsku . . . ." (*Lider*, created by Lider media, Hrvatski Telekom, and 01 Content&Technology—C3 Croatia, 28 Apr. 2022, lidermedia.hr/ukratko/5g-mijenja-hrvatsku-tehnoloska-revolucija-koja-nam-donosi-1-3-milijarde-eura-evo-kako-to-svi-to-mozemo-iskoristiti-142460); *5G budućnost* (Hrvatski Telekom, 2022, 5gbuducnost.hr).

Table 3.1

Historical Development of Mobile Communications Networks[a]

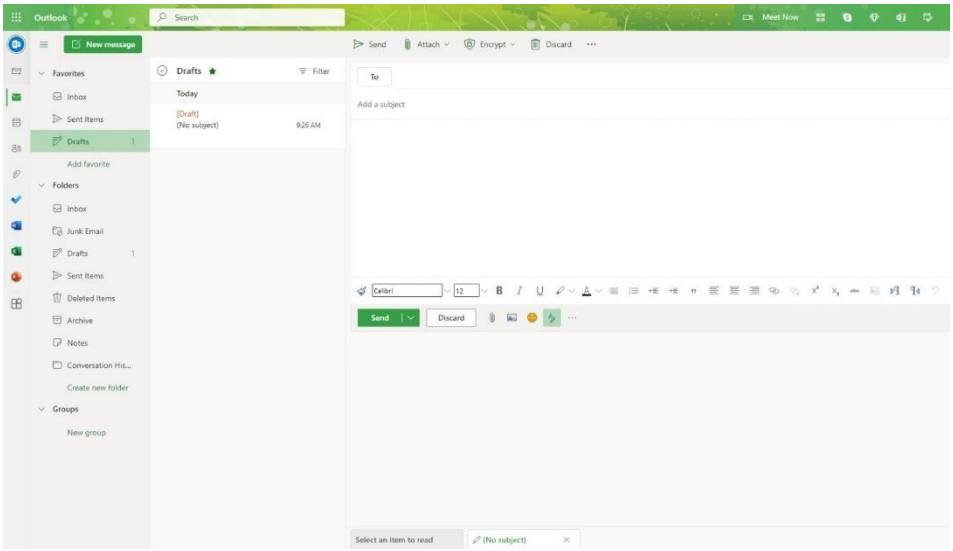
Network	5G
Technology	Binds up the world
Launch	?
Latency	< ? ms
Download speed	? Gbps
Network range	?

Adapted from: "Tablica 1: Povijesni razvoj . . . ." *Ekonomski učinci* . . . , Ekonomski institut, Zagreb, 2021, p. 28. *HT*, www.t.ht.hr/webresources/tht/pdf/HT_5G_atlas.pdf.

a. For additional information, see *The 5G Economy: How 5G Technology Will Contribute to the Global Economy*. IHS Economics / IHS Technology, Jan. 2017, cdn.ihs.com/www/pdf/IHS-Technology-5G-Economic-Impact-Study.pdf; "On Our Way to Industrial 5G!" *Ingenuity*, Siemens, 15 Nov. 2019, ingenuity.siemens.com/2019/11/on-our-way-to-industrial-5g.

D E-mail Writing Assignment


Imagine yourself sending an e-mail to a company proposing some investment in 5G network rollout in the Smart Rural cluster. Use the data in the infographic itself (fig. 3.6, p. 61), especially the epigraph contained within, supplemented by the tabular data on the following page (tables 3.2 and 3.3). (Web capture of *Outlook.com* courtesy of Microsoft.)



Agriculture is one of Croatia's most underserved economic sectors, which also makes it the sector wherein considerable room for improvement exists, arising from the investment in the development of 5G network. Technological solutions based on 5G infrastructure have a potential to substantially increase the total agricultural output too, which is continuously decreasing in Croatia in the last decade, as well as to improve the effectiveness of agricultural production in Croatia itself. . . .
—Maruška Vizek, *Ekonomski učinci*

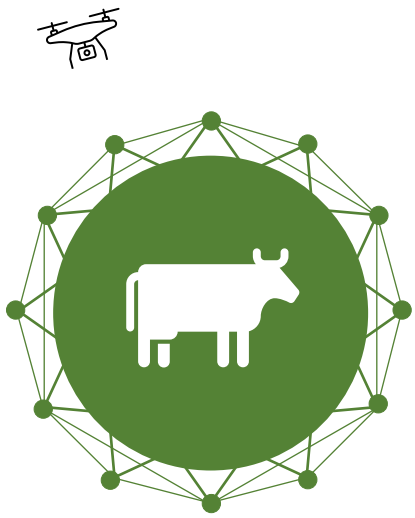


Fig. 3.6. "Razvoj ruralnih krajeva Hrvatske . . . ." *5G budućnost*, Hrvatski Telekom, 2022, 5gbuducnost.hr/7.

Table 3.2

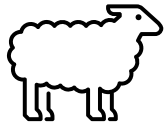
Balance of Benefits of 5G-Based Open Innovation Platform at the Level of the European Economy

Cluster	Use Case	Benefits			
		Economic (Cost-Benefit)		Social	Environmental
		Billions of Euros	Ratio		
Smart Rural	FWA in rural areas	28/10	3	An increase in social inclusion, a reduction in the digital divide	Shorter traveling time
	Agriculture	45/8	5	Rural sustainability	An increase in efficacy, a lower demand for pastureland in livestock production
	Cluster total	73/18	4		

Adapted from: "Tablica 2: Pregled koristi . . . ." *Ekonomski učinci* . . . , Ekonomski institut, Zagreb, 2021, p. 39. *HT*, www.t.ht.hr/webresources/tht/pdf/HT_5G_atlas.pdf.

Table 3.3

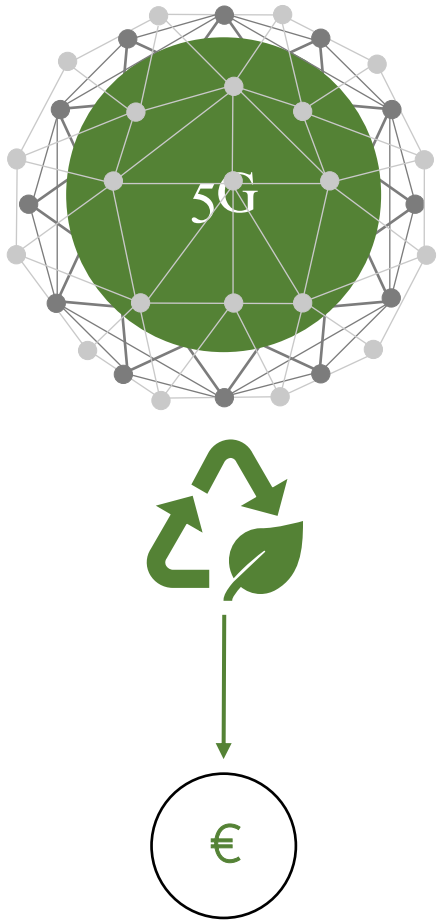
Investment Costs and Benefits in the Smart Rural Cluster

	Investments (Millions of Euros)	Benefits (Millions of Euros)	Benefit per Inhabitant (Euros per Year)
Brod-Posavina County	4.4	23.6	9.5
Osijek-Baranya County	5.8	61.1	13.7
Požega-Slavonia County	1.7	12.3	10.9
Virovitica-Podravina County	2.5	15.9	12.3
Vukovar-Syrmia County	4.3	33.6	13.2
Croatia	**142.0**	**605.0**	**7.6**

Adapted from: "Troškovi ulaganja i koristi . . . ." *5G budućnost*, Hrvatski Telekom, 2022, 5gbuducnost.hr/7.

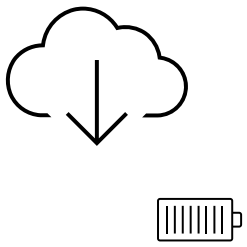
E Synthetizing Activity

Summarize a data set related to 5G, with a special emphasis put on the Smart Rural cluster in Croatia. In this cluster—which involves agriculture—the investment-to-benefit ratio is most favorable in Osijek-Baranya County.



▶ *1*

It takes thirty-five seconds for 5G to download three gigabytes (GB) of data, with an extended battery life.



▶ *2*

In 2021, commercial 5G networks were available in 1,336 cities of sixty-two countries. Most cities, however, were located in China and in the United States.

▶ *3*

In 2021, 236 million 5G subscriptions were active on a global scale, and it is anticipated that it will have reached 3 billion by the year 2025. What is more, it is expected that sixty-nine percent of smartphones will have come equipped with the 5G modem installed by that time, while 22.3 million jobs in Europe will have been supported by 5G technology by the year 2035.

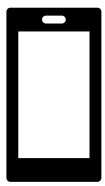


Fig. 3.7. Adapted from: "5G Statistics . . . ." *FinancesOnline*, 2022, financesonline.com/5g-statistics; Gigi Onag. "EY: Nearly 50% of Firms . . . ." *FutureIoT*, Cxociety, 4 Mar. 2022, futureiot.tech/ey-nearly-50-of-firms-use-5g-to-optimise-business-process.

GLOBAL GROWTH GENERATED BY 5G

- the number of IoT hot spots on a 5G-enabled network should skyrocket to forty-nine million in 2023
- connected vehicles are intended to become the largest segment of the global 5G IoT market, with a scheduled total of nineteen million hot spots operational by 2023

AGRICULTURAL INTENSIFICATION

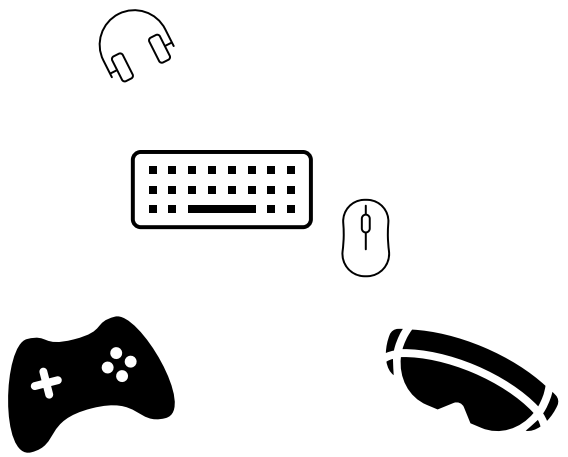


Fig. 3.8. Adapted from: Simon O'Dea. "5G—Statistics and Facts." *Statista*, 2 Aug. 2022, www.statista.com/topics/3447/5g/#dossierContents_outerWrapper.

Lesson 1

A Vision of Modern Farming

Inasmuch as there are no human contacts in robotic operations, which is very convenient under present-day conditions, consider the problems such as the absence of possibility, disinclination, the high price of machinery and the lack of education and whether the sense of traditional agriculture is lost if there are no jobs for humans.

PRE-READING ACTIVITY

Discussion

1. Since robots have taken upon themselves the tasks of harvesting the fruits to a certain extent, is it realistic to expect that the farmers will still do a considerable part of the job, bearing in mind that the vast majority of countries is too destitute to afford itself such mechanization?

2. Can we expect a robot to drive in the field and husk corn as soon as we decide to take up farming?

3. Are human beings willing to get involved in modern farming, or are people who avoid working in the agricultural sector responsible for an increased deployment of robots?

4. Are a labor shortage and an escape from agronomy exclusively attributable to a necessity of commitment and sacrifice and the inevitability of toil in farming, as young people increasingly turn to other professions?

COMPREHENSION

A Foci

automation — the technique of making a system operate automatically

drone — an autonomous, remotely controlled aircraft—that is, an uncrewed aerial vehicle (UAV)—that carries electronic transmitters and sensors and is alternatively denominated as "remotely piloted vehicle (RPV)" or "unmanned aircraft system (UAS)"

in-service training — a training going on while in service

labor shortage — the unavailability of the number of appropriately experienced and qualified personnel sufficient to maintain the project schedule at cost acceptable to the proprietor where the effort is to be completed

machinery — a range of machines—for instance, the one operated in farming

mechanization — the process of putting a system under the control or regulation of electronic devices

picker — a machine used in picking fruits

robot — a device that automatically performs complicated, frequently repetitive operations

Note: The definitions are adapted from H. Dean Chamberlain's "AII a Matter of Scale" (*FAA Aviation News*, vol. 42, no. 1, Jan.-Feb. 2003, p. 1); John F. Guilmartin's "Unmanned Aerial Vehicle" (*Encyclopaedia Britannica*, 15 July 2020, www.britannica.com/technology/unmanned-aerial-vehicle); "In-Service, *Adj*. (1)" (*Merriam-Webster's Unabridged Dictionary*, Merriam-Webster, 2022, unabridged.merriam-webster.com/unabridged/in-service); "Labor Shortage" (*Law Insider*, 2022, www.lawinsider.com/dictionary/labor-shortage); "Machinery, *N*. (1)" (*Merriam-Webster's Unabridged Dictionary*, Merriam-Webster, 2022, unabridged.merriam-webster.com/unabridged/machinery); "Mechanization" (*Merriam-Webster's Collegiate Thesaurus*, Merriam-Webster, 2022, unabridged.merriam-webster.com/thesaurus/mechanization); "Picker" (*Merriam-Webster's Collegiate Dictionary*, Merriam-Webster, 2022, unabridged.merriam-webster.com/collegiate/picker); and "Robot, *N*. (2)" (*Merriam-Webster's Collegiate Dictionary*, Merriam-Webster, 2022, unabridged.merriam-webster.com/collegiate/robot.

B Peruse the article, take a look at the new words and phrases, and then respond to the questions below it.

Fig. 4.1. Suwin Puengsamrong. *Agriculture Robotic and Autonomous Car . . . .* 2022. *Dreamstime*, www.dreamstime.com/agriculture-robotic-autonomous-car-working-smart-farm-future-g-technology-farming-concept-image242865796.

A Game-Changing Experience

RECENT YEARS HAVE SEEN THE TREND OF PRECISION AGRICULTURE—that is, of **agricultural machinery**, robots, and **unmanned aerial vehicles** (UAVs)—experience its culmination (Yanushevsky xi). One can say that this time of COVID-19 is an ideal fertile ground for even greater use of **robotic farmers** (Abnet 242), evidently in order to avoid human contacts and prevent infection. In view of the fact that the farmers already suffer a lot, the **automation of machines** assists the agricultural sector in several ways:

Operating costs are significantly reduced by use of machines, and, as a result, the work was done better and in a shorter time.

The risk of infection was mitigated, since humans play almost no role in this work.

The robots take over all the work, from the preparation of soil for seeding, cultivation, and seeding to the final part, when the robots package the finished products for sale.

Various robots are encountered on the market—for example, the **citrus pickers**, **lettuce pickers**, and **strawberry pickers**. The robots have an ability to sort the harvested fruits by class, maturation period, and size.

A large part of automated robots was manufactured by the juvenile engineers, because robotics is very popular in the countries such as Finland, Norway, or Sweden, where the students undergo **in-service trainings** on local farms and, in conversations with the farmers, get an idea of the issues that plague them the most.

Agriculture is a **primary sector**, for people need food to survive. Consequently, the objective of modern agriculture and of the robotic farmers is to prevent future scenarios of agronomy being left without manpower. By all means, the future holds both new trends and new jobs for which workers will be needed. However, some professions will disappear completely. It is considered that the traditional occupations—for example, those in civil engineering and farming—will take the first blow.

Even today, it is difficult to find the workforce to do these backbreaking and responsible jobs that people take on reluctantly.

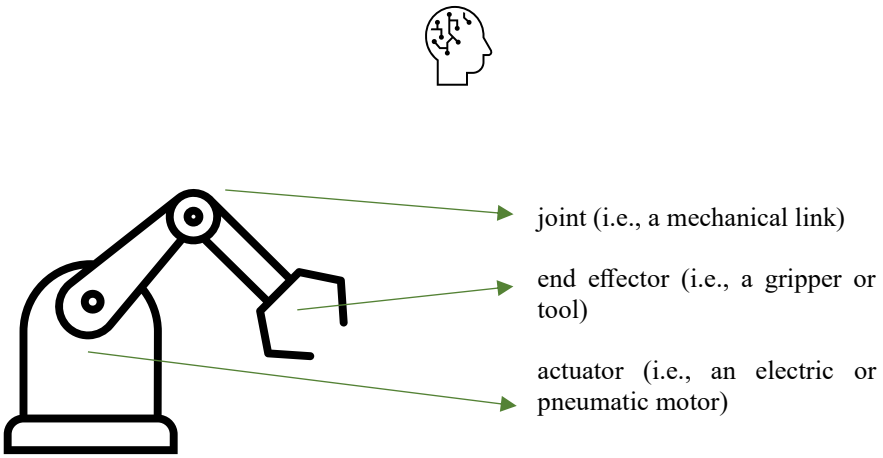
The development of technology leads to the manufacturing of robots that are sophisticated enough to readily replace people in an increasing number of workplaces. Word is that these **androids** (Thompson 113) are about the height of an average man—that is, their heads and extremities, as well as other parts of the body necessary for operation, are exactly like those of a human being. Such robots are also equipped with **optics**, **advanced sensors**, and other complex systems by which they function with delicate precision. But there is a difference in **cost-effectiveness** too: robots are a less expensive labor force. They do not take a vacation, they do not take a day off, they are never on sick leave, and they never take a break. They are capable of working twenty-four hours a day almost without any error.

If, however, a robot commits an error, it is automated to revert to the previous state and rectify that error.

Fig. 4.2. Suwin Puengsamrong. *Agriculture Drone . . . .* 2022. *Dreamstime*, www.dreamstime.com/agriculture-drone-fly-to-sprayed-fertilizer-sweet-corn-fields-image139968362.

The UAVs that can fly across the field in a moment, **take the visuals** of everything that needs to be recorded (Bestaoui Sebbane 249), and carefully **calculate** how much pesticide concentrate is needed on the basis of ground surface covered are currently in use. There are no losses, and the operation is flawless. This is a present-day reality, so a report about the adoption of **drones** and robots in agriculture is not something which people in the twenty-first century had not encountered before. It may be concluded that the robots will perform all menial tasks that demand repetition. There is a vague possibility that the robots may take over the world, as they are not as creative as humans, and they express emotions differently when compared to humans. Young people should invest in themselves, educate themselves about all new trends in technology, and be diligent and resourceful. Finally, it is possible that some of them will be working on an **anthropomorphic**, or humanoid, robot that will be marketed in a few years.

Note: The examples are adapted from Martina Dugonjić's "Zašto vizija moderne poljoprivrede . . . ." (*Feniks*, vol. 17, Oct. 2021, pp. 48–49).



Automaton is a sensor-equipped machine programmed by a central computer system that performs an action—for example, the process of locating an object or the process of manipulating an object—precisely and repetitively.

Fig. 4.3. Adapted from: Santiago Remacha Esteras and Elena Marco Fabré. "Robots, Androids, AI." *Professional English in Use for the Computers and the Internet: ICT*, Cambridge UP, 2007, pp. 70–71.

Robots and drones change the vision of modern farming and dominate the farms all around the world. They enable farmers to finish a job more accurately and on time, which is extremely important in farming. Robots and drones are efficient, fast, and precise and operate routinely twenty-four hours a day, with a minimum of errors.

Examples of Current Usage

Some robots can be **solar-powered** and driven by GPS technology, and solar energy enables them to operate full time, although they carry **batteries** for added power (Stiffler). Their principal purpose is to **eradicate weeds** and **regenerate soil**, so **the application of pesticides** may be reduced by up to ninety percent by means of such weeders. The projected **savings** are sizeable, while the **health benefits** are enormous. Frequently, the **robot-manufacturing companies** also manufacture other farm machinery products which are based on the use of solar energy. The prices of these robots range from US$125,000 to US$160,000, depending on purchasable **add-ons**. The engineers dealing with **microtechnology** and **agricultural technology**, or "ag tech" (Stiffler), and are also to be credited for the robot owned by the American company Aigen, headquartered in Kirkland, Washington. This **robotic weeder** autonomously navigates rows of crops and uses its mechanical arms to remove undesired weeds, whereas its AI is trained to leave **benign weeds**, with an intention to promote **carbon retention** in the soil (Stiffler).

According to *GeekWire*'s Lisa Stiffler, robotic machines more robust than Aigen's prototype are, for instance, Carbon Robotics' **laser-powered weeders**. Based in Seattle, Washington, Carbon Robotics manufactures robots that can treat sixteen acres in a day, or five times the acreage of Aigen's device, but Aigen's robot, which is tested on sugar-beet farms in Idaho, is **lightweight** and **beneficial for the climate**, because it does not generate **additional carbon emissions**. In the near future, Aigen intends to produce devices that are also capable of **insect and disease identification** and **measuring the carbon and nutrient content of soil**.

Fig. 4.4. Adapted from: Lisa Stiffler. "Tech Vets Lend $4M . . . ." *GeekWire*, 18 Jan. 2022, www.geekwire.com/2022/tech-vets-land-4m-to-develop-solar-powered-robots-that-zap-weeds-and-regenerate-soil.

By contrast, Energid Technology Corporation from North Reading, Massachusetts, manufactures a **robotic system** developed in conjunction with NASA researchers that can harvest citrus with several times the precision of hand tools: **picking speed** is two seconds per orange ("Citrus Harvesting"). The $400,000 system, which was tested in a Florida orange grove, operates **with no damage to citrus** by extending its "frog tongue." Besides robots, Energid Technologies Corporation develops various intelligent systems that make our lives easier.

Fig. 4.5. Adapted from: "Robotic Citrus Harvesting." *YouTube*, uploaded by Energid Technologies, 28 Apr. 2014, www.youtube.com/watch?v=Gf60au-U318&t=7s.

Thus, **robotic technology** entails the entire array of robots that are used to perform various tasks about the farm, such as the **extirpation of weeds**, **hoeing**, and actual **assistance in the finishing operations**, but robots are most frequently used for **harvesting operations**. This technology was created by junior engineers, and it has been a real example of how young and innovative people can become successful and famous. They believe that they have much to offer to the world of agronomy by means of automata. It often starts when a junior engineer strikes up a conversation with a farmer about his everyday problems on the farm. All of that provides a stimulus to the engineer to facilitate the business of local farmers.

As noted earlier, robots intended to be used for the harvesting of berries, such as blackberries, raspberries, strawberries and so forth, have also been invented. The major advantage of these dedicated "agrobots" (Forte 135) is that they can sort the berries by size **in preselected and prepared containers**. The robots are constructed out of **corrosion-resistant materials**, which are **modified to reduce degradation**. With assistance from sensors, the agrobots **accurately determine the time of harvest**, so that it cannot happen that fruits are harvested too early or late, which will result in **major savings**. Many companies are currently

working on the production of a machine that will navigate through a field of row crops and will **collect pests that gather near the plants** successfully.

Within this framework, Blue River Technology, an independently run subsidiary of Deere & Company from Sunnyvale, California, has designed a **lettuce bot**—that is, a robot ideal for lettuce thinning and the harvesting of vegetables of a similar nature. The lettuce bot operates as a **tractor attachment** while also automating the arduous process of lettuce thinning "by taking images, identifying which plants to remove, spraying them, and verifying the accuracy and performance of the system" ("Meet Lettuce Bot") in real time. Consequently, Blue River Technology has the vision to **help farmers to apply modern technology** in an accessible manner, the main goal being reducing the application of pesticides.

Fig. 4.6. Adapted from: Katie Fehrenbacher. "The Startup behind the Lettuce Robot . . . ." *Fortune*, Fortune Media IP, 2022, fortune.com/2015/06/03/3d-crop-scanner.

Vision Robotics Corporation (VRC) from San Diego, California, on the other hand, has invented an intelligent **grapevine pruner** attached to a tractor that moves autonomously through the rows. The pruner operates while moving eighteen inches (i.e., forty-six centimeters), then stopping and cutting. A model is generated on the basis of pictures taken by front cameras, and **cutting points** are calculated.

Fig. 4.7. Adapted from: Richard Lenhert. "Automated Pruning with Robotics." *Good Fruit Grower*, Washington State Fruit Commission, 2022, www.goodfruit.com /automated-pruning-with-robotics.

Finally, certain robots may be employed in **floriculture**, particularly in the production of chrysanthemums, because their **automated sensors** allow them to be very precise in planting. In fact, such a machine may take **propagation material** out of a container, and it may deposit it in **support netting**.

As far as the farming drones are concerned (Royakkers and van Est 141), they **collect and analyze data** about crops and make work easier for the farmers while so doing. The UAVs such as the one manufactured by AgEagle Aerial Systems Inc. from Wichita, Kansas (fig. 4.8), are capable of taking **high-resolution images** of the field from a desired distance (Bhatnagar et al. 233) and subsequently transmit the data to the owner of the UAV. The drones use **special sensors** to detect **crop health condition** (Zhang and Pierce 42, 69) and provide timely information if something is wrong with the field—for example, if there are excessive weeds.

Indeed, the use of the **robotic drones** is multiple, and they are an excellent selection for numerous farmsteads, since the farmers can do many activities using a single drone.

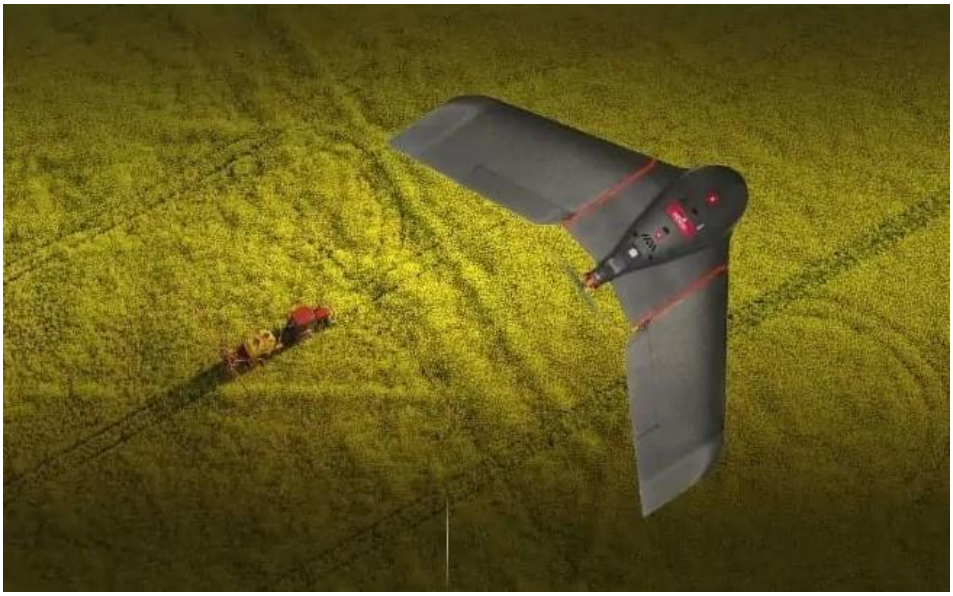


Fig. 4.8. Adapted from: Mike Ball. "Agribotix and senseFly Announce Agricultural Drone . . . ." *Unmanned Systems Technology*, EchoBlue, 6 Jan. 2017, www.unmannedsystemstechnology.com/2017/01/agribotix-sensefly-announce-agricultural-drone-data-processing-solution.

Note: The examples are adapted from Martina Dugonjić's "8 robota . . . ." (*Feniks*, vol. 17, Oct. 2021, pp. 50–52).

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Lesson 2

VOCABULARY

A Matching Exercise

Match the words on the left with the definitions on the right by drawing arrows from each of the words to a correctly drafted detailed description.

1. add-on
2. carbon retention
3. floriculture
4. grapevine pruner
5. health benefit
6. lettuce bot
7. optic
8. propagation material
9. robotic farmer
10. robotic weeder
11. sensor
12. support netting
13. tractor attachment
14. UAV

a) a device that measures a physical property
b) a plastic mesh with approximately four-inch[1] square openings that helps keep the plants growing in an upright habit when their blooms become heavy
c) a remotely piloted vehicle
d) a robot that harvests lettuce
e) a robot that is fitted with sensors to detect weeds
f) a tool that cuts canes (i.e., branches developed from vine shoots) at specified distance from vine with shears, leaving required number of buds (i.e., protuberances or joints that develop into offshoots) on vine
g) a vehicle that actually performs plowing, fertilizing, dusting and harvesting crops using GPS and laser-based guidance systems (i.e., range finders)
h) an optical instrument
i) any part of the plant that is used in the reproduction and multiplication thereof
j) something that can be added to an existing object
k) supplementary devices for the tractor
l) the cultivation of flowers
m) the limitation of soil-disturbing activities and the minimization of carbon emissions from soils
n) the phenomenon of improved health that people can derive from an activity, food, or substance

[1]Four inches equals approximately ten centimeters.

Note: The definitions are adapted from "Add-On, *N.*" (*New Oxford American Dictionary*, p. 19); "Floriculture, *N.*" (*New Oxford American Dictionary*, p. 665); "Grapevine Pruner" (*Dictionary of Occupation Titles: Supplement 1*, 2nd ed., U.S. Dept. of Labor, Mar. 1955, p. 60); Kowligi R. Krishna's [*published as* K. R. Krishna] *Push Button Agriculture: Robotics, Drones, Satellite-Guided Soil and Crop Management* (Apple Academic Press, 2016); Michael Levantino and Audrey Levantino's *The Joy of Hobby Farming: Grow Food, Raise Animals, and Enjoy a Sustainable Life* (Skyhorse Publishing, 2011); Mahindra USA's "Understanding Tractor Attachments and Implements" (*Mahindra USA*, 25 Feb. 2022, www.mahindrausa.com/blog/understanding-tractor-attachments-and-implements--45461?category=4489); *New Oxford American Dictionary*, 3rd ed. (Oxford UP, 2010); "NRCS Practice Standards . . . ." (*Natural Resources Conservation Service*, U.S. Dept. of Agriculture, www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/air/quality/?cid=stelprdb1044982. Accessed on 14 Aug. 2022); "Optic, *N.*" (*Merriam-Webster's Unabridged Dictionary*, Merriam-Webster, 2022, unabridged.merriam-webster.com/unabridged/optic); "Plant Propagation Material" (*Law Insider*, 2022, www.lawinsider.com/dictionary/propagation-material); "RPV, *N.*" (*Merriam-Webster's Collegiate Dictionary*, Merriam-Webster, 2022, unabridged.merriam-webster.com/collegiate/RPV); "Sensor, *N.*" (*New Oxford American Dictionary*, p. 1590); and Andrew M. Thorpe's *The Commercial Space Station: Methods and Markets* (AuthorHouse, 2009).

B Video Clip Exercise

1. Scan the QR Codes embedded below with your smartphone, then watch the video clips in their entirety.

Fig. 4.9. Artursfoto. *Flying Quadrocopter . . . .* 8 June 2018. *iStockphoto*, www.istockphoto.com/photo/flying-quadrocopter-remote-controlled-drone-with-camera-gm962832550-262979500?phrase=quadcopter.

"Blue River Technology—Lettuce Bot." *YouTube*, uploaded by Blue River Technology, 31 Jan. 2015, www.youtube.com/watch?v=jL4kcrumHA8.

"Pruning Overview 2014 3." *YouTube*, uploaded by TheVisionRobotics, 22 Mar. 2014, www.youtube.com/watch?v=4Ov8g0smOF4&t=1s.

"AgEagle LLC Sees Promise in Drone/UAV Use for Agriculture." *YouTube*, uploaded by Michigan Farm Bureau, 3 Mar. 2015, www.youtube.com/watch?v=CVPZ7E9wD3o.

An unmanned aerial vehicle—that is, a drone—is an uncrewed flying machine whose flight patterns are controlled remotely, or it is any device that flies autonomously while being computer-driven (Uredništvo). With reference to the robotic aircraft, a remotely controlled UAV is guided by radio signals (Sadraey), and

automated flight data are entered in the computer prior to the flight according to the aircraft's flight path.

As per the principles of flight, the UAVs are frequently aerodynes and have the airplane-like fixed wings, or they have one or more helicopter-like rotors. They are powered by electric motors, internal-combustion engines, or jet engines and are variously sized—from a few inches in case of a micro air vehicle to several tens of feet, which is the wingspan of the principal ones among them.

Quadcopters, which are powered by electric motors and utilize directable cameras, are accessible to the widest range of users (Solanki et al. xix) due to a relatively small price, as suggested by Terry Kilby and Belinda Kilby. Nowadays, the UAVs are put to an increasing civilian use in the monitoring of agricultural crops too.

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2. Give consideration to the text of Exercise 1 above by providing an overview of current drone architecture and the use of modern drones as accessible devices. Then, address the following questions below:

   What is an unmanned aerial vehicle?

   How is a remotely controlled UAV guided to a distant target?

Are automated flight data entered in the computer prior to the flight or subsequent to the flight?

What is the name of the path in the air followed by a robotic aircraft in flight?

What are the UAVs that have the airplane-like fixed wings called?

How are the UAVs powered?

Why are quadcopters accessible to the widest range of users?

Can the "Internet of Drones (IoD)" (Solanki et al. xxii; Sakalle et al. 323) play an essential role in various smart urban applications—for example, in agriculture and environmental impact reduction?

3. Render a three-hundred-word account of the information furnished by video clips and the text of Exercise 1 on pages 81–82. The précis should include the outline of the material and some information about all of the main trends in the production of UAVs in Croatia.

Fig. 4.10. Adapted from: Stephen Beard. "Could Fruit-Picking Robots . . . ." *Marketplace*, Minnesota Public Radio, 10 Dec. 2019, www.marketplace.org/2019/12/10.

C Sentence Completion Exercise

Refer to the text on pages 69–71 and complete the sentences below.

1. Recent years have seen the trend of _____—that is, of _____, _____, and _____ (UAVs)—experience its culmination.

2. One can say that this time of COVID-19 is an ideal fertile ground for even greater use of _____, evidently in order to avoid human contacts and prevent infection.

3. In view of the fact that the farmers already suffer a lot, the _____ assists the agricultural sector in several ways.

4. _____ are significantly reduced by use of machines, whereas the work was done better in the brief time.

5. _____ was mitigated, since humans play almost no role in this work.

6. The robots take over all the work, from the _____, _____, and _____ to the final part, when the robots _____ the finished products for sale.

7. Various robots are encountered on the market—for example, the _____, _____, and _____.

8. A large part of automated robots was manufactured by the juvenile engineers, because robotics is very popular in the countries such as Finland, Norway, or Sweden, where the students undergo _____ on local farms and, in conversations with the farmers, get an idea of the issues that plague them the most.

9. Word is that these _____ are about the height of an average man—that is, their heads and extremities, as well as other parts of the body necessary for operation, are exactly like those of a human being.

10. Such robots are also equipped with _____, _____, and other _____ by which they function with delicate precision.

11. But there is a difference in _____ too: robots are a less expensive labor force.

12. The UAVs that can fly across the field in a moment, _____ of everything that needs to be recorded, and carefully _____ how much pesticide concentrate is needed on the basis of ground surface covered are currently in use.

13. This is a present-day reality, so a report about the adoption of _____ and _____ in agriculture is not something which people in the twenty-first century had not encountered before.

14. Finally, it is possible that some of them will be working on an _____, or humanoid, robot that will be marketed in a few years.

D True-False Exercise

Verify the accuracy of the assertions, then mark each statement as true (T) or false (F).

1. __ A UAV—that is, a drone—is a manned flying machine whose flight patterns are controlled remotely, or it is any device that flies dependently while being computer-driven.

2. __ A remotely controlled UAV is guided by radio signals, and automated flight data are entered in the computer prior to the flight according to the aircraft's flight path.

3. __ As per the principles of flight, the UAVs are frequently aerostats and do not have the airplane-like fixed wings, or they do not have one or more helicopter-like rotors.

4. __ The UAVs are powered by electric motors, internal-combustion engines, or jet engines and are variously sized—from a few inches in case of a micro air vehicle to several tens of feet, which is the wingspan of the principal ones among them.

5. __ Helicopters, which are powered by electric motors and utilize directable cameras, are accessible to the widest range of users due to a relatively small price.

6. __ Nowadays, the UAVs are put to an increasing civilian use in the monitoring of agricultural crops too.

E Security Verification Task

1. Why is it important that operators of unmanned aircraft systems (UASs) should familiarize themselves with the security and operating procedures in their aircraft instruction manual and make sure they are adhered to?

2. Can you relate to the notions of aircraft mass, flight altitude, and flight velocity when it comes to the UASs?

3. Croatia's civilian aviation authority is a national body that is entrusted with the function to administrate the air sector, being the equivalent of the United States' Federal Aviation Administration (FAA). What is the official designation of the agency?

4. In your opinion, what are the most important capabilities that we have that contribute to the security of agricultural drones?

THE VARIOUS PROCEDURAL AND TECHNICAL SECURITY MEASURES THAT ARE TO BE INCORPORATED ARE THE FOLLOWING:

In the European Union (EU), aviation insurance for unmanned aircraft is compulsory for commercial drones of forty-four pounds (i.e., twenty kilograms) and over, which must have a human operator and cannot fly beyond the operator's visual line of sight.

A competent civil aviation authority requires the registration of commercial drones, which must fly below 394 feet (i.e., 120 meters) above ground or the top of a building and below forty-two miles per hour (i.e., sixty-eight kilometers per hour) under favorable climatic conditions to avoid surrounding obstacles.

An automatic computer-driven system of distributed air traffic control for drones should be developed to move forward in collision avoidance technology and to include emergency kill switches to bring down a malfunctioning drone.

The drones should be confined to specific air corridors in city areas that are dedicated to them—that is, they should never fly near other aircraft or airports; near emergency response efforts; over crowds of people, national parks, and stadiums; or over any space where a descending drone risks public safety.

Note: The first procedural and technical security measure is adapted from the European Parliament and the Council of the European Union's Regulation (EC) No 785/2004 . . . . (30 Apr. 2004. *EUR-Lex*, 30 July 2020, eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32004R0785&from =EN. PDF download). The following procedural and technical security measures are adapted from FamilyEducation Staff's "5 Drone Safety Tips for Your Family" (*FamilyEducation*, 12 Feb. 2020, www.familyeducation.com/entertainment-activities/5-drone-safety-tips-your-family); Kowligi R. Krishna's [*published as* K. R. Krishna] *Agricultural Drones: A Peaceful Pursuit* (Apple Academic Press, 2017); G. Michael Schneider and Judith L. Gersting's *Invitation to Computer Science*, 8th ed. (Cengage Learning, 2019); William W. Taylor and colleagues' *Fighter Drawdown Dynamics: Effects on Aircrew Inventories* (Rand, 2009. Rand Corporation Monograph Series); and Tamara Thompson's, editor's, *Drones* (Greenhaven Press, 2016).

Lesson 1

The Manipulation of Living Organisms

Etymologically, the term *biotechnology* comes from the Greek βío- ("organic life") and τεχνολογία ("systematic treatment") and refers to the use of biological systems for environmental management and in the manufacture of drugs ("Bio-, *Comb. Form* [1]," "Biotechnology, *N.*," and "Technology, *N.*" *New Oxford American Dictionary*, 3rd ed., Oxford UP, 2010, pp. 168, 170, 1782; "Biotechnology, *N.*" *Random House Compact Unabridged Dictionary*, special 2nd ed., Random House, 1996, p. 211). *Biotechnology* was first used by the Hungarian scientist Károly Ereky in his book *Biotechnologie der Fleisch-, Fett- und Milcherzeugung im landwirtschaftlichen Großbetriebe für naturwissenschaftlich gebildete Landwirte verfasst* (Paul Parey, 1919). *Der Große Brockhaus*, on the other hand, formulates a definition of *biotechnology* as "the investigation and commercial use of a life activity of microorganisms" (my trans.; "Biotechnologie." *Der Große Brockhaus: Handbuch des Wissens in zwanzig Bänden*, 15th rev. ed., F. A. Brockhaus, 1929, p. 747. Vol. 2 of *Der Große Brockhaus*)—that is, as a study and industrial utilization of biological functions of microscopic life-forms such as fermenting organisms and yeasts. During the time of the Second World War, the term *biotechnology* was used for a description of industrial fermentation, in which industrial raw materials were produced—for example, acetone for the manufacture of the high-powered explosive known as cordite.

PRE-READING ACTIVITY

Discussion

1. How closely have you been following the news about the use of bioreactors in manufacturing?

2. What do you know about genetically engineered (GE) bacteria used to produce human hormones, microorganisms used to degrade organic waste, or monoclonal antibodies used to identify antigens?

3. Since fermentation is one of the oldest methods of processing food into a form that is suitable for preservation ("Fermentation"), have you acquired hands-on experience in preparing some of the fermented foods—for example, alcoholic and nonalcoholic beverages, such as beer, brandy, cider, mead, or wine; dairy products, such as cheese or yogurt; meat products, such as prosciutto; sourdough bakery products, such as bread; and vegetables, such as cauliflower, garlic, olives, onion, pickles, sauerkraut, or whole peppers?

4. Because the fermentation process increases enzyme, or biocatalyst, content, neutralizes *Escherichia coli*, stores food longer than canning does, and supplements certain nutrients, do you have a constant intake of some fermented foods? What medical advantages may be derived from such practices?

COMPREHENSION

A Foci

antibody — a Y-shaped protein secreted into the blood or lymph that neutralizes the antigen, also known as immunoglobulin

antigen — a substance that stimulates the production of an antibody

aquaculture — the cultivation of water animals and plants for human consumption

bacterium — a prokaryotic, or typically unicellular, microorganism

bioprocess — a technique that produces a biological material for commercial use

bioreactor — an apparatus for growing organisms that are used for the bioconversion of organic waste or in the biotechnological production of substances

bioremediation	a process in which microorganisms are introduced into a region to counteract destructive insects, plant disease, pollution, and the like
genetic engineering	scientific alteration of the structure of genetic material
hormone	a "peptide or steroid produced by one tissue and conveyed by the bloodstream to another to effect psychological activity" (*American Heritage Dictionary* 847)
microbiome	the microorganisms in a particular environment
microorganism	an organism of microscopic size
monoclonal	derived as clones from a single cell
"nutrient bioextraction"	an "environmental management strategy under which nutrients are removed from an aquatic ecosystem through the harvest of enhanced biological production" (United States)
probiotic	a nutraceutical, or a naturally occurring food supplement thought to prevent disease, containing live bacteria
relish	a spicy or savory appetizer
rutabaga	Swedish turnip, also known as swede
synthetic	made by chemical synthesis, especially to imitate a natural product
traceability	the state of being traceable—that is, of a kind to be attributed
transgenic	having genetic material, in all cells, that includes a deoxyribonucleic acid (DNA) sequence or gene transferred by means of genetic engineering from a genetically unlike organism (*Webster's New World College Dictionary* 1539)

Note: The definitions are adapted from *The American Heritage Dictionary . . . .* , 5th ed. (Houghton Mifflin Harcourt, 2016); "Antibody, *N.*" (*American Heritage Dictionary*, p. 77); "Antigen, *N.*" (*American Heritage Dictionary*, p. 78); "Aquaculture, *N.*" (*Webster's New World College Dictionary*, p. 71); "Bacterium, *N.*" (*American Heritage Dictionary*, p. 112); "Bioprocess, *N.*" (*American Heritage Dictionary*, p. 132); "Bioreactor, *N.*" (*American Heritage Dictionary*, p. 184); "Bioremediation, *N.*" (*Webster's New World College Dictionary*, p. 149); "Biotechnology, *N.*" (*Random House Compact Unabridged Dictionary*, p. 211); "Fermentation" (*Fashionably Pickled*, fashionablypickled.com. Accessed 26 Aug. 2022); "Genetic Engineering, *N.*" (*American Heritage Dictionary*, p. 732); "Hormone, *N.* (1)" (*American Heritage Dictionary*, p. 847); "Microorganism, *N.*" (*American Heritage Dictionary*, p. 1112); "Monoclonal, *Adj.*" (*American Heritage Dictionary*, p. 1139); "Nutraceutical, *N.*" (*American Heritage Dictionary*, p. 1404); "Probiotic, *N.*" (*American Heritage Dictionary*, p. 1409); "Prokaryotic, *Adj.*" (*Merriam-Webster's Collegiate Dictionary*, Merriam-Webster, 2022, unabridged.merriam-webster.com); *Random House Compact Unabridged Dictionary*, special 2nd ed. (Random House, 1996); "Relish, *N.* (2)" (*American Heritage Dictionary*, p. 1484); "Rutabaga, *N.* (2)" (*American Heritage Dictionary*, p. 1538); "Synthetic, *Adj.* (1)" *New Oxford American Dictionary*, 3rd ed. (Oxford UP, 2010, p. 1763); "Traceability, *N.*" (*Merriam-Webster's Unabridged Dictionary*, Merriam-Webster, 2022, unabridged.merriam-webster.com); "Transgenic, *Adj.*" (*Webster's New World College Dictionary*, p. 1539); and *Webster's New World College Dictionary*, 5th ed. (Houghton Mifflin Harcourt, 2016).

B Peruse the article, take a look at the new words and phrases, and then respond to the questions below it.

Fig. 5.1. Chernetskaya. *Laboratory Glassware . . . .* 2022. *Dreamstime*, www.dreamstime.com.

Recombinant-DNA Techniques

BIOTECHNOLOGY, OR "BIOTECH," IS AN INTERDISCIPLINARY SCIENCE that combines the areas of **biology**, **chemistry**, and **technology** and employs **living organisms**, especially **cells** and parts thereof, for industrial purposes—for example, in agriculture, environmental protection, and veterinary medicine (Hughes; *EuropaBio*).

Some refuse to use the term *biotechnology* if the use of **genetic engineering technology** (Holcberg; Hanrahan 98) or the **discoveries of molecular biology** are not integrated into the process or product, or they try to emphasize it as the syntagm "modern or new biotechnology" in contrast to classical biotechnology, which particularly covers the production of **fermented food products**. The coverage is comprehensive, as in the baking trade; the brewing industry; cheese production; liquor production; pickling, such as of sauerkraut and other vegetables; salami production; soy sauce manufacturing; and viniculture. Occasionally, however, the manufacture of pickled rutabagas is implicit.

For the reasons that research scientists have given heed to the fundamentals laid down, the chronological milestones of biotechnology (Russo) are as follows:

- the conduct of research on **recombinant DNA**, or "rDNA" (Lee 393), and the development of recombinant-DNA technology in 1973 by Herbert W. Boyer and Stanley N. Cohen, as evidenced by the article that Cohen wrote for *PNAS* on 16 September 2013 ("DNA Cloning")

- the establishment of Genentech, Inc., set up in 1976 by Boyer and Robert A. Swenson to pioneer in the field of rDNA technology (Abate), being a subsidiary of the Roche Group, a **multinational** owned by Switzerland's health-care giant, Roche Holding, provider of top-notch medical services for **biotech** and **pharma**, **diagnostics**, and **research projects** (Pollack)

- the commercialization of Genentech's **synthetic human insulin**, approved by the United States Federal Drug Administration (FDA) in 1982

The Classification of Biotechnology; or, The Selection of Colors

Biotechnology is classified into

agricultural biotechnology—also known as "green biotechnology" (Mishra, "Green biotechnology")—which is the biotechnology employed in bioenergetics (DaSilva), in the manufacture of "biofertilizers" (Agarwal et al. 413), and in the development of pest-resistant cultivars of major crops, but green biotechnology is quietly being used in "geomicrobiology" (DaSilva; Ehrlich, ch. 1; Konhauser), too, to encourage natural synergies in farming processes, annually benefiting more than thirteen million farmers worldwide;

bioethics, known under the appellation of "violet biotechnology," creating a common framework for protecting and exercising intellectual property rights (IPRs)—for example, those pertaining to the requirements and procedures surrounding business or trade names, computer code, copyright, databases, geographic indications, industrial design, inventions, logos, patents, plant varieties, trademarks, trade secrets, and so forth (DaSilva);

bioinformatics, or "gold biotechnology," that might involve nanotechnology to compile a central database containing retrievable information about amino acids and DNA sequences (DaSilva; Lewis; Mishra, "Gold biotechnology");

bioterrorism, "dark biotechnology" that implies readiness to engage in biowarfare—for instance, by perpetrating a crime that involves the use of anticrop chemical weapons (DaSilva; Lewis);

desert biotechnology, which is predominantly concerned with the arid zones, hereafter optionally referred to as "brown biotechnology" (DaSilva);

environmental biotechnology, otherwise known as "gray biotechnology" and being principally concerned with bioremediation and innovative cleanup technologies—that is, with ecosystem restoration (DaSilva; Mishra, "Grey biotechnology");

industrial biotechnology, or "white biotechnology," as the sector alternatively denominates itself, which adheres to natural principles and uses natural resources to produce biologically based chemicals, fabricate fuels, and manufacture materials;

marine biotechnology, or "blue biotechnology," continuing to perfect current techniques for microalgal biofuel production, enabling the production of cosmetics and health-care products, and allowing fish and shellfish growers to carry out aquaculture in coastal waters under the watchful eye of conservationists in most of the states (DaSilva; Mishra, "Blue biotechnology");

medical biotechnology, which is also named "red biotechnology" (Kafarski 814; Mukherjee and Koller 53–55; Singhal et. al. 221), comprising biomedical vaccines and biopharmaceuticals, exploring the potential of generating artificial organs and tissues, and developing regenerative therapies (DaSilva; Mishra, "Red biotechnology"); and

nutritional biotechnology, also known under the designation of "yellow biotechnology" (Mishra, "Yellow biotechnology"; Teixeira and Vicente xi), associated with wood production and, especially, with progressive reduction of saturated fat in the diet.

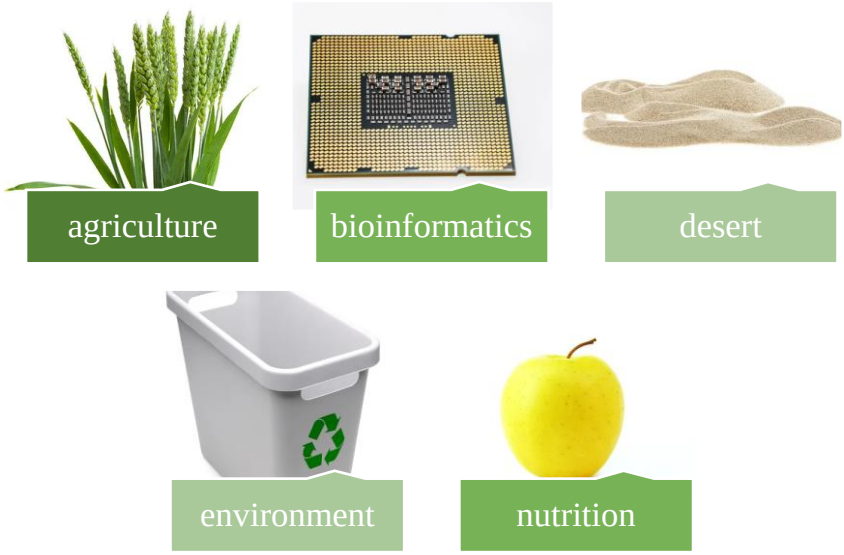

Fig. 5.2. The five major categories of biotechnology applications involved in solving present-day problems, as seen from the farmers' perspective.

Illustrations: Ksena32. *Green Ears of Wheat* . . . . 23 May 2018. *Depositphotos*, depositphotos.com/196924116/stock-photo-green-ears-wheat-isolated-white.html; Wirestock. *Computer Processor* . . . . 15 Mar. 2022. *Depositphotos*, depositphotos.com/552710776/stock-photo-computer-processor-cpu-electronic-components.html; Domnitsky.yar. *Sand Pile* . . . . 15 Apr. 2019. *Depositphotos*, depositphotos.com/257355304/stock-photo-sand-pile-isolated-on-a.html; Pryzmat. *Recycle Bin*. 15 Mar. 2012. *Depositphotos*, depositphotos.com/9533192/stock-photo-recycle-bin.html; and Saras66. *Yellow Apple*. 23 Feb. 2010. *Depositphotos*, depositphotos.com/2304032/stock-photo-yellow-apple.html.

Green Biotechnology: From Minnesota's Honeycrisp Apple to Biological Ballistics or Biolistics

"Agrobiotech" (Blatt 100, 103, 107, 110) is a field of **agricultural science** that tries to devise techniques to see how **cell and tissue culture** complements the work of **genetic engineers**, **molecular diagnosticians**, and **vaccinators** (Mishra, "Agricultural biotechnology"). For example, in **marker-assisted selection** (MAS), **molecular marker technology** assists plant breeders to isolate individual plants on the basis of their **genotype**, or marker pattern, rather than their **phenotype**, or observable traits ("Brief Overview").

Agricultural biotechnology may **modify living structures**—namely, animals, microorganisms, and plants (Agricultural Biotechnology Support Project; Hanrahan 103). It can be applied to administer genetic therapies; to make plants more resistant to pests; to "produce more nutritious and healthy food, with higher protein and vitamin contents" (Holcberg); to synthesize drugs that are based on preparations isolated from plants belonging to various families; and to use animals as a source of medically valuable proteins.

For millennia, the application of **artificial selection** has played a central role in shaping traditional farming methods, so the application of selective breeding precedes that of agricultural biotechnology, which is used to accumulate the desired traits that make the ultimate fruit—that is, a **vivid color**, a **delicate flavor**, an **optimum maturation time for each stage**, and an **ideal size**. Through the agency of agricultural biotechnology, **higher tolerance for environmental stress**, such as vegetative desiccation tolerance and inundation tolerance; **tolerance for herbicides**[1] that kill competing weeds; and **crop yields** can be elevated. Thus, the year 1990 saw the new **bioengineered foods** being introduced into the marketplace (Agricultural Biotechnology Support Project).

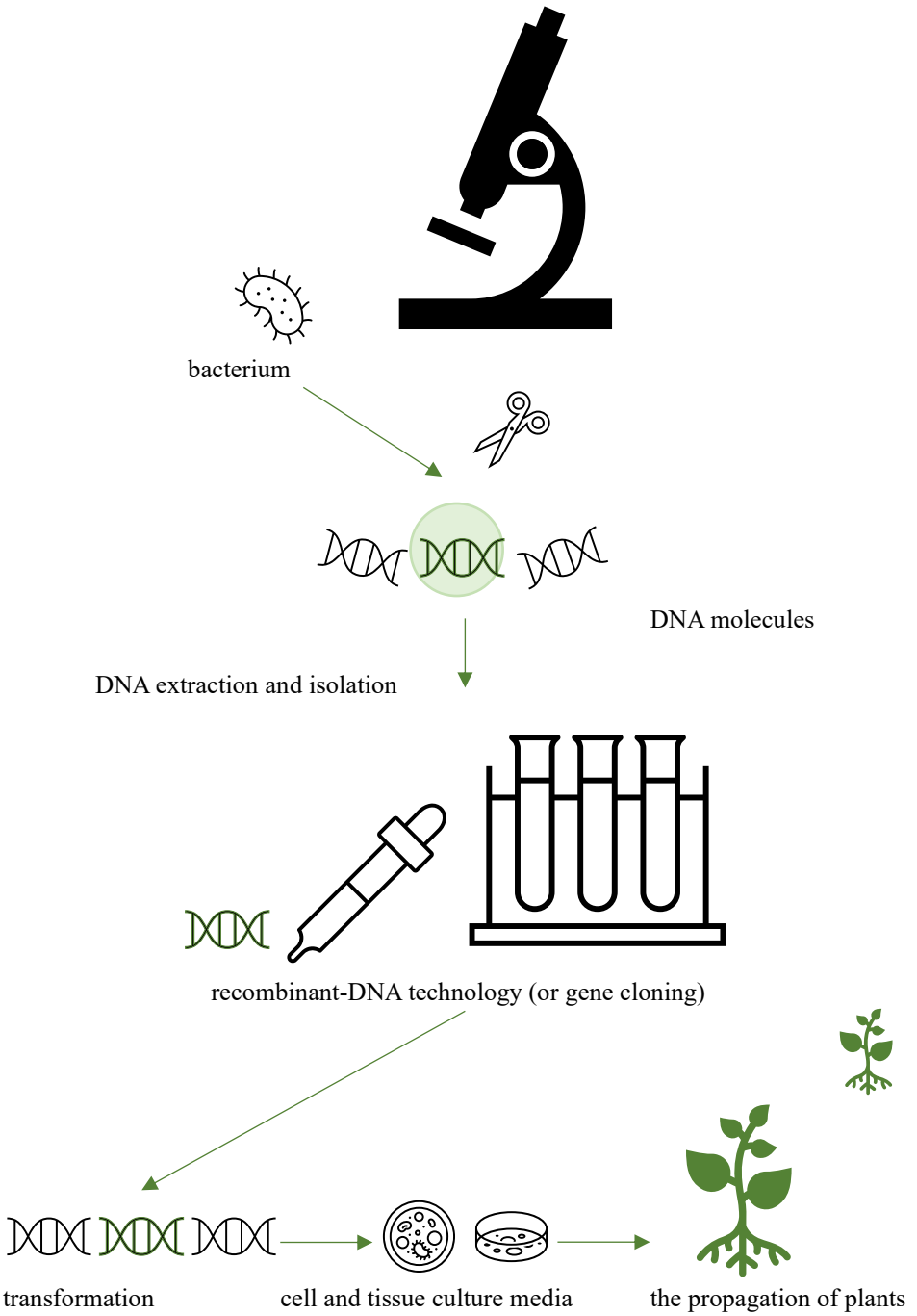

Fig. 5.3. Adapted from: Prashant Mishra [@drprashantmish6]. Photo of a diagram showing the applicability of rDNA technology in agricultural biotechnology. *Twitter*, 9 Apr. 2021, twitter.com/drprashantmish6/status/1380528208936767489/photo/1.

In addition to traditional crossbreeding, a centennial Quality Improvement Strategy (QIS) and quantity optimization model formulated to pollinate sexually compatible species to produce a special variety, or a hybrid, that exhibits desirable parental traits, agricultural biotechnology applies the following techniques to modify crops by genetic manipulation or by selection for suitability to particular environments:

1. **gene editing**, also known as genome editing, which is related to the plants—for instance, herbicide-tolerant canola—generated by intracellular modification of DNA with an enzymatic system;

2. **mutagenesis**, implying the use of chemicals—such as ethyl methanesulfonate (EMS)—or of radioactivity to induce random mutations in DNA, in atomic gardens;

3. **polyploidy**, denoting a chemically induced or natural chromosome modification influencing crop's fertility and magnitude—for example, in a sterile, or seedless, triploid watermelon;

4. **protoplast fusion**, signifying a cellular-component intermixture facilitating an interspecific transfer in hybrids, as masculine sterility transferred from radish to red cabbage (Mariani et al.);

5. **ribonucleic acid interference** (RNAi), which pertains to the method of effective gene silencing, or of gene suppression, while disrupting messenger ribonucleic acid (mRNA) to inhibit protein synthesis; and

6. **transgenics**, which involves the implementation of biolistic particle-delivery systems, or the use of the so-called gene guns, to introduce a test-tube DNA fragment and insert it into an organism's genetic material to produce a new genetic information (Carter et al. 249–50)—for instance, in case of papaya's ring-spot resistance (ACSH Staff).

Fig. 5.4. Agracetus. Photograph of a gene gun. "Gene Gun: The Tool That Revolutionized Plant Breeding . . . ," by Matthew Wilde, 1 Mar. 2021. *Genetic Literacy Project*, geneticliteracyproject.org/2021/03/01.

Agronomic Interest in Genetic Differentiae

Viniculturalists were, indeed, the first to employ biotechnology (Mishra, "Oldest biotechnology"). But as a result of genetic engineering, agricultural biotechnology will provide substantial improvements in the following areas:

- **high-quality traits**, which entail food-processing innovations and storage-capacity increases

- **insect resistance** (IR), which heightens the yield of GE crops while isolating the insect-resistant genes from the *Bacillus thuringiensis* bacterium (Bt), synthesizing nontoxic insecticidal proteins, and introducing these genes into the Bt crops—for example, into the Bt corn, cotton, cowpea, rice, sunflower, soybean, sugarcane, tobacco, tomato, and walnut (Mishra, "Green biotechnology")

- **nutritional content enhancement**, which is implemented to combat micronutrient and vitamin A deficiency, as well as to respond to the population increment in developing countries of Africa, whereby genetically modified (GM) bananas contain vitamin A, iron, and starch, while the GM golden rice synthesizes compounds convertible to vitamin A to suppress the principal factor of cecity; accordingly, allergens and toxins can be eliminated, the dietary value of some products may be obtained, and nutrient bioextraction may also be performed (United States)

- **tolerances**, which in agricultural biotechnology, for example, would be salt tolerance and temperature tolerance of a genetically engineered organism (GEO) under extreme salinity conditions or under extreme cold and heat conditions, whereby such an organism is described as a halophile, a psychrophile, or a hyperthermophile (Figueroa-Yañez et al.)

- **utilization ratios**, which relate to nitrogen-use efficiency (NUE) and to water-use efficiency (WUE), whereby the bioindustry sector states an objective to generate bioenergy out of biofuel and biomass (Fageria and Baligar; Hatfield and Dold; Mishra, "Bio-Industrial")

- **virus resistance** (VR), which relies on genetically engineered disease-resistant plants, such as cassava, corn, and sweet potato, that reduce the relative incidence of disease affliction and its aphid transmission—namely, a difficultly controllable process thereof—previously managed to eventuate in the affected plant's extirpation

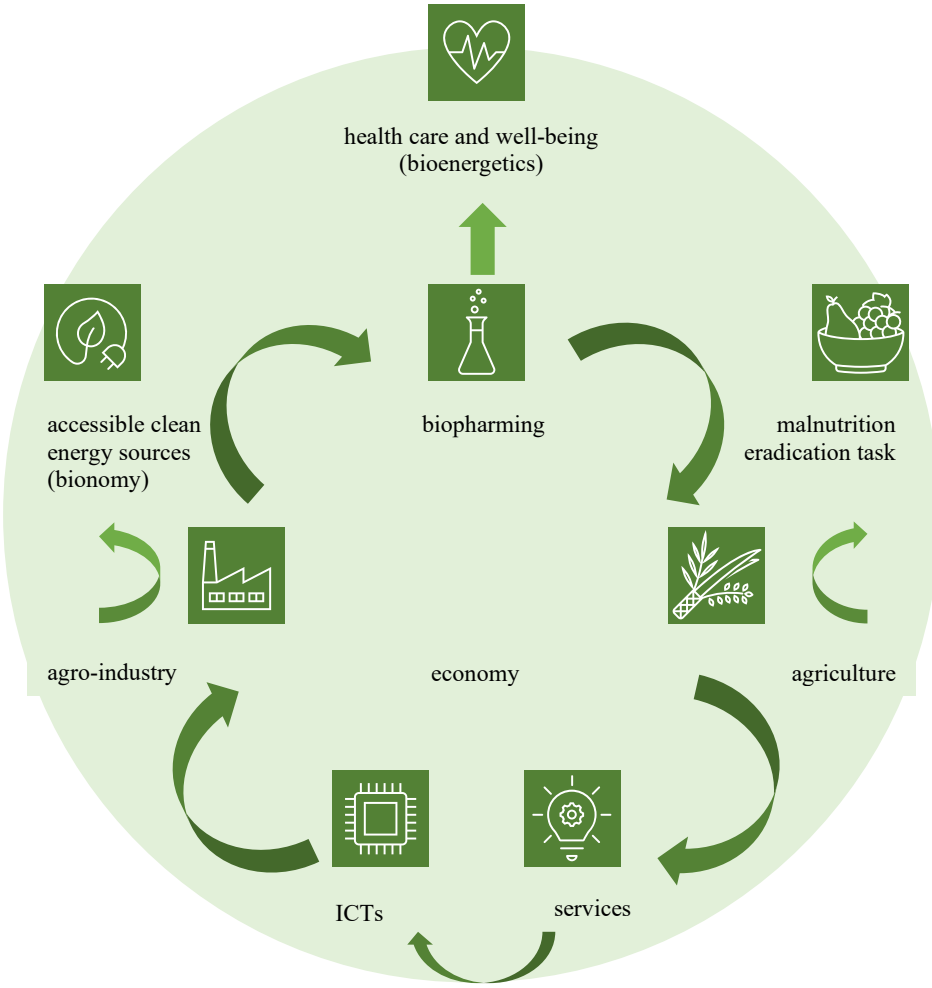

Fig. 5.5. Adapted from: Prashant Mishra [@drprashantmish6]. "See how all sectors are interlinked." *Twitter*, 9 Apr. 2021, twitter.com/drprashantmish6/status /1380528221570002944/photo/1.

Figure 5.5 depicts the second, the third, and the seventh objective of the United Nations' (UN's) Sustainable Development Goals (SDGs), formulated in 2015. A total of seventeen different objectives are attainable by 2030. Thus, the mottoes read "Zero hunger," "Good health and well-being," and "Affordable and clean energy," respectively (United Nations, Department of Economic and Social Affairs).

Genetically Modified Organisms (GMOs)

In the United States, gene editing is not equated with **genetic modification**, also known as gene transfer therapy ("CRISPR Definition"). In the European Union (EU), on the one hand, a GMO is any organism that has been altered or produced by genetic engineering (Purnhagen and Wesseler); on the other hand, GMO regulations in the European Union may approve existing models and methodologies of **crop cultivation**, as well as the activities of **importation** and the sequence of **crop processing** by which the plants growing in the field are harvested and prepared for cooking.

Currently, however, a modicum of **GM crops**—namely, alfalfa, apples, canola, corn, cotton, papaya, potatoes, soybean, squash, and sugar beet—is purchasable and consumable pursuant to an approval by the United States Department of Agriculture (USDA), whereby, for instance, the true **fruit flavor** is preserved better when genetic engineering is practiced, **food waste** is reduced, and the treatments preventing **enzymatic browning** are unnecessary (National Academies). Additionally, to obviate **indigestion** and to not induce **horizontal gene transfer**, the Environmental Protection Agency (EPA) regulates **insecticide-producing crops**, while the FDA[2] conducts **safety testing** for currently marketed GM crops. Thus, in the United States, **GMO research and development programs** are pursued in an approximate duration of thirteen years, incurring an expense of $130 million and being governmentally supervised ("What Does It Take").

As regards the initiatives that have been exercised, the whole issue of Croatia's aspiration to certify **GMO-free status** makes up a vicennial period. All Croatia's counties affirmed the decision to declare their territories GMO-free, thus prohibiting the introduction of **living modified organisms** (LMOs) into the environment. On the European Union level, an amendment to the Directive 2001/18/EC was issued which left open the possibility for the member states **to limit or to prohibit the cultivation of GM crops on their territories**, being devoted to individual crops or crop groups ("Predsjednica Odbora").

On 25 March 2022, Croatia's parliament adopted a declaration on the GMO-free status of a region between the Alps, the Adriatic Sea, and the Danube River to assist in the branding of Croatia as **a land of home-cooked food**, which is focused on **organic farming** and on the cultivation of GM crops to preserve **biodiversity** inherent in the heritage of this part of Central Europe (Republic of Croatia). This initiative correlates with the

process of drafting the legislation on the **labeling of GM food**, what, in the sense of **integrative bioethics**, is significant for consumer protection, environment preservation, and the maintenance of sovereignty over all the living creatures residing in this territory.

Since the European Commission (EC) plans to create a new legal framework for organizing and governing the sowing of agricultural crops created by genome-editing techniques, a period of struggle for the protection of fields from the GM crops is imminent on the European Union level. The media promotion of GMOs fell silent, however, during the COVID-19 pandemic, developmental activities in the agrochemical industry have slowed down, and GMOs have lost their priority status.

The Areas of Use of Biotechnology

The areas of use of biotechnology are the **DNA-assisted identification of biological species**, the **DNA tracing of propagation material**, and the **transgenic animals**. Biotechnology is also used for **biosensors** and for **bioprocessing services**—for example, in environmental protection (*Guidelines*). The commercialization of agricultural biotechnological products has been intensified to a great extent, whereby **market competition between American and European biotechs** is intense; yet, Moderna, Inc., from Cambridge, Massachusetts, and Novo Nordisk A/S from Bagsværd, Denmark, are the flagship companies outmaneuvering the competition (Reiff).

In examining the potential of the **nonmedical market**, scientists remarked that biotechnology will not soon, if ever, feed the world's growing population, particularly if we judge man's need for food from a global perspective, and especially from the perspective of the countries of the South. This will continue to be a task of classical, or conventional, farming.

The bioindustry is capable of significantly assisting agriculture perform its tasks; if, of course, it is accompanied by the surmounting of a formidable obstacle—that is, of the **absence of adequate technologies applicable to the developing countries**. The biggest part of biotechnological development, however, rests on short-term incentives and solutions to impediments offered by the developed countries. For instance, it is estimated that biotechnology already affects approximately twenty-one percent of the European Union's gross domestic product (GDP).

In this century, humanity is predicted to reach and exceed **ten billion people**, and, according to some projections, it may happen by the

year 2050. Consequently, **food demand** would be greater both quantitatively and qualitatively, so by the year 2030 more food will be used than has been consumed by the Earth's population since the beginning of agriculture.

A number of important applications have been developed in the field of **food biotechnology**. **Genetic modification of food** with a view to increasing the protein content and enhancing salt and drought tolerance in plants can help **reduce world hunger**. Besides, biotech has the potential to transform the world's fish supply from an uncertain quantity to a market niche that is suitable for agricultural production by means of **mariculture** and **freshwater aquaculture**.

The agricultural use of biotechnology involves, inter alia, the following general types of activities:

- genetic improvement of **seed quality** and the regulation of growth and maturation

- the provision of **simple diagnostic laboratory facilities** and systems of inexpensive diagnostics for the field verification of contamination plumes and toxic substances—for instance, a biocide (Flick)

The industrial use of biotechnology, however, involves various sectors of manufacture, including the **original chemical compounds**, to address future industrial needs and issues that include efforts that range from **biowaste processing** (*Guidelines* 110, 120, 124) to **cosmetic preparations** (Michalun and DiNardo).

A Secret of Genetics

The discovery of **supersymmetry in the genetic code** is one of the secrets of genetics that many of the world's scientists tried to reveal during more than half a century (*Britannica Guide*; Rosandić and Paar). The genetic code is a method by which twenty-four "products" are encoded by sixty-four genetic "signs," or **codons**, in all living beings. Each codon is comprised of a **triplet of nucleotides**. There are four types of nucleotides. Those marked by the letters A (adenine), C (cytosine), G (guanine), and T (thymine) have been attested to by the scientists and are attributed to the DNA, and those marked by the letters A, C, G, and U (uracil) have been attested to by the scientists and are attributed to the RNA molecule. The

"products" are the **twenty types of amino acids** that build the proteins, and all living creatures are made of proteins, from viruses to man. Thus, the genetic code is a rule that says which genetic sign corresponds to which protein product (Lučić).

It is mathematically established that the landscape of possibilities of associating the number sixty-four with the number twenty approximately amounts to **ten to the power of eighty-four**, or 10^{84}. You can imagine how big this number is when its size is comparable to that of the number of atoms in space. The theory is based on Albert Einstein's general writings, claiming that the symmetries are a dominant concept in the fundamental laws of physics in a sense much broader than that recognized by the common people, so the principle of symmetry is considered to be a primary property of nature. Therefore, the principle of symmetry governs the fundamental laws of nature.

With this discovery, the scientists came up with a new view to the origin of life and evolution based on symmetries, by which it is presumed that the **evolution of genetic code did not occur**, but that it is immutable and unchanging from the beginning of life, as are the number and type of the standard amino acids (*Britannica Guide* 9). In other words, all amino acids and the genetic code are present from the beginning of the development of life as a concrete realization of that fundamental symmetry. That golden rule of evolution is universal and unchangeable with regard to all living creatures on Earth.

The validity of the theory was confirmed by additional arguments and a scientific discovery proving that amino acid samples, a fundamental structure of all animate beings on Earth, are located on the asteroid Ryugu 186 million miles, or 300 million kilometers, away, which is double the distance from Earth to the Sun (Naraoka et al.; Anderson 11).

Bioecology: How the Plants Are Interrelated with Their Common Environment

A student duo joined forces and designed a **smart garden**. What is at issue here is a product which allows the **growing of plants indoors**, so that they proliferate with great certainty and are healthier than any plant grown in a jar, in the garden, or anywhere else. The garden is **fully ecological** and consists of **natural materials** at the rate of ninety-five percent, with only the electronics being made of artificial materials. It is crucial that **everything is procured from Croatia**.

The garden follows exact specifications of a large assortment of plants, because of which it is **capable of taking care of them alone**. In conventional plant cultivation, however, "apartment gardening" (Pennington) generally uses interchangeable plastic soil containers, and it is our duty to take care of the plant, water it, and make sure it has sufficient light. This clearly necessitates some prior knowledge of said items, and certain experience is also required. On the contrary, in case of the Smart Garden System, one just needs to set a new plant in its hole or to insert into the system an old plant being dug up ("All-In-One Solution"). The work for the assignment is reduced, the plant is healthier, and one does not have to worry about in which portion of the room the Smart Garden System is situated because the system has its own illumination source.

According to junior innovators, plant cultivation can be initiated while downloading the *Smart Garden* app, and, as previously referenced, a mature plant can be inserted into the system, whereby the garden takes further care of it, or seeds can be planted in order to subsequently germinate in a container (*Smart Garden*). Seeds and plants are provided when one purchases the product. Then, fresh water is poured into the tank and organic soil conditioners are applied, whereas the water is replaced every thirty days; also, one has to choose when the system will be activated, depending on one's natural daily biorhythm. The app is connectable to a smartphone. Thus, the idea was conceived on the basis of problems that appear to be quite simple; yet, they cause the plants to wither and die to the ground (Ni Hrvatska).

Andrej Penić, a student at the University of Zagreb's Faculty of Electrical Engineering and Computing, and Josip Lukešić, a student at the University of Rijeka's Faculty of Engineering, dream big, want to perfect every single detail, and plan the development of the second version of the *Smart Garden* app, called *Simply*. Thanks to the introduction of artificial intelligence (AI) into the forthcoming product demonstration, the **superstructure color** and the **light color** will then be quickly selectable from the panel, and **personalized messages** will be addable too.

In addition to being an economic issue, **food production** also becomes an important political issue to secure **social stability**. **Global crises** on the food markets caused by the pandemic and the war in Ukraine have opened eyes to the needs for using the full potential of the agricultural sector in Croatia, and that the **strengthening of domestic production of agricultural and food products** is especially significant for the counties in predominantly rural areas.

The data on **foreign-trade exchange of agricultural and food products** in 2022 confirm an insufficient production for domestic needs. That year's **import** amounted to €4.93 billion, being a thirty-three percent increase over 2021, while **export** amounted to €3.52 billion, or 27.8 percent more than in the preceding year. The **deficit** was increased by forty-six percent—that is, by €446 million—amounting to €1.41 billion.

The **self-sufficiency of agricultural and food products** with which Croatia can be competitive and which are important for the supply to the population can be increased by investing in the **intensification of production** and by mobilizing the use of **natural resources**. That increase would also be reflected in the employment demand and in the improvement of the quality of life of individuals in rural areas. The Croatian Chamber of Economy (CCE) will continue to encourage cooperation between economy, science, national institutions, and local and regional administration, in order to find the best solutions to improve production in agriculture.

The **Rural Development Program of the Republic of Croatia** has paid more than €2.48 billion to Croatian agriculture, and the new funds will be important to continue strengthening **productivity**, **resilience**, and the **competitiveness of agriculture and domestic food producers**.

Agriculture and self-sufficiency in food production in times of continuous market disturbances and global crises come to be **security categories** and a **strategic orientation** of national economies. It was recognized in due course, so the interventions and funds for future investments are defined by national strategic plans. **Generational renewal**, **digital and green transition**, **short supply chains**, a closer integration of the **domestic food-supply chain**, and the **combination and enhancement of necessary infrastructure** are some of the key segments to which, inter alia, the funds of the Strategic Plan of the Common Agricultural Policy (CAP) for the years 2023–27, worth close to €3.8 billion; the funds of the National Recovery and Resilience Plan (NRRP); and the funds of reforms defined in the agricultural sector, worth more than €131.1 million, will be advanced.

Note: The example is adapted from Zdenka Rupčić's "Pametnom poljoprivredom za održivu budućnost: Uz nove tehnologije vertikalni uzgoj ili 3D printanje hrane . . . ." (*Glas Slavonije*, 10 May 2023, pp. 8–9).

Value-Added Products

A Sustainable Food Production

LOGISTICS | STORAGE | KNOWLEDGE | AGROTECHNY

Digitalization:

In addition to a **massive foreign-trade deficit** in the exchange of agricultural and food products, the **structure of importation**, in which the higher value-added products are dominant, also constitutes a problem. Croatian agriculture needs a complete transformation of operating modes in order to produce the **value-added products** and to stop exporting the raw materials on the basis of which other countries create added value. The increasing added value of the sector will result in the creation of new job opportunities in rural areas, a revenue increase, and the stark differentiation of Croatia's products. Croatia has a natural predisposition for the production of all types of food, for high-quality agricultural products, and for the value-added products for the domestic market, tourist spending, and export; however, Croatia is self-sufficient only in the production of **cereals** and **oleaginous crops**, exports raw materials, and imports finished products, with all of which it cannot be satisfied. Thus, one should invest into the processing capacities for **primary agricultural products** and **new production technologies**, **strengthen logistics** and **improve storage capacities**, and **transfer knowledge**.

In Croatia, the essential subjects in **agrotechny**—namely, the companies involved in agricultural technology—have been talking about the importance of **digitalization** for a long time, but there are no significant developments in this respect. It is estimated that **less than ten percent** of Croatian agriculture has been digitalized. Hence, it is essential for us to realize that the cooperation of the whole community is necessary and that everyone in the food-production chain is committed to **traceability**, which is ensured by digitalization.

Fig. 5.6. "Photo of a person using a laptop computer . . ." prompt, *Image Creator*, version 113.0.1774.42, Microsoft Bing, 18 May 2023, www.bing.com/images/create/photo-of-a-person-using-a-laptop-computer-with-a-d.

Note: The example is adapted from Zdenka Rupčić's "Pametnom poljoprivredom za održivu budućnost: Uz nove tehnologije vertikalni uzgoj ili 3D printanje hrane . . . ." (*Glas Slavonije*, 10 May 2023, pp. 8–9).

National Objectives

New Production Technologies

VERT FARM | 3-D PRINTING | MICROALGAE | PBR

Technopreneurs:

It is worth emphasizing that technology will be increasingly important in food production in the years ahead, and **vertical farming** or **3-D printing of food**, for instance, will be carried out with its assistance. Certain segments of **technopreneurs** already rely substantially on technology in the **microalga-production process**, intended for the food industry, pharmaceutical industry, and cosmetic industry; indeed, the "photobioreactors" (PBRs) of a patented design enable the **twenty-four-hour photosynthesis process** (Slocombe and Benemann 232).

An **alliance** between the local community, food producers, and food purchasers is crucial for a **sustainable food production** in the future and beneficial to each farmer, because the quantity and value of the merchandise increase in this way, the costs are reduced, and a higher profitability is achieved than would be possible for an individual's market performance. Also, it is necessary to recall the National Development Strategy of the Republic of Croatia for the Period to 2030 and **national objectives** of the Agriculture Strategy for the Period to 2030, which have announced a planned increase in the **volume of agricultural production** amounting to €3.98 billion up to the year 2030, an **increase in labor productivity** by sixty percent, and a **decline in poverty rate** in rural areas by twenty-five percent.

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Fig. 5.7. "Photo of a man in a white overall . . ." prompt, *Image Creator*, version 113.0.1774.42, Microsoft Bing, 18 May 2023, www.bing.com/images/create/photo-of-a-man-in-a-white-overall-wearing-pale-gre.

Note: The example is adapted from Zdenka Rupčić's "Pametnom poljoprivredom za održivu budućnost: Uz nove tehnologije vertikalni uzgoj ili 3D printanje hrane . . . ." (*Glas Slavonije*, 10 May 2023, pp. 8–9).

NOTES

[1] Then, the agricultural plants are referred to as herbicide-resistant crops (HRCs), which are being genetically engineered to withstand chemicals such as glyphosate, whereas the herbicide-tolerant species survive an herbicide application and reproduce normally within the population because of the characteristics donated by their newly inherited abilities. For details, see The Editors of *Encyclopaedia Britannica*, "Weed."

[2] Bovine somatotropin (BST), a growth hormone (GH) affecting the dairy cows' milk production, was sanctioned by the FDA in 1993, and the introduction of GMOs into agriculture in the United States continued in 1994, when a genetically engineered tomato having a longer shelf-life period—namely, Calgene's Flavr Savr—was approved. Since the USDA's Animal and Plant Health Inspection Service (APHIS) has deregulated a GM purple tomato on 7 September 2022, see, for instance, The Editors of *Encyclopaedia Britannica*, "Biotechnology"; Sottile; Freeman Rosenzweig.

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Lesson 2

VOCABULARY

A Sentence Completion Exercise

Review the text on pages 104–05. Then, complete the sentences with the words from the box.

Fig. 5.8. Adapted from: Andrej Penić and Josip Lukešić. "Vrt koji se sam zalijeva." Interview by Tea Blažević. *Klimatska budućnost*, season 3, episode 19, N1 Hrvatska, 23 Feb. 2023. *N1 Info*, n1info.hr/klimatske-promjene/klimatska-buducnost-vrt-koji-se-sam-zalijeva-23-2-2023.

healthier indoors jar product proliferate smart
assortment capable ecological electronics natural specifications
assignment hole insert plant procured reduced
illumination portion situated worry
care container cultivation downloading germinate initiated seeds
biorhythm conditioners fresh

1. A student duo joined forces and designed a _____ garden, a _____ which allows the growing of plants _____, so that they _____ with great certainty and are _____ than any plant grown in a _____, in the garden, or anywhere else.

2. The garden is fully _____, follows exact _____ of a large _____ of plants, because of which it is _____ of taking care of them alone, and consists of _____ materials at the rate of ninety-five percent, with only the _____ being made of artificial materials.

3. Since everything is _____ from Croatia, the work for the _____ is _____, so one just needs to set a new plant in its _____ or to _____ into the system an old _____ being dug up.

4. One does not have to _____ about in which _____ of the room the Smart Garden System is _____ because the system has its own _____ source.

5. Plant _____ can be _____ while _____ the *Smart Garden* app, and a mature plant can be inserted into the system, whereby the garden takes further _____ of it, or _____ can be planted in order to subsequently _____ in a _____.

6. _____ water is poured into the tank and organic soil _____ are applied, whereas the water is replaced every thirty days; also, one has to choose when the system will be activated, depending on one's natural daily _____.

B Abbreviations Exercise

Consult the text on pages 88–108 to determine the meaning of the following abbreviations. Write the meaning of the abbreviation in the space provided. The first one is done for you.

AI	artificial intelligence	IPRs	_____
APHIS	_____	IR	_____
BST	_____	LMO	_____
CAP	_____	MAS	_____
CCE	_____	mRNA	_____
DNA	_____	NRRP	_____
EMS	_____	NUE	_____
EPA	_____	PBR	_____
FDA	_____	QIS	_____
GDP	_____	rDNA	_____
GE	_____	RNA	_____
GEO	_____	RNAi	_____
GH	_____	SDGs	_____
GM	_____	USDA	_____
GMO	_____	VR	_____
HRC	_____	WUE	_____

C Part-of-Speech Sorting Activity

Find the part of speech for the following headwords in the text on pages 106–08. Write *adjective*, *adverb*, *noun*, *preposition*, *pronoun*, or *verb* in the space provided. If you find homographs in this exercise, list the parts of speech for all of them.

agrotechny	_____	inter alia	_____
economic	_____	namely	_____
food	_____	strengthening	_____
foreign	_____	substantially	_____
in addition to	_____	thirty-three	_____
increasingly	_____	worth	_____

D Article Exercise

Supply the requisite articles—that is, complete the sentences with a, an, the, or –. Note that an article is not required between all the parentheses.

1. Etymologically, ( ) term *biotechnology* comes from ( ) Greek βío- ("organic life") and τεχνολογία ("systematic treatment") and refers to ( ) use of biological systems for ( ) environmental management and in ( ) manufacture of drugs.

2. "Agrobiotech" is ( ) field of agricultural science that tries to devise ( ) techniques to see how ( ) cell and tissue culture complements ( ) work of genetic engineers, molecular diagnosticians, and vaccinators.

3. Viniculturalists were, indeed, ( ) first to employ ( ) biotechnology.

4. On 25 March 2022, Croatia's parliament adopted ( ) declaration on ( ) GMO-free status of ( ) region between ( ) Alps, ( ) Adriatic Sea, and ( ) Danube River to assist in ( ) branding of Croatia as ( ) land of home-cooked food, which is focused on ( ) organic farming and on ( ) cultivation of GM crops to preserve ( ) biodiversity inherent in ( ) heritage of this part of ( ) Central Europe.

5. ( ) areas of use of biotechnology are ( ) DNA-assisted identification of biological species, ( ) DNA tracing of propagation material, and ( ) transgenic animals.

6. ( ) discovery of supersymmetry in ( ) genetic code is one of ( ) secrets of genetics that many of ( ) world's scientists tried to reveal during more than half ( ) century.

E Think-Write-Pair-Share Exercise

Work with a partner. Take turns. As you read, consider, ask, and answer questions about biotechnology. Use the language from this unit.


1. Biotechnology can be applied to solve present-day problems, as seen from the farmers' perspective. What issues have emerged in your community that you feel concerned about? What stake do they have in the problems? What types of solutions could solve these problems (see fig. 5.2)?

2. What phenomenon is the phrase "biolistics" in the subtitle describing (see p. 95)?

3. What purposes might scientists have when they, for instance, genetically modify bananas (see p. 99)? Are they trying to persuade the consumers? Are they informing by posting links to articles? What does reposting of certain articles imply about the scientists' purpose? How has the purpose of this nutritional content enhancement changed over time?

4. What are the affordances and constraints of using genetic engineering (see p. 101)?

5. Based on the textbook examples (see pp. 103–04), what is the definition of the genetic code? Do the data for the landscape of possibilities of associating the number sixty-four with the number twenty represent only a minuscule number of overall combinations possible?

6. As Albert Einstein explains, the symmetries are a dominant concept in the fundamental laws of physics. How does Einstein say the principle of symmetry governs the fundamental laws of nature (see p. 104)?

7. What happened to the evolution of the genetic code, as the scientists relate in their viewpoint (see p. 104)?

8. What is the economic situation for Croatian agriculture? Just what is the objective of a complete transformation of operating modes? How well does the transformation achieve its goal (see p. 107)?

9. The chapters you just read teach you about the manipulation of living organisms. From the coign of vantage we have adopted in this unit, what will be increasingly important in food production in the years ahead (see p. 108)?

10. What are the ground rules for the National Development Strategy of the Republic of Croatia for the Period to 2030 and the national objectives of the Agriculture Strategy for the Period to 2030? What is the required result in terms of their deliverables (see p. 108)?

F Noun Pluralization Exercise

Write the plurals.

	Singular	Plural
Ex.	*differentia*	*differentiae*
1.	bacterium	_____
2.	bioethics	_____
3.	cosmetics	_____
4.	datum	_____
5.	information	_____
6.	logo	_____
7.	medium	_____
8.	microalga	_____
9.	motto	_____
10.	photosynthesis	_____
11.	physics	_____
12.	species	_____
13.	symmetry	_____
14.	synergy	_____
15.	tomato	_____
16.	value added	_____

G Verb Tense Exercise

Complete each sentence below with the correct form of the verb in parentheses. Use indicative mood.

1. Few commercial products _____ (**market:** present perfect tense, passive voice, simple tone) for use in plant agriculture, but many _____ (**test:** present perfect tense, passive voice, simple tone).

2. Interest _____ (**center:** present perfect tense, active voice, simple tone) on _____ (**produce:** present gerund, active voice, simple tone) plants that _____ (**be:** present tense, active voice, simple tone) tolerant to specific herbicides.

3. This tolerance _____ (**would, allow:** present infinitive without the introductory *to*, active voice, simple tone) crops _____ (**spray:** present infinitive, passive voice, simple tone) with the particular herbicide, and only the weeds _____ (**would, kill:** present infinitive without the introductory *to*, passive voice, simple tone), not the genetically _____ (**engineer:** past participle, active voice, simple tone) crop species.

4. Recombinant-DNA strategies _____ (**can, use:** present infinitive without the introductory *to*, passive voice, simple tone) _____ (**retard:** present infinitive, active voice, simple tone) the _____ (**soft:** present gerund, active voice, simple tone) of tomatoes, so they _____ (**can, reach:** present infinitive without the introductory *to*, active voice, simple tone) the consumer with better flavor and _____ (**keep:** present participle, active voice, simple tone) qualities.

5. Genetic-engineering techniques _____ (**can, use:** present infinitive without the introductory *to*, passive voice, simple tone) _____ (**lower:** present infinitive, active voice, simple tone) the proportion of _____ (**saturate:** past participle, active voice, simple tone) fat by _____ (**insert:** present gerund, active voice, simple tone) the gene for the stearoyl-acyl carrier protein desaturase enzyme into canola and other oil-_____ (**produce:** present participle, active voice, simple tone) crop plants.

6. Biotechnology also _____ (**hold:** present tense, active voice, simple tone) great promise in the production of vaccines for use in _____ (**maintain:** present gerund, active voice, simple tone) the health of animals.

7. Animals _____ (**may, transform:** present infinitive without the introductory *to*, passive voice, simple tone) _____ (**carry:** present infinitive, active voice, simple tone) genes from other species, including humans, and _____ (**use:** present tense, passive voice, progressive tone) _____ (**produce:** present infinitive, active voice, simple tone) valuable drugs.

8. Plant scientists _____ (**amaze:** present perfect tense, passive voice, simple tone) at the ease with which plants _____ (**can, transform:** present infinitive without the introductory *to*, active voice, simple tone) _____ (**enable:** present infinitive, active voice, simple tone) them _____ (**express:** present infinitive, active voice, simple tone) foreign genes.

Note: The examples are adapted from Milton Zaitlin's "Biotechnology" (*McGraw-Hill Encyclopedia of Science and Technology: Bio–Cha*, pp. 129–32. *McGraw-Hill Encyclopedia of Science and Technology*, 11th ed., vol. 3, McGraw-Hill, 2012. 20 vols.).

A Compact Thesaurus of the Essential Concepts of Digital Agricultural Technologies (DATs)

A Lexicon of Terms Used in an Agricultural Context

NOMENCLATOR

antibody	a Y-shaped protein secreted into the blood or lymph that neutralizes the antigen, also known as immunoglobulin
antigen	a substance that stimulates the production of an antibody
aquaculture	the cultivation of water animals and plants for human consumption
automation	the technique of making a system operate automatically
bacterium	a prokaryotic, or typically unicellular, microorganism
bioprocess	a technique that produces a biological material for commercial use
bioreactor	an apparatus for growing organisms that are used for the bioconversion of organic waste or in the biotechnological production of substances
bioremediation	a process in which microorganisms are introduced into a region to counteract destructive insects, plant disease, pollution, and the like

brain drain — the departure of intellectuals or experienced personnel (i.e., of educated or professional people) "from one country, economic sector, or field" for another, usually for better pay or living conditions

curriculum — the subjects comprising a course of study in a college, or "the whole body of courses offered by an educational institution or one of its branches"

digital communications platform — a software solution (e.g., *Google Workspace*, *Microsoft 365*, or *Zoom*) that facilitates external and internal messaging while offering customer communications functionality, file sharing, and project management and utilizing channels (e.g., phone, task management, team messaging and videoconferencing)

drone — an autonomous, remotely controlled aircraft—that is, an uncrewed aerial vehicle (UAV)—that carries electronic transmitters and sensors and is alternatively denominated as "remotely piloted vehicle (RPV)" or "unmanned aircraft system (UAS)"

genetic engineering — scientific alteration of the structure of genetic material

hormone — a peptide or steroid produced by one tissue and conveyed by the bloodstream to another to effect psychological activity

icebreaker game — an exercise that prompts conversations from participants

information technology — information processing via computers

in-service training	a training going on while in service
intercultural management	management based on the understanding of interaction between diverse cultural elements in order to create a successful business cooperation and successful business relationships
interpersonal communication	a transmission of certain content to the interlocutor and an opinion on the content, interlocutor, and on oneself
labor shortage	the unavailability of the number of appropriately experienced and qualified personnel sufficient to maintain the project schedule at cost acceptable to the proprietor where the effort is to be completed
machinery	a range of machines—for instance, the one operated in farming
mechanization	the process of putting a system under the control or regulation of electronic devices
microbiome	the microorganisms in a particular environment
microorganism	an organism of microscopic size
monoclonal	derived as clones from a single cell
mobile application development	the creation of software applications running on a mobile device and utilizing a network connection to operate with remote computing resources
"nutrient bioextraction"	an environmental management strategy under which nutrients are removed from an aquatic ecosystem through the harvest of enhanced biological production

online store a website navigated to in order to download applications, or apps, to a computer or smartphone and to perform retail sales

picker a machine used in picking fruits

probiotic a nutraceutical, or a naturally occurring food supplement thought to prevent disease, containing live bacteria

relish a spicy or savory appetizer

road map a detailed plan guiding progress toward a goal

robot a device that automatically performs complicated, frequently repetitive operations

robotics the science of the creation and use of robotic devices

rutabaga Swedish turnip, also known as swede

software developer a software-designing and software-writing person or organization

software industry the development, distribution, and maintenance of application software, database and analytics software, operating systems, software as a service (SaaS) and system infrastructure software

syllabus an outline of the subjects in a course of study

synthetic made by chemical synthesis, especially to imitate a natural product

team communications tool a proofing software or a tool used for document collaboration (e.g., *Office 365*), file sharing (e.g., *OneDrive*), project management, real-time chat (e.g., *Microsoft Teams*) and voice and videoconferencing (e.g., *Skype* or *Zoom*) operational on various platforms (e.g., on *Android* devices, *iOS*, *macOS*, web or *Windows*)

traceability the state of being traceable—that is, of a kind to be attributed

transgenic having genetic material, in all cells, that includes a deoxyribonucleic acid (DNA) sequence or gene transferred by means of genetic engineering from a genetically unlike organism

virtual breakfast a free, live online meeting that usually runs 7:00 a.m.–7:30 a.m. via digital communications platform, with presentations on timely topics

virtual happy hour an online social event held over video meeting platforms that includes drinks and icebreaker games and usually runs 5:00 p.m.–7:00 p.m.

web application development the creation of web apps (i.e., nontransferable, server-residing and Internet-deliverable application programs), accessible to the end user through a web browser

Source Materials

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