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Contact Hours: **1**

Novel Coronaviruses including COVID-19
Mutations, Variants, and Vaccines

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LEARNING OUTCOME AND OBJECTIVES: Upon completion of this course, you will be able to demonstrate knowledge of the pathophysiology of novel coronaviruses and the impact of such viruses on health. Specific learning objectives to address potential knowledge gaps include:

- Explain the etiology of novel coronaviruses.
- Describe the pathophysiology of novel coronaviruses.
- Discuss coronavirus mutations.
- Identify the types of vaccines used in the prevention of novel viruses.

NOVEL CORONAVIRUSES AND THEIR ETIOLOGY

It is imperative that healthcare professionals understand novel coronaviruses, how they impact humans, and what can be done to prevent spread and adverse impact.

Definitions

The word ***novel*** comes from the Latin word *novus*, which means "new." In healthcare, *novel* typically refers to a virus or bacteria that has not been previously known to affect humans. In other words, a novel pathogen is one that previously was either brand new or only found in nonhuman animals or other life forms (Billingsley, 2023; BRG, 2020).

Novel pathogens can cause both epidemics and pandemics. An outbreak of disease is designated an **epidemic** when there is a sudden increase in the number of cases of the disease occurring over a wide geographic area and affecting a high proportion of the population above what is normally

expected. When that disease spreads across several countries and affects large numbers of people around the world, it is then designated a **pandemic** (Mayo Clinic Health System, 2022).

SARS-CoV-2 and Other Novel Viruses

Viruses are named according to their genetic structure for the purpose of developing diagnostic tests, vaccines, and medicines. The diseases caused by these pathogens are named in order to facilitate discussion on disease prevention, spread, transmission, severity, and treatment (WHO, n.d.).

Coronaviruses are a family of viruses named for crown-like spikes on their surface. These viruses can cause illnesses ranging from a mild common cold to serious, even fatal, diseases. There are literally hundreds of different coronaviruses, and most of these viruses are found in animals. Although coronaviruses can be transmitted from animals to people, it is not a common event. It is even more uncommon for an animal coronavirus to infect people and then spread from person to person. When viruses are transmitted from animals to humans, they generally cause illnesses that affect the upper respiratory tract with varying degrees of severity (BRG, 2020; Billingsley, 2023).

The first human coronaviruses were identified in the mid-1960s. Seven of these viruses are known to affect humans today. This includes **SARS-CoV-2**, which is the coronavirus that causes COVID-19. Four of the seven human coronaviruses typically cause mild to moderate illness and are responsible for 10% to 30% of upper respiratory tract infections in adults. However, the other three viruses, including SARS-CoV-2, can lead to more serious infections (Billingsley, 2023).

SARS-CoV-2 is the first novel coronavirus to cause a pandemic in the last 100 years. Other pandemics were caused by novel influenza A viruses, not coronaviruses. COVID-19 has claimed millions of lives throughout the world and is among the most serious pandemics recorded.

There are two other novel coronaviruses that have caused severe illness:

- **SARS-CoV** is the virus that causes severe acute respiratory syndrome (SARS). This disease was first reported in Asia in 2003. The disease rapidly spread to 26 countries before being contained. Containment took about four months. There have not been any cases of SARS reported since 2004.

- **MERS-CoV** is the virus that causes Middle East respiratory syndrome (MERS). It first emerged in Saudi Arabia in 2012. The disease spread to 27 countries. An estimated 80% of reported cases of MERS were found in Saudi Arabia. In the United States, only two people tested positive, and both recovered.
  (Billingsley, 2023)

Etiology of SARS-CoV-2

The virus that causes COVID-19 was first identified in Wuhan, China, in 2019 and spread quickly throughout the world. The World Health Organization (WHO) declared a pandemic in March 2020 (Rath, 2023).

Determining the source of a viral outbreak is typically a complex process. Epidemiologists perform field investigations, conduct surveys in the community and healthcare facilities, and collect specimens for lab analyses.

Investigations into the origin of the virus that causes COVID-19 in particular have aroused scientific and political controversy, and as of yet, there is no definitive conclusion about the origin of the COVID-19 virus. The majority of scientific evidence supports the theory of natural emergence through zoonotic (from animal to human) transmission at the Huanan Seafood Wholesale Market in Wuhan, China. Most scientists refute the theory of an accidental laboratory leak, but this possibility cannot be unequivocally ruled out (Gostin & Gronvall, 2023). Additional scientific research is needed to determine its origin and what, if any, actions interfered with the existing research.

PATHOPHYSIOLOGY OF CORONAVIRUSES

Coronaviruses are enveloped, positive-stranded RNA viruses. These viruses infect many animals, and their human adaptations are probably introduced through zoonotic transmission from animal reservoirs (CDC, 2022a).

How Pathogens Cause Disease

Pathogen infection does not always cause disease. Infection occurs when pathogens such as viruses multiply inside the body. Disease occurs when the infection damages the cells of the body, resulting in signs and symptoms of illness. Whether or not disease develops depends on the specific pathogen and how susceptible a person is to that pathogen.

Novel viruses cause illness by destroying cells or by interfering with cell functioning. The body responds to viral infection with fever (since heat inactivates many viruses), the secretion of interferon (which prevents viruses from reproducing), or by using the immune system's antibodies to target the virus (NAS, n.d.).

Immune Response

When viruses laden with antigens infect a human or an animal, the body recognizes them as foreign substances and reacts in what is called an *immune response*. This response creates antibodies against the foreign substance and is referred to as ***active immunity***. After recovery from the infection, the human or animal is usually immune to getting the same viral disease for varying periods of time or, in some instances, for a lifetime.

Passive immunity occurs when a person is given antibodies to a disease rather than producing them through the immune system. Passive immunity can be obtained by receiving antibody-containing blood products such as immune globulin when immediate protection is required. Such protection lasts only for a few weeks or months (CDC, 2021).

HERD IMMUNITY

Herd immunity (also referred to as *herd protection*) occurs when most of a population becomes immune to a disease. This makes the spread of the disease from person to person unlikely. Achieving herd immunity protects the entire community, not only those who are immune. The percentage of the population that needs to be immune in order to achieve herd immunity varies from disease to disease. The more contagious a disease is, the higher the percentage of the population that must be immune. The exact percentage needed to produce herd immunity depends on many factors, including how people interact with each other, how infectious the virus is, and the presence of variants (Mayo Clinic, 2023; Suryawanshi & Biswas, 2023).

Clinical Manifestations

Human coronaviruses typically cause mild to moderate upper respiratory tract illnesses. These types of illnesses usually last for brief periods of time. However, several human coronaviruses can cause severe symptoms and illness, such as pneumonia or bronchitis. Severe illness is more common in older adults, infants, and people with other chronic illnesses, cardiopulmonary disease, and weakened immune systems (AL DPH, 2020).

Below are the clinical manifestations of three coronaviruses that have been or are currently responsible for pandemics:

- **MERS-CoV (MERS):** MERS typically affects the lower respiratory system and often causes severe symptoms including fever, cough, and shortness of breath, which often progresses to pneumonia. An estimated 3 or 4 out of every 10 patients with MERS have died. MERS continues to occur, most often appearing on the Arabian Peninsula.

- **SARS-CoV (SARS):** SARS symptoms usually include fever, chills, and body aches, eventually progressing to pneumonia. No human cases of SARS have been reported anywhere in the world since 2004.

- **SARS-CoV-2 (COVID-19):** There are multiple symptoms of COVID-19, ranging from mild to severe, that can lead to fatal illnesses such as pneumonia or sepsis. Symptoms vary considerably from patient to patient. Relatively common symptoms include, but are not limited to, fever, chills, shortness of breath, difficulty breathing, fatigue, muscle or body aches, headache, new loss of taste or smell, sore throat, congestion or runny nose, nausea or vomiting, and diarrhea. Symptoms may change as new variants of the virus

appear. Symptoms can also vary from person to person. The Centers for Disease Control and Prevention (CDC) updates these lists of symptoms as new information is identified (AL DPH, 2023; CDC, 2024b; WHO, 2024a).

LONG COVID

Long COVID (also called *postacute COVID-19 syndrome*) is defined as signs, symptoms, and conditions that continue or develop after acute COVID-19 and that last for at least two months without other explanation. Symptoms vary significantly from patient to patient and may include heart palpitations, cough, nausea, fatigue, cognitive impairment ("brain fog"), and others (Leitner, 2024). An estimated 17% of patients who acquire COVID-19 will develop postacute COVID-19 syndrome, and people between the ages of 40 and 49 have the highest reported rates.

The CDC has identified important points about long COVID, which include:

- Long COVID is a real illness that can lead to chronic conditions.
- Long COVID can include a wide range of ongoing health problems that can last weeks, months, or years.
- Long COVID occurs more often in people who had severe COVID-19, but anyone infected with the virus may develop it.
- People who are not vaccinated against COVID-19 and become infected may have a higher risk of developing long COVID compared to people who have been vaccinated.
- People can be reinfected with the virus that causes COVID-19 multiple times; every time a person is infected or reinfected, a risk of developing long COVID exists.
- Most people with long COVID have evidence of infection or COVID-19 illness; however, some people with long COVID may not have tested positive for the virus or even known that they were infected.
  (CDC, 2024a)

Transmission of SARS-CoV-2

Human coronaviruses typically spread via close contact from person to person. Anyone who is infected with COVID-19 can transmit it to other people, even if the affected person does not have symptoms. The more closely someone interacts with a person infected with the virus and the longer the interaction lasts, the higher the risk of the spread of COVID-19. Indoor spaces are riskier compared to outdoor spaces.

SARS-CoV-2 is easily transmitted from person to person and spreads primarily by:

- Coming in close contact with infected people, typically within three feet (one meter)

- Coming in contact with aerosols or droplets that contain the virus, facilitating the entry of the virus via inhalation or by direct contact with the eyes, nose, or mouth
- Being in poorly ventilated or crowded indoor settings where people spend long periods of time (because aerosols remain in the air or travel farther than three feet)
- Touching the eyes, nose, and mouth with hands that have the virus on them
- Touching surfaces that have been contaminated by the virus and then touching eyes, nose, or mouth without cleaning the hands
  (CDC, 2023a; Katella, 2023; WHO, 2021a)

Regardless of whether or not they have symptoms, persons infected with the SARS-CoV-2 virus can be contagious and spread the virus to other people. Research data indicate that infected persons can spread it to others two to three days before symptoms start and are most contagious one to two days before feeling sick. A person with mild to moderate COVID-19 may be contagious for 10 days from the first day symptoms are noticed. Severely affected or critically ill people may remain infectious for up to 20 days from the onset of symptoms (Collins & Starkman, 2024; WHO, 2021a, 2021b).

Replication

Viruses depend on their host cell's protein pathways to reproduce or replicate. Replication can be quite different between different species and types of viruses. Generally, a virus requires attachment, penetration, uncoating and replication, assembly, and virion release (Ryding, 2023).

- **Attachment** occurs when the viral proteins bind to the host cell's surface. When this takes place, viral proteins interact with receptors specific to them as well as the host cells.
- After attachment takes place, viruses **penetrate** the cell according to the changes that occur after binding. Such changes lead to the fusing of the viral and cellular membranes.
- After successful penetration, the next step is uncoating. **Uncoating** involves the degradation of the viral capsid (protein cage), which releases the genomic information that facilitates the beginning of **replication** via transcription of viral genomic information. The remainder of the replication step is the synthesis of viral genome and proteins.
- During **assembly** (also referred to as *maturation*) the products of replication can be modified. Viral proteins and viral genome are packed into new virions (the active, infectious part of the virus) that can be released from the host cell.
- **Virion release** from the host cell can occur in two ways. One is the lysis method, which causes the death of the host cell and allows for the release of the virion. Viruses that release in this way are called *cytolytic viruses*. The second method is budding. These types of viruses (called *cytopathic viruses*) have envelopes and do not typically kill the host cell. Instead, budding allows viruses to acquire a viral phospholipid envelope that facilitates virion release.

VIRUS MUTATIONS AND VARIANTS

When a virus's structure changes as it replicates, such changes are referred to as *mutations*, and a virus with one or more new mutations is referred to as a *variant*. Viral mutation is the alteration of the sequence of a virus's genetic code. Viral mutation is a normal physiologic occurrence, and viruses are constantly mutating. Where mutations are located in a virus's genetic material determines how they alter a virus's properties. For instance, a mutation may alter a virus so that it spreads more or less easily or so that it causes more or less severe disease (WHO, 2021b).

MEASURES TO HELP REDUCE VARIANTS

The more opportunities a virus has to spread, the more it replicates and the greater the chances for mutation. It is possible to reduce the number of variants that a virus develops. To reduce spread and opportunity for the appearance of variants, public health measures for disease prevention (such as wearing a mask, washing hands, limiting close contact with others, and getting vaccinated) must be followed (Cleveland Clinic, 2024).

Antigenic Drift

One way that viruses can mutate is via antigenic drift. *Antigenic drift* refers to small changes in the genes of viruses that happen on a continual basis over time as the virus replicates. These genetic changes typically produce viruses that are closely related to each other. These viruses usually share the same antigenic properties. Thus, an immune system exposed to a similar virus will usually recognize and respond to it (CDC, 2022b).

However, these small genetic changes accumulate over time and eventually cause the development of viruses that are antigenically different. When this occurs, the body's immune system may not recognize such viruses, and illness can occur.

Antigenic viral changes are anticipated, so the composition of any vaccine must be evaluated regularly and updated as needed. Pandemics are less likely to occur with antigen drift thanks to researchers who continually monitor virus evolution and update vaccines as needed and to the gradual nature of virus replication (CDC, 2022b).

Antigenic Shift

Antigenic shift is an abrupt, major change in a virus that causes the production of new proteins in the viruses that infect humans. It is typically unexpected and unpredictable. Antigenic shift leads to a new virus subtype or one that has emerged from an animal population that is so different from the same subtype of viruses in humans that most people do not have immunity to the new type of virus. When this type of shift occurs, the new viruses infect people, spread rapidly, and can lead to a pandemic (CDC, 2022b).

COMPARING ANTIGENIC DRIFT AND SHIFT	
Antigenic Drift	**Antigenic Shift**
• Small, incremental build-up of changes • Expected, researchers alert to potential • Less likely to lead to pandemic	• Abrupt, major change • Unexpected and unpredictable • More likely to lead to pandemic

Variants of the COVID-19 Virus

There are multiple variants of the SARS-CoV-2 coronavirus that are different from the version first detected in China. The original virus is no longer circulating, but dozens of variants and subvariants are circulating throughout the world. For example, Delta, the once-dominant variant, is now no longer a "variant of concern." Omicron is a variant of concern responsible for a global surge that started in November 2021 (Cleveland Clinic, 2024).

According to information from the CDC, the omicron variant spreads more rapidly and more easily than both the original virus and the delta variant. To date, this continues to be the case, and the omicron variant continues to evolve, with a number of subvariants that include HV.1 and EG.5 (CDC, 2023b).

Omicron and its variants are the variants of most concern in the United States as of 2024. At this time, more than 30 omicron subvariants are circulating and are responsible for almost 100% of COVID-19 cases in the United States (Cleveland Clinic, 2024).

As long as the SARS-CoV-2 virus spreads, mutations will continue to occur and new variants will be found. Researchers will work to determine whether each variant spreads more easily, the impact it has on the severity of illness, and the effectiveness of current vaccines against the variant (Johns Hopkins Medicine, 2022).

CLASSIFYING CORONAVIRUS VARIANTS

All viruses change over time. Most changes have minimal or no impact on the properties of the virus. However, some changes may alter important factors such as how easily it is transmitted, severity, vaccine performance, treatments, and diagnostic tools (WHO, 2024b).

Variants are classified according to various systems. The U.S. Department of Health and Human Services (HHS) established a SARS-CoV-2 Interagency Group (SIG) to, in part, characterize emerging variants and monitor their potential impact. The SIG uses four types of classifications:

- Variant of high consequence (**VOHC**): A VOHC has clear evidence that prevention measures or medical countermeasures (MCMs) have significantly reduced effectiveness relative to previously circulating variants. As of 2024, no SARS-CoV-2

variants are designated as VOHC. This may change over time based on available information.

- Variant of concern (**VOC**): These types of variants show an increase in transmissibility; more severe disease; significant reduction in neutralization by antibodies; and reduced effectiveness of treatments, vaccines, or diagnostic detection.
- Variant of interest (**VOI**): These variants have reduced neutralization by antibodies, reduced efficacy of U.S. Food and Drug Administration (FDA) approved treatments or diagnostic tests, or predicted increase in transmissibility or disease severity.
- Variants being monitored (**VBM**): These variants have lineages with potential impact on available medical countermeasures; lineages that previously caused more severe disease or increased transmutations but are no longer detected; lineages with unusually large numbers of antigenic mutations and presence in multiple countries with collection dates within four weeks; and/or lineages previously designated as a VOI, VOC, or VOHC that are currently circulating at very low levels in the United States. (CDC, 2023c)

VACCINES

Vaccines are a critical tool in the battle against viral diseases, including COVID-19. Thus, it is important for healthcare professionals to have a general understanding of vaccines, including their effectiveness against variants, types of vaccines, and common reasons individuals may hesitate to receive a vaccine.

Effectiveness Against Variants

Concerns about the effectiveness of COVID-19 vaccines against variants are widespread. When people hear the words *mutation* and *variants,* they may assume that something seriously different about the changed virus will render a vaccine ineffective.

In reality, although vaccines may be somewhat less effective against some COVID-19 variants, vaccines have clear public health and lifesaving benefits for the public. COVID-19 vaccines have been, or are being, tested against many different coronavirus mutations, and research indicates that vaccines already authorized or currently in development will be effective even with a fair amount of antigenic drift in the SARS-CoV-2 virus. Therefore, people should not avoid vaccination because of concerns about new variants (Elterman, 2021; WHO, 2021b; Nightengale, n.d.).

Types of Vaccines

There are several basic strategies used to make vaccines. One type of vaccine, **live-attenuated**, contains live, weakened viruses with a limited ability to reproduce. Vaccines for measles, mumps, Rubella, chickenpox, and varicella are made in this way. In live-attenuated vaccines,

because the virus does not reproduce effectively, disease does not occur due to the vaccine. However, vaccine viruses are able to replicate just enough to induce memory B cells in the body, which then protect against future infections. An advantage of using live, weakened viruses is that one or two doses typically provide life-long immunity. A disadvantage is that persons with weakened immune systems usually cannot receive this type of vaccine.

Another type of vaccine, **inactivated**, contains viruses that are completely inactivated (killed) using a chemical. This dead virus cannot reproduce. Examples of inactivated vaccines include polio, hepatitis A, influenza, and rabies. The inactivated virus is still recognized by the immune system, which protects against disease development. Benefits of this type of vaccine are that the vaccine cannot cause even a mild form of the disease, and these vaccines can be administered to people with weakened immune systems. A disadvantage is that it usually requires several doses to achieve immunity.

Using a part of the virus to make the vaccine is another strategy. These are referred to as ***recombinant***, ***polysaccharide***, and ***conjugate*** vaccines. Examples include the vaccines for hepatitis B, shingles, and HPV. These vaccines can also be given to people whose immune systems are compromised.

Several COVID-19 vaccines are made by providing the **genetic code** (DNA, mRNA, or vectored viruses) for part of the vaccine. The immune system recognizes that the genetic code is foreign to the body, and the immune system responds against it. Thus, the next time someone is exposed to the virus, the immune system is ready to provide a rapid response (CHOP, 2021).

COVID-19 Vaccines

Several vaccines have been approved for COVID-19 infection, and others continue to be developed. Information about these vaccines continues to change rapidly, and healthcare professionals are encouraged to access CDC, WHO, and state and local government websites. (For the most current information about COVID-19 vaccines, see “Resources” at the end of this course.)

- Pfizer-BioNTech (brand name Comirnaty): This vaccine has been updated over time to focus on new virus variants, and the original and bivalent vaccines are no longer in use. It has yet to be decided whether updated injections will be administered annually like the flu shot.

- Moderna (brand name Spikevax): The original vaccine has been replaced over time to target newer variants. It has yet to be decided whether updated injections will be administered annually like the flu shot.

- Novavax (brand names Nuvaxovid and Covovax): This vaccine, which is a protein adjuvant, had a 90% efficacy in its clinical trial, performing almost as well as the mRNA vaccines in their early trials. It is simpler to manufacture than some of the other vaccines and can be stored in a refrigerator

- Johnson & Johnson / Janssen: This vaccine expired in May 2023 and is no longer available in the United States. People who received this vaccine are considered up to date when they received one updated (2023–2024 formula) COVID vaccine.
- Corbevax: This vaccine was developed by scientists at Texas Children's Hospital and Baylor College of Medicine, in part to support initiatives for equitable global vaccine accessibility and availability. Over 100 million doses of the vaccine have been administered in India.
  (Yale Medicine, 2023; Schnirring, 2024; WHO, 2023)

VACCINE SIDE EFFECTS

Most reported side effects of the COVID-19 vaccines are mild. However, research shows that several serious side effects have occurred, although these are fairly uncommon. These serious side effects may include:

- Anaphylaxis
- Myocarditis
- Pericarditis
- Thrombosis and thrombocytopenia occurring 5–30 days after vaccine administration

Research regarding severe side effects is ongoing (Bekal et al., 2023; CDC, 2024c).

Common Reasons for COVID-19 Vaccine Hesitancy

Despite the history of vaccines' ability to stop disease, some people are hesitant to be immunized in this way. In the case of the COVID-19 vaccine, many reasons have been cited for such hesitancy:

- Distrust of vaccines: Some people believe that vaccines do not work or that they will get sick from the vaccines. Others are concerned that, despite being disproven, there is a link between vaccines and autism disorder.
- Vaccine timeline: Some people are hesitant to be vaccinated because they believe that the COVID-19 vaccine is too new and was created too quickly.
- Effectiveness: People want answers to questions about the effectiveness of the vaccine. Since both COVID-19 and its vaccines are recent developments, some of these questions simply cannot be answered yet. Early studies, however, show that the vaccines are generally safe and effective.
- Side effects: Some people fear possible side effects or long-term complications of receiving a vaccine.

- Lower concern about the virus: Some people and groups do not believe that they are at risk of serious disease from the COVID virus. Or they may believe that the risks of the vaccine outweigh the risks of having the disease.
- Not recommended by one's healthcare provider: One of the major reasons people do not get immunized is that "a doctor hasn't told me I need it." It is imperative that healthcare professionals explain immunization and the purpose of getting vaccines according to schedules based on age and health status.
- Government trust: Research indicates that vaccine acceptance depends on how much people trust their government. For example, in Asian countries where most citizens trust the government, acceptance of the vaccine is nearly 80%. In the United States, acceptance is estimated to be 69%. In countries with low government trust, such as Russia, the acceptance rate is less than 50%.
  (CHOP, 2021; Henry, 2023)

Part of the vaccine process is addressing the issue of vaccine hesitancy. Experts note that addressing concerns about side effects, safety, registration, and access are critical to the success of any vaccine program.

Suggestions for increasing vaccine compliance and reducing vaccine hesitancy include building trust by having in-person conversations with community leaders such as religious leaders, local elected officials, and so forth. If community leaders support vaccine use, members of the public are more likely to support it as well (Firth, 2021).

It is also important to **improve access** to the vaccine, which is another barrier to increasing vaccination rates. Proposals to increase access include:

- Creating a centralized database to help identify at-risk persons
- Simplifying vaccine registration by increasing telephone registration and outreach programs
- Expanding mobile vaccination to target the areas where access is limited
- Establishing programs to administer the vaccine to people who are homebound
  (Firth, 2021)

CONCLUSION

Viral infections are complex processes, with complexity depending on the specific pathogen. Healthcare professionals must be familiar with the viral infection process, mitigation efforts, and vaccine efficacy.

Data show that novel viruses and their mutations have existed for centuries. When such viruses cause a pandemic, it is imperative that global, cooperative action be taken. Healthcare professionals must be able to educate patients and families about how viruses are transmitted,

how to reduce spread, treatment measures, and vaccine administration as well as to dispel myths and inaccurate information.

Vaccines are essential to controlling the spread of these pathogens. Accurate information about vaccine administration, safety, and side effects should be provided through healthcare channels, including patient and family education and community outreach such as print or visual media tools.

RESOURCES

Coronavirus disease (COVID-19) (WHO)
https://www.who.int/health-topics/coronavirus#tab=tab_1

COVID-19 (CDC)
https://www.cdc.gov/coronavirus/2019-ncov/index.html

Infection prevention and control recommendations (CDC)
https://www.cdc.gov/coronavirus/2019-ncov/hcp/infection-control-recommendations.html

Safety information by vaccine (CDC)
https://www.cdc.gov/vaccinesafety/vaccines/index.html

Stay up to date with vaccines (CDC)
https://www.cdc.gov/coronavirus/2019-ncov/vaccines/stay-up-to-date.html

REFERENCES

Alabama Department of Public Health (AL DPH). (2023). *Human coronaviruses.* https://www.alabamapublichealth.gov/covid19/coronavirus.html

Baton Rouge General (BRG). (2020). *What does "novel" coronavirus mean?* https://www.brgeneral.org/news-blog/2020/march/what-does-novel-coronavirus-mean-/

Bekal S, Husari G, Okura M, et al. (2023). Thrombosis development after mRNA COVID-19 vaccine administration: A case series. *Cureus, 15*(7), Article e41371. http://doi.org/10.7759/cureus.41371

Billingsley A. (2023). *The novel coronavirus: What are novel viruses, and how do they impact public health?* https://www.goodrx.com/blog/what-does-novel-coronavirus-mean-science-medical-definition/

Centers for Disease Control and Prevention (CDC). (2024a). *Long COVID.* https://www.cdc.gov/coronavirus/2019-ncov/long-term-effects/index.html

Centers for Disease Control and Prevention (CDC). (2024b). *Symptoms.* https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/symptoms.html

Centers for Disease Control and Prevention (CDC). (2024c). *Coronavirus disease 2019 (COVID-19) vaccines.* https://www.cdc.gov/vaccinesafety/vaccines/Covid-19-vaccines.html

Centers for Disease Control and Prevention (CDC). (2023a). *About COVID-19.* https://www.cdc.gov/coronavirus/2019-ncov/your-health/about-covid-19.html

Centers for Disease Control and Prevention (CDC). (2023b). *Variants.* https://www.cdc.gov/coronavirus/2019-ncov/variants/

Centers for Disease Control and Prevention (CDC). (2023c). *Classifications & definitions.* https://www.cdc.gov/coronavirus/2019-ncov/variants/variant-classifications.html#anchor_1632237683347

Centers for Disease Control and Prevention (CDC). (2022a). *Genomic surveillance.* https://www.cdc.gov/coronavirus/2019-ncov/variants/genomic-surveillance.html

Centers for Disease Control and Prevention (CDC). (2022b). *How flu viruses can change.* https://www.cdc.gov/flu/about/viruses/change.htm

Centers for Disease Control and Prevention (CDC). (2021). *Immunity types.* https://www.cdc.gov/vaccines/vac-gen/immunity-types.htm

Children's Hospital of Philadelphia (CHOP). (2021). *Making vaccines: How are vaccines made?* https://www.chop.edu/centers-programs/vaccine-education-center/making-vaccines/how-are-vaccines-made

Cleveland Clinic. (2024). *Everything you need to know about COVID-19 variants.* https://health.clevelandclinic.org/what-does-it-mean-that-the-coronavirus-is-mutating

Collins S & Starkman E. (2024). *How long is the COVID-19 incubation period?* WebMD. https://www.webmd.com/covid/coronavirus-incubation-period

Elterman K. (2021). *COVID-19 vaccine distrust: Why it's high and how to respond to it.* https://www.goodrx.com/blog/distrust-of-the-covid-19-vaccine/

Firth S. (2021). *Building trust and bridges: Ways to overcome vaccine hesitancy, access.* https://www.medpagetoday.com/infectiousdisease/covid19/91736

Goston LO & Gronvall GK. (2023). The origins of COVID-19: Why it matters (and why it doesn't). *NEJM, 388*(25), 2305–8. https://www.nejm.org/doi/full/10.1056/NEJMp2305081

Johns Hopkins Medicine. (2022). *New variants of coronavirus: What you should know.* https://www.hopkinsmedicine.org/health/conditions-and-diseases/coronavirus/a-new-strain-of-coronavirus-what-you-should-know

Henry TA. (2023). *COVID-19 vaccine hesitancy: 10 tips for talking with patients.* https://www.ama-assn.org/delivering-care/public-health/covid-19-vaccine-hesitancy-10-tips-talking-patients

Katella K. (2023). *9 things everyone should know about the coronavirus outbreak.* https://www.yalemedicine.org/news/2019-novel-coronavirus

Leitner B. (2024). *What is long COVID? Understanding the pandemic's mysterious fallout.* https://www.yalemedicine.org/news/what-is-long-covid

Mayo Clinic Health System. (2022). *Endemic vs. epidemic vs. pandemic: What you need to know.* https://www.mayoclinichealthsystem.org/hometown-health/featured-topic/endemic-epidemic-pandemic

Mayo Clinic. (2023). *Herd immunity and COVID-19 (coronavirus): What you need to know.* https://www.mayoclinic.org/diseases-conditions/coronavirus/in-depth/herd-immunity-and-coronavirus/art-20486808

National Academy of Sciences (NAS). (n.d.). *How pathogens make us sick.* http://needtoknow.nas.edu/id/infection/how-pathogens-make-us-sick/

Nightengale L. (n.d.). *How COVID-19 mutates and how it affects vaccines.* https://www.osfhealthcare.org/blog/how-covid-19-mutates-and-how-it-affects-vaccines

Rath L. (2023). *What is the history of coronavirus?* WebMD. https://www.webmd.com/covid/coronavirus-history

Ryding S. (2023). *How does viral replication work?* https://www.news-medical.net/health/How-does-Viral-Replication-Work.aspx

Schnirring L. (2024). *WHO grants emergency listing for Corbevax COVID vaccine.* https://www.cidrap.umn.edu/covid-19/who-grants-emergency-listing-corbevax-covid-vaccine

Suryawanshi YN & Biswas DA. (2023). Herd immunity to fight against COVID-19: A narrative review. *Cureus, 15*(1), Article e33575. https://doi.org/10.7759/cureus.33575

World Health Organization (WHO). (2024a). *Coronavirus disease (COVID-19).* https://www.who.int/health-topics/coronavirus#tab=tab_1

World Health Organization (WHO). (2024b). *Tracking SARS-CoV-2 variants*. https://www.who.int/activities/tracking-SARS-CoV-2-variants

World Health Organization (WHO). (2023). *Annexes to the recommendations for use of the Biological E Limited's Corbevax (BECOV-2) vaccine against COVID-19.* https://www.who.int/publications/i/item/WHO-2019-nCoV-vaccines-SAGE_recommendation-BECOV-2-annexes-2023.1

World Health Organization (WHO). (2021a). *Coronavirus disease (COVID-19): How is it transmitted?* https://www.who.int/news-room/q-a-detail/coronavirus-disease-covid-19-how-is-it-transmitted

World Health Organization (WHO). (2021b). *The effects of virus variants on COVID-19 vaccines.* https://www.who.int/news-room/feature-stories/detail/the-effects-of-virus-variants-on-covid-19-vaccines

World Health Organization (WHO). (n.d.). *Naming the coronavirus disease (COVID-19) and the virus that causes it.* https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance/naming-the-coronavirus-disease-(covid-2019)-and-the-virus-that-causes-it

Yale Medicine. (2023). *Comparing the COVID-19 vaccines: How are they different?* https://www.yalemedicine.org/news/covid-19-vaccine-comparison

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TEST

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1. Which term is used to describe a sudden increase in the number of disease cases over a wide geographic area within one country and affecting a high proportion of the population?

a. Pandemic
b. Epidemic
c. Sustained outbreak
d. Community outbreak

2. Which statement is **true** about novel coronaviruses?

a. The majority of coronaviruses are found in humans.
b. The MERS-CoV virus causes COVID-19 and first emerged in China.
c. SARS-CoV-2 is the first novel coronavirus to cause a pandemic in the last 100 years.
d. Four of the seven human coronaviruses are responsible for over 50% of all adult upper respiratory infections.

3. Which term is used to describe the body recognizing viruses as foreign substances and reacting to these viruses with an immune response?

a. Passive immunity
b. Interferon secretion
c. Zoonotic transmission
d. Active immunity

4. At which time are people with SARS-CoV-2 most infectious to others?

a. Forty-eight hours after symptoms appear
b. Late in the course of the illness
c. One week before symptoms appear
d. One to two days before the person feels sick

5. Which statement best explains the process of viral mutation that occurs during antigenic drift?

a. Small changes in the genes of viruses occur on a continual basis over time as the virus replicates.
b. An abrupt, major change in a virus causes the production of new proteins in the virus.
c. A new virus subtype forms after unexpected and unpredictable changes to the original virus.
d. A new virus evolves that is more likely to spread rapidly and lead to a pandemic.

6. Which vaccine type is contraindicated for persons with weakened immune systems?

a. Live-attenuated
b. Inactivated
c. Recombinant
d. Genetic code