

# Background

SARS-CoV-2, which causes COVID-19, is a virus from the Coronavirus family. Coronaviruses are named after the Latin word, “corona”, meaning “crown” because they express spike proteins on their surface which resembles the ‘thrones of a crown’. The spike protein is comprised of three domains: a short cytoplasmic tail, a transmembrane domain, and an ectodomain. The ectodomain is arguably the most critical structure of the virus because of its role in facilitating the entry of SARS-CoV-2 into host cells. The ectodomain has two general subunits which can be denoted as S1 and S2. To infect host cells, SARS-CoV-2 uses its spike S1 unit to bind to the host entry receptor, angiotensin-converting enzyme 2 (ACE2). Once bound, SARS-CoV-2 then uses the spike S2 unit to fuse its viral envelope with the cellular outer membrane in order to enter the host cell.

Viruses including SARS-CoV-2 can undergo change by acquiring genetic mutations to generate new variants of the virus. As these new variants emerge, some will persist if their mutations improve their virulence and/or transmissibility. As a result, a major concern about the ongoing genetic evolution of SARS-CoV-2 is that the virus could acquire mutations to its spike protein that will improve the virus’ transmissibility and/or disguise its detection from the immune system.

**As of August 13 2021** there have been **4** SARS-CoV-2 **Variants of concern (VOC)** that have emerged and undergone transmission around the world. A variant becomes a concern when it exhibits features of increased infectivity and/or transmissibility.

## COVID-19 Variant of Concerns in Canada

Province	Alpha	Beta	Gamma	Delta
Canada	228,525	2,390	21,129	16,136
Ontario	145,641	1,493	5,176	5,873
Alberta	45,818	180	2,888	5,368
British Columbia	14,932	163	11,792	2,612
Quebec	7,254	449	564	467
Manitoba	7,195	73	240	855
Saskatchewan	7,085	10	433	934
Newfoundland and Labrador	187	6	1	1
New Brunswick	180	4	1	0
Nova Scotia	103	12	1	22
Northwest Territories	78	0	2	1
Prince Edward Island	28	0	0	3
Nunavut	21	0	0	0
Yukon	3	0	31	0

Note: The table reports publicly available information from the provinces and territories. In case of discrepancies, the provincial or territorial data should be considered current and correct. Adopted from [CTV News](#)

**Variant of Concern:** B.1.1.7 | Alpha

**Other Names:** 202012/01

**Location of Origin:** UK

**Initial Emergence:** September, 2020 (World Health Organization, 2021)

**Impact on Vaccine Efficacy**

- June 3, 2021: Sera from vaccinees with two-doses of the Pfizer vaccine were able to neutralize all three variants, although at reduced levels compared to the wild-type strain: B.1.17 (-2.6 fold), B.1.617.2 (-5.8 fold) and B.1.351 (-4.9 fold). Conversely, one-dose of the Pfizer vaccine was associated with reduced neutralization titers against the aforementioned variants at statistically significant levels compared to the wild-type (Wall et al., 2021)
- March 9, 2021: A study published by the New England Journal of Medicine found the Pfizer vaccine, vaccine, BNT162b2, to be effective in neutralizing both the P.1 and B.1.1.7 at equally high levels. Even though the vaccine efficacy against the B.1.351 was effective, it was relatively lower (Liu et al., 2021).
- January 28, 2021: Novavax announced results from their phase 3 clinical trials in the United Kingdom showing their vaccine, NVX-CoV2373, had a protective efficacy of 89.3% against SARS-CoV-2 (Novavax, 2021b). About 50% of PCR-confirmed symptomatic cases from their placebo group, who did not receive the vaccine, were infected by the B.1.1.7 variant. Thus, these results suggest that the NVX-CoV2373 vaccine can still confer protection against the B.1.1.7 variant.
- January 25, 2021: Moderna Inc. announced their vaccine, mRNA-1273, was able to induce similar levels of neutralizing antibodies against the B.1.1.7 variant as prior variants (Moderna, 2021b; Wu et al., 2021)
- January 19, 2021: Pfizer and BioNTech constructed a pseudovirus with the B.1.1.7 variant mutation, N501Y. The company tested their vaccine, BNT162b2, against the pseudovirus and found the protective efficacy to remain unaffected (Muik et al., 2021)

**Impact on Transmission**

- January 7, 2021: One peer-reviewed study detected a 75% increase in transmissibility of the B.1.1.7 variant than the original strain (Leung, Shum, Leung, Lam, & Wu, 2021)
- December 18, 2021: UK's New and Emerging Respiratory Virus Threats Advisory Group (NERVTAG) released a report suggesting that B.1.1.7 exhibits a higher rate of transmission than previous SARS-CoV-2 strains (Hayward, Shen Lim Julian Hiscox, & Edmunds, 2020). Within three months of its emergence (September), the B.1.1.7 variant has become the predominant circulating strain in the UK (Ecdc, 2021)

**Arrival to Canada:**

- April 26, 2021: Nunavut confirmed province's first cases of B.1.1.7 variant. A total of 21 positive cases of the B.1.1.7 variant were confirmed on this date. (Tranter, 2021)
- April 2, 2021: Northwest Territories reported first case of the B.1.1.7 variant at remote mining site (CBC News, 2021b)
- March 25, 2021: Yukon confirmed first case of the B.1.1.7 variant (Government of Yukon, 2021; PLONKA, 2021).
- February 13, 2021: Prince Edward Island confirmed first case of B.1.1.7 variant which has been linked

to international travel. The individual was reported to be their 20s and had no close contacts upon their return to Canada (MacLeod, 2021; Press, 2021).

- February 12, 2021: Newfoundland and Labrador confirmed an outbreak of the B.1.1.7 variant in St John's Metro region. Pre-liminary testing of 19 cases sent by the Newfoundland and Labrador government found all samples to be positive for the B.1.1.7 variant (Quon, 2021)
- February 9, 2021: Manitoba confirmed first case of the B.1.1.7 variant from a sample that was collected on January 22, 2021. The case has been linked to international travel. Further reports revealed the infected individual was in contact with 5 other people, all of whom remained negative for COVID-19 to date (Bergen, 2021; Billeck, 2021).
- February 2, 2021: New Brunswick confirmed first three cases of the B.1.1.7 variant; 2 from the St. John area and 1 one from the Miramichi area. Two of the cases were linked to international traveling, whereas the one case was linked to travel within Canada (L. Brown & Horne Van, 2021).
- February 2, 2021: Saskatchewan confirmed first two positive cases of the B.1.1.7 variant infection in two residents from Regina (Saskatchewan, 2021; Sciarpelletti, 2020). Two days later, Saskatchewan confirmed first case of B.1.1.7 variant infection in Saskatoon (Government of Saskatchewan, 2021).
- January 22, 2021: Nova Scotia confirmed first two variant cases of COVID-19, B.1.1.7 and B.1.351. Both cases were associated with international travel and did not result in community transmission (Farnell, 2021; Government of Nova Scotia, 2021d)
- December 29, 2020: Quebec confirmed first case of the B.1.1.7 variant from an individual whose family member travelled to the UK and returned on December 11. The traveller was then tested positive for COVID-19 on December 13<sup>th</sup>. The traveller continued follow quarantine rules and remained at home with three members of their immediate family. The B.1.1.7 variant was later confirmed in a member of this family. Further testing revealed all three members to be infected with COVID-19 (Caruso-Moro, 2020; Cori-Manocchio, 2020; Magder, 2020; Québec, 2020).
- December 25, 2020: Alberta confirmed first positive case of the B.1.1.7 variant from an individual that recently travelled to the UK (Franson, 2020; Mertz, 2020).
- December 27, 2020: British Columbia confirms first positive case of the B.1.1.7 variant from an individual that returned from the UK on December 15th (Uguen-Csenge & Kearney, 2020).
- December 26, 2020: Ontario confirmed Canada's first cases of the B.1.1.7 variant in two individuals from Toronto (Aziz, 2020; Jabakhanji, 2020; Rocca, 2020).

#### **Risk to Canadians:**

- March 29, 2021: A report by Ontario's COVID-19 Science Advisory Table stated that 67% of all COVID-19 cases in Ontario were due to variants of concern (VOC). Cases of VOC were associated with increased risk of hospitalization (63%), intensive care unit admission (103%), and death (56%). The report also found 90% of VOC cases in Ontario were from the B.1.1.7 variant (Tuite et al., 2021)
- March 30, 2021: One published study predicted that the B.1.1.7 variant is 50% more transmissible than the wild-type strain and is increasing in proportions at a rate of ~7.5% per day in the United States (Washington et al., 2021)
- March 23, 2021: Canada's Chief Public Health Officer, Dr. Theresa Tam, reports that COVID-19 cases due to the B.1.1.7 variant are currently the highest among young age groups in Canada (D'Amore,

2021)

- March 19, 2021: Dr. Theresa Tam reports there are approximately 4,500 variant cases of COVID-19 in Canada, in which 90% are from the B.1.1.7 variant (Zuber, 2021).
- March 18, 2021: A pre-print study reported first case of infection by the B.1.1.7 variant in domestic cats and dogs (Ferasin, Fritz, Ferasin, Legros, & Leroy, 2021).
- March 16, 2021: Quebec's Premier, François Legault, shares warning that the B.1.1.7 variant will become the province's dominant strain by the end of April (Derfel, 2021)
- March 2, 2021: Public health found a second SARS-CoV-2 variant from the outbreak at the Skyline Lancelot Apartment, in North Bay, Ontario; two positive cases of the B.1.1.7 variant (MacDonald, 2021c).
  - o March 1, 2021: Third person has been confirmed dead due to the COVID-19 variant outbreak at the Skyline Lancelot Apartment (MacDonald, 2021b).
  - o February 26, 2021: The North Bay Parry Health Unit confirmed 42 positive COVID-19 cases from the outbreak at the Skyline Lancelot Apartment. Public health also found 12 of the positive COVID-19 cases to be from the B.1.351 variant (MacDonald, 2021a).
  - o February 11, 2021: A COVID-19 variant outbreak was declared at the Skyline Lancelot Apartment. Public Health confirmed 24 positive cases of COVID-19 (Mullan, 2021).
- February 13, 2021: In a modeling study by epidemiologist Caroline Colijn, researcher shows that failure to contain and prevent transmission of the B.1.1.7 variant can lead to an outbreak in March with more than 5,000 cases per day in British Columbia, Ontario, and Saskatchewan (Are & Colijn, 2021).
- February 12, 2021: Newfoundland and Labrador government declared outbreak in St. John area due to a spike in positive cases for SARS-CoV-2. The province has transitioned to Alert Level 5 with the assumption that the variant B.1.1.7 is responsible for the outbreak. Pre-liminary testing of 19 cases sent by the Newfoundland and Labrador government found all samples to be positive for the B.1.1.7 variant (Quon, 2021).
- February 12, 2021: According to a pre-print study, the B.1.1.7 variant was able to accelerate its transmission in the Greater Toronto Area by 1.8 fold per week during the month of January (K. A. Brown et al., 2021).
- February 11, 2021: Scientific experts predict that the B.1.1.7 variant will eventually become the dominant strain of SARS-CoV-2 in Ontario. Cases of the B.1.1.7 variant are believed to increase in late February (*Update on COVID-19 Projections Science Advisory and Modelling Consensus Tables*, 2021).
- January 25, 2021: Alberta confirmed its first case of B.1.1.7 variant without links to travel exposure. Alberta's Minister of Health, Tyler Shandro, shares the concern that the variant may have begun circulating inside the community (Antoneshyn, 2021).
- January 8, 2021: Long-term care home, Roberta House, from Barrie Ontario was deemed to be in a COVID-19 outbreak.
  - o January 2: preliminary testing detected 6 positive cases were from the B.1.1.7 variant. This variant was believed to have spread onto at least 21 household members of staff and those that visited the facility (CBC, 2021a)

- January 26, 2021: The Simcoe Muskoka District Health Unit discovered over 100 cases of the B.1.1.7 variant which were linked to the Roberta House outbreak (Momney, 2021)
- February 8, 2021: Reports found 129 residents at Roberta House to be positive for COVID-19 in which 69 have died (Goldfinger, 2021; Morris, 2021)
- February 9, 2021: 65 cases of infected residents were confirmed to be from the B.1.1.7 variant. 18 additional cases have been screened positive for presence of mutation and will require further validation of the variant (CP24, 2021).
- December 12, 2020: Public Health England releases a report suggesting that the B.1.1.7 variant can evade detection by PCR assays which use the 'S' gene as the amplification target, also known as a S gene target failure (SGTF) (England, 2020; Galloway et al., 2021; Public Health England, 2021c).

### Disease Severity

- April 12, 2021: Two published studies found no evidence of increased disease severity among patients infected with the B.1.1.7 variant (Frampton et al., 2021; Graham et al., 2021).
- March 15, 2021: A study published in Nature estimated a 61% increase in risk of death among those infected with the B.1.1.7 variant (Davies et al., 2021).
- March 10, 2021: A study published in BMJ estimated a 64% increase in risk of death among those infected with the B.1.1.7 variant (Challen et al., 2021)
- January 21, 2021: NERVTAG published a report suggesting that B.1.1.7 was linked to a 30% increase in risk of death compared to previous strains (Horby et al., 2021). The same report also identified several limitations in their conclusion including their small sample size.

### Critical Mutations

- N501Y: Mutation at genomic position 501 in the receptor binding domain (RBD) of the spike protein. This resulted in an amino acid change from asparagine (N) to tyrosine (Y)
- P681H: Mutation at the cleavage site of the spike protein (CDC, 2020)

**Variant of Concern:** B.1.351 | Beta

**Other Names:** 501Y.V2

**Initial Date of Emergence:** May 2020 (World Health Organization, 2021)

**Initial Location:** South Africa

### Impact Vaccine Efficacy

- June 7, 2021: Sera from both COVID-19 recovered individuals and vaccinees of the two-dose COVAXX vaccine were able to neutralize both the Beta and Delta variants. However, the neutralization titers of the beta variant were reduced in sera from recovered cases (-3.3 fold) and vaccinees (-3.0 fold) (Yadav, Sapkal, Ella, et al., 2021)
- June 3, 2021: Sera from vaccinees with two-doses of the Pfizer vaccine were able to neutralize all three variants, although at reduced levels compared to the wild-type strain: B.1.17 (-2.6 fold), B.1.617.2 (-5.8 fold) and B.1.351 (-4.9 fold). Conversely, one-dose of the Pfizer vaccine was

associated with reduced neutralization titers against the aforementioned variants at statistically significant levels compared to the wild-type (Wall et al., 2021)

- March 9, 2021: A study published by the New England Journal of Medicine found the Pfizer vaccine, vaccine, BNT162b2, to be effective in neutralizing both the P.1 and B.1.1.7 at equally high levels. Even though the vaccine efficacy against the B.1.351 was effective, it was relatively lower (Liu et al., 2021).
- February 7, 2021: AstraZeneca released vaccine trial results in South Africa showing reduced vaccine efficacy against the B.1.351 variant (Wits University, 2021). The study is currently under peer-review.
- January 29, 2021: Johnson & Johnson, also the only drug corporation that is developing a one-shot vaccine, released results from its phase 3 vaccine trials in the United States, Latin America, and South Africa. Analysis of the results found the vaccine efficacy to be 72%, 66%, and 57% in the United States, Latin America, and South Africa, respectively. The reduced vaccine efficacy found in the South African clinical trial has been attributed to the B.1.351 variant (Johnson & Johnson, 2021a; Zimmer, Weiland, & LaFraniere, 2021).
- January 28, 2021: Novavax shared interim results from its clinical trial in South Africa, revealing reduced protective efficacy (40-60%) of its vaccine against the variant B.1.351 (Novavax, 2021b).
- January 25, 2021: Moderna Inc. found a six-fold reduction in the neutralizing titer induced by their vaccine, mRNA-1273, in response to the B.1.351 variant. Despite the reduced efficacy, the neutralizing titers remained above levels required for protection against SARS-CoV-2 infection (Moderna, 2021b; Wu et al., 2021). Moderna Inc. is looking to study how an additional booster of its vaccine can impact the level of neutralizing titers against the B.1.351 variant. Additionally, the company is also seeking to develop a booster vaccine, mRNA-1273.351, against the B.1.351 variant (Moderna, 2021b).

### **Impact on Transmission**

- January 28, 2021: The United States' first two cases of B.1.351 variant was detected in South Carolina (Johnson & Achenbach, 2021; LIU & STOBBE, 2021)
- December 23, 2020: Professor Salim Abdool Karim, Chairperson of the COVID-19 Ministerial Advisory Committee, suggest there is evidence that the B.1.351 variant is 50% more infectious than previous strains (SABC, 2021).

### **Arrival to Canada:**

- April 12, 2021: New Brunswick reported first two cases of the B.1.351 variant in Saint John region (Renic, 2021)
- March 31, 2021: Newfoundland and Labrador confirmed first case of the B.1.351 variant in the Eastern Health region (Moore, 2021b).
- March 2, 2021: Manitoba confirmed first two cases of the B.1.351 variant in Winnipeg (Gibson, 2021a; Government of Manitoba, 2021).
- February 23, 2021: Saskatchewan confirmed first case of the B.1.351 variant in the North Central region of Saskatchewan (Ellis, 2021a).
- February 9, 2021: Quebec confirmed first two cases of the B.1.351 variant in Abitibi-Témiscamingue of Western Quebec. Both cases had no history of international travel (Montpetit & Shingler, 2021;

- Ross, 2021; Simona Maratta, 2021).
- February 2, 2021: Ontario confirmed first case of B.1.351 in the Peel region of Southern Ontario (Freeman, 2021)
- January 22, 2021: Nova Scotia confirmed first two variant cases of COVID-19, B.1.1.7 and B.1.351. Both cases were associated with international travel and did not result in community transmission (Farnell, 2021).
- January 14, 2021: British Columbia confirmed first case of B.1.351 variant (Holliday, 2021; Little, 2021a).
- January 8, 2021: Alberta confirmed Canada's first case of the B.1.351 variant (Heidenreich & Ramsay, 2021).

**Risk to Canadians**

- March 2, 2021: Public health found a second SARS-CoV-2 variant from the outbreak at the Skyline Lancelot Apartment, in North Bay, Ontario; two positive cases of the B.1.1.7 variant (MacDonald, 2021c).
  - o March 1, 2021: Third person has been confirmed dead due to the COVID-19 variant outbreak at the Skyline Lancelot Apartment (MacDonald, 2021b).
  - o February 26, 2021: The North Bay Parry Health Unit confirmed 42 positive COVID-19 cases from the outbreak at the Skyline Lancelot Apartment. Public health also found 12 of the positive COVID-19 cases to be from the B.1.351 variant (MacDonald, 2021a).
  - o February 11, 2021: A COVID-19 variant outbreak was declared at the Skyline Lancelot Apartment. Public Health confirmed 24 positive cases of COVID-19 (Mullan, 2021).
- February 9, 2021: According to Quebec's Public Health Director, Dr. Horacio Arruda, the B.1.351 may have been responsible for two COVID-19 outbreaks in Abitibi-Témiscamingue during January, 2021. According to Abitibi-Témiscamingue's medical officer, Dr. Omobola Sobanjo, preliminary results suggest that up to 30 cases can be directly linked back to the two first cases of B.1.351 in Quebec (Montpetit & Shingler, 2021; Ross, 2021; Simona Maratta, 2021).
- January 28, 2021: Novavax Inc. releases findings from their phase 3 and 2b clinical trials in the United Kingdom and South Africa, respectively. In their preliminary analysis, they have provided data suggesting that patients who were previously infected with the original SARS-CoV-2 strain can still be re-infected with the B.1.351 strain (Novavax, 2021b). Data was later published in the following report (Novavax, 2021a).

**Disease Severity**

No Data (2021-02-14)

**Notable Mutations**

Acquired several mutations in the spike proteins: N501Y, E484K, K417N, D614G, and A701V (CDC, 2020)

**Variant of Concern** P.1 | Gamma

**Other Names:** B.1.1.248

**Initial Date of Emergence:** November 2020 (World Health Organization, 2021)



**Initial Location:** Brazil

### **Impact Vaccine Efficacy**

- June 5, 2021: According to a pre-print study, one dose of either the Pfizer or Moderna vaccine were able to confer high vaccine effectiveness against variants P.1 (61%) and B.1.1.7 (67%) among  $\geq 70$ -year-olds from British Columbia at  $\geq 21$  days post-vaccination (Skowronski et al., 2021)
- March 9, 2021: A study published by the New England Journal of Medicine found the Pfizer vaccine, vaccine, BNT162b2, to be effective in neutralizing both the P.1 and B.1.1.7 at equally high levels. Even though the vaccine efficacy against the B.1.351 was effective, it was relatively lower (Liu et al., 2021).
- January 25, 2021: Due to its mutation similarities with the B.1.1.7 variant, researchers predict that the Moderna vaccine will be equally protective against both variants (Pietsch & Mandavilli, 2021)

### **Impact on Transmission**

- March 5, 2021: In a pre-print study, researchers predicted the P.1 variant was 2.5-times more transmissible than the wild variant and was associated with a reinfection probability of 6.4% (Mendes Coutinho et al., 2021)
- January 27, 2021: Researchers declared the P.1 variant as the dominant SARS-CoV-2 strain in Manaus Brazil (France24, 2021).
- January 25, 2021: Minnesota confirmed America's first case of the P.1 variant (Health, 2021).
- January 12, 2021: The Center for Arbovirus Discovery, Diagnostics, Genomics, and Epidemiology (CADDE) Genomic Network reported 85% of genotyped samples from Manaus Brazil to be from the P.1 variant (N. R. Faria, Claro, et al., 2021)
- December 16-23: Researchers discovered 13 out of 31 (42%) RT-PCR tests in Manaus, Brazil to be positive for the new P.1 variant. Data were published onto a public domain on January 12, 2021 (N. Faria & Et-al, 2021)

### **Arrival to Canada**

- May 6, 2021: New Brunswick confirmed first case of the P.1 variant from the Bathurst region, Zone 6 (Sutherland, 2021)
- April 28, 2021: Newfoundland and Labrador reported first case of the P.1 variant (The Canadian Press, 2021a)
- April 20, 2021: Saskatchewan confirmed first five cases of the P.1 variant from southwest region (Ellis, 2021b; Quenneville, 2021).
- April 18, 2021: Nova Scotia reported first P.1 case (April, 2021; Government of Nova Scotia, 2021a).
- April 15, 2021: Manitoba confirmed first case of the P.1 variant from the Interlake-Eastern health region (Gibson, 2021b; Unger, 2021).
- March 14, 2021: Alberta confirmed first two cases of the P.1 variant from the Calgary zone (Babych, 2021; CBC, 2021b).
- March 10, 2021: Quebec confirmed first case of the P.1 variant from Montreal (Laframboise, 2021a; The Canadian Press, 2021b).
- February 8, 2021: Ontario confirmed Canada's first case of the P.1 variant in Toronto, Ontario. The case was linked to international travel to Brazil (Favaro, St. Philip, & Jones Mae, 2021).

### Risk to Canadians

- April 6, 2021: Total P.1 cases in British Columbia increases up to 872, thereby rendering the province as the world's largest sequenced P.1 outbreak outside of Brazil (BC Centre for Disease Control, 2021)
- April 5, 2021: Alberta Public Health reported a P.1 variant outbreak at three major work sites. The outbreaks were traced back to one individual who recently travelled outside the province (Junker, 2021; Woo & Hunter, 2021)
- March 3, 2021: In a pre-print study by the Centre for Arbovirus Discovery, Diagnosis, Genomics and Epidemiology (CADDE), researchers predicted the P.1 variant to be 1.4-2.2 times more transmissible than non-P.1. variants. Researchers also found a 25-61% increase in likelihood that the P.1 variant can evade protective immunity induced by non-P.1 lineages (N. R. Faria, Mellan, et al., 2021).
- January 17, 2021: First confirmation of re-infection with the P.1 variant in a 29-year-old female with no signs of immunosuppression (Naveca et al., 2021).

### Disease Severity:

No Data (2021-03-08)

### Notable Mutations

- Three mutations in the receptor binding domain (RBD) of the spike protein: N501Y, K417T and E484K  
Consists of 3 deletions and 17 unique changes in amino acid sequence (CDC, 2020)

**Variant Under Investigation:** B.1.617 | Delta

**Location of Origin:** India

**Initial Emergence:** October, 2020 (World Health Organization, 2021)

### Impact Vaccine Efficacy:

- July 7, 2021: Despite vaccination, individuals infected by the Delta can exhibit equally high viral loads in their nose/mouth as those who are unvaccinated. However, vaccine efficacy remains at 85% against severe illness by the Delta variant (Mcmorrow, 2021).
- June 26, 2021: National Microbiology Lab confirmed 2 case of the Delta variant in Nova Scotia (Cooke, 2021; Government of Nova Scotia, 2021c) .
- June 14, 2021: Public Health England reported that one- and two-doses of the Pfizer vaccine were 94% and 96% protective against hospitalization by the Delta variant, respectively. Whereas, one- and two doses of the AstraZeneca were found to be 71% and 92% protective against hospitalization from Delta, respectively (Stowe et al., 2021).
- June 7, 2021: Sera from both COVID-19 recovered individuals and vaccinees of the two-dose COVAXX vaccine were able to neutralize both the Beta and Delta variants. However, the neutralization titers were reduced against Delta in sera from recovered cases (4.6-fold) and vaccinees (2.7-fold) (Yadav, Sapkal, Ella, et al., 2021)
- June 5, 2021: According to a pre-print study, one dose of either the Pfizer or Moderna vaccine were able to confer high vaccine effectiveness against variants P.1 (61%) and B.1.1.7 (67%) among  $\geq 70$ -year-olds from British Columbia at  $\geq 21$  days post-vaccination (Skowronski et al., 2021)

- June 3, 2021: Sera from vaccinees with two-doses of the Pfizer vaccine were able to neutralize all three variants, although at reduced levels compared to the wild-type strain: B.1.17 (-2.6 fold), B.1.617.2 (-5.8 fold) and B.1.351 (-4.9 fold). Conversely, one-dose of the Pfizer vaccine was associated with reduced neutralization titers against the aforementioned variants at statistically significant levels compared to the wild-type (Wall et al., 2021)
- May 24: A study by the Public Health England found that one dose of either the Astra Zeneca or Pfizer vaccine was ~20% less effective in preventing symptomatic disease from the delta variant (33.5%) than the alpha variant (51.1%). Fortunately, vaccine effectiveness against the Delta variant was much higher following the second dose of the Astra Zeneca (60%) or Pfizer (88%) vaccine (Lopez Bernal et al., 2021).
- May 20, 2021: BioNTech released a public statement that their Pfizer vaccine is expected to be 70-75% protective against the B.1.617 variant (Toksabay & Reuters, 2021)
- April 23, 2021: In a pre-print study, researchers showed Covaxin – a vaccine candidate in India – was able to neutralize the B.1.617 variant (Yadav, Sapkal, Abraham, et al., 2021).

#### **Impact on Transmission:**

- July 7, 2021: The viral load of the Delta variant upon early infection was found ~1000 times higher than the original SARS-COV-2 strain in 2020, thus indicating a higher viral replication rate and increased infectiousness (Li et al., 2021).
- June 21, 2021: A pre-print study found the growth rate of Delta variant to be the highest among other variants in the United States (Bolze et al., 2021)
- June 11, 2021: UK public health reported delta as the dominant variant in the country (Public Health England, 2021b)
- June 4, 2021: Professor and leading UK epidemiologist, Neil Ferguson, from Imperial College London estimated that the Delta variant is 60% more transmissible than the alpha variant (Cecil, 2021; Le Page et al., 2021)

#### **Arrival to Canada:**

- June 11, 2021: Nova Scotia reported two cases of the Delta (B.1.617) . Both have been linked to travel (Government of Nova Scotia, 2021b)
- May 19, 2021: Manitoba confirmed 18 cases of the B.1.617 variant in which some of the cases had been identified since late April (Gibson, 2021c; Rosen, 2021)
- May 14, 2021: Saskatchewan confirmed first case of the B.1.617 variant (Ellis, 2021c)
- April 28, 2021: Newfoundland and Labrador confirmed first case of the B.1.617 variant(The Canadian Press, 2021a)
- May 4, 2021: Prince Edward Island confirmed first two cases of the B.1.617 variant(Long, 2021)
- April 26, 2021: New Brunswick reported first case of the B.1.617 variant in the Fredericton region, Zone 3 (MacKinnon & Fraser, 2021)
- April 23, 2021: Ontario confirmed 36 cases of the B.1.617 variant (Aguilar, 2021; Patton & Westoll, 2021)
- April 22, 2021: Alberta confirmed first case of the B.1.617 variant from an inter-provincial traveller (CBC News, 2021a, 2021c).

- April 21, 2021: Quebec confirmed province's first case of the B.1617 variant from the Mauricie and Centre-du-Quebec region (Bruemmer, 2021; Laframboise, 2021b).
- April 21, 2021: British Columbia confirmed 39 cases of the B.1617 variant which had been identified since April 4, 2021 (Little, 2021b)

### **Risk to Canadians**

- August 11, 2021: A pre-print study found that vaccinated individuals can harbour equally high levels of viral load in their nasal swaps as unvaccinated individuals. This would suggest that vaccinated individuals can still contribute to community transmission and/or become infected (Riemersma et al., 2021).
- August 11, 2021: Data published by the Government of Canada showed that ~90% of COVID-19 cases, since the start of the vaccine campaign (July 24, 2021), has mainly been unvaccinated individuals (Public Health Agency of Canada, 2021b).
- August 6, 2021: After several large public gatherings at a beach town in Massachusetts, the CDC reported an outbreak of 469 COVID-19 cases, of which 74% (346) were fully vaccinated individuals (i.e. 2 doses of Pfizer or Moderna, 1 dose of Johnson & Johnson). Among those with vaccine breakthrough infections, 79% (274) were symptomatic (C. M. Brown et al., 2021).
- August 1, 2021: A pre-print study showed the Delta variant was able to infect vaccinated individuals at about three-times the rate of other COVID-19 variants (17.4% vs 5.8%)(Musser et al., 2021)
- July 29, 2021: According to the CDC, the Delta variant has a reproduction number (Ro) of 5-9, thus indicating that this variant could be more transmissible than other viruses such as, Ebola, Smallpox, Spanish Flu, MERs, and SARS. The Delta variant has also been associated with longer periods of infectivity compared to past variants (Mcmorrow, 2021).
- July 20, 2021: According Infectious Disease Expert, Dr Anthony Fauci, more than 80% of COVID-19 cases in the U.S are attributed to the Delta variant (O'donnell & Roy, 2021).
- June 18, 2021: Public Health Agency confirmed over 2000 cases of the Delta variant across Canada. Canadian chief public health officer, Dr Theresa Tam, shared concerns about the rapid spread of the variant across all provinces (Rabson, 2021).
- June 17, 2021: A pre-print study found the rate of COVID-19 cases among children aged 5-12 years old were 5-folds higher than adults (18-24) in the UK. The authors speculated that this rapid increase in infection among children is potentially driving the surge in Delta cases in the UK (Riley et al., 2021).
- June 16, 2021: The Delta variant outbreak at Calgary's Foothill Medical Centre reported two deaths: a patient with both doses of vaccination and another individual who did not receive any doses (Short, 2021)
- June 12, 2021: Calgary's Foothill Medical Centre reported Delta variant outbreak with 16 patients and 6 health-care workers who tested positive for the Delta variant, despite receiving the mRNA vaccines: 6 patients & 5 health-care workers (2 doses); 7 patients and 1 health-care worker (1 dose)(CBC News, 2021d)
- May 27, 2021: Public Health Ontario reported that the number of Delta cases changed from 45 to 260 between May 12 to May 19, thus indicating almost a 6-fold increase within a week (Herhalt, 2021)

- May 26, 2021: Newfoundland and Labrador public health reported the Delta variant was driving the COVID-19 outbreak through their central province (Moore, 2021a; The Canadian Press Staff, 2021)
- May 10, 2021: A pre-print study showed the B.1.617 variant was 6.8-fold more resistant to neutralization than the Wuhan strain in response to sera from both convalescent individuals and Pfizer- and Moderna-vaccinated individuals. However, all sera from vaccinated individuals and majority of sera from convalescent individuals remained effective in neutralizing the variant. (Venkata-Viswanadh Edara et al., 2021).
- May 10, 2021: The World Health Organization declared the B.1.617 as a global variant of concern (Reuters, 2021)
- April 22, 2021: To address the spread of the B.1.617 variant, the Canadian government has declared a 30-day ban on all flights travelling from India and Pakistan (Cochrane & Jones Patrick, 2021; Gilmore & Connolly, 2021; Hunter, 2021)
- April 21, 2021: Researchers speculated that the B.1.617 could be driving the second wave of COVID-19 cases in India (Mallapaty, 2021).
- April 16, 2021: United Kingdom reported 77 cases of the B.1.617 variant (Public Health England, 2021a)
- April 15, 2021: India reported 60% of 361 COVID-19 cases between January and March were derived from the B.1.617 variant (Press Trust of India, 2021)
- March 24, 2021: Researchers from India characterized the B.1.617 variant and discovered the presence of two mutations which have been identified in past variants: E484Q (B.1.1.7, B.1.351) and L452R (B.1.427/B.1.429). This variant is believed to exhibit increased infectivity and capacity for immune escape (Press Information Bureau Delhi, 2021).

## Updates about Vaccine Development

- July 28, 2021: Findings released by Pfizer suggested that a third dose of the Pfizer/BioNTech COVID-19 vaccine could increase neutralizing antibody titers by >5-folds against the Delta variant (Stevo, 2021).
- February 24, 2021: Moderna announced its shipment of the B.1.351 variant-specific vaccine candidate to NIH for Phase 1 clinical trials (Moderna, 2021a).
- February 27, 2020: FDA approves Johnson & Johnson vaccine for emergency use (FDA NEWS RELEASE, 2021).
- February 19, 2021: Pfizer submits vaccine stability data to the Food and Drug Administration (FDA) revealing that their vaccine, BNT162b2, can be stored at higher temperatures between -25 to -15 °C. This current label requires that the vaccine be stored between -80 to -60 °C. New storage conditions is currently pending approval from the FDA (Pfizer, 2021; Reuters Staff, 2021).
- February 10, 2021: South Africa replaced its original vaccine candidate, AstraZeneca, with the Johnson & Johnson vaccine, which has not yet been approved by the U.S. Food and Drug Administration and the South Africa's regulatory authority. The South African government intends to provide this vaccine to its front-line health workers in the following week (Meldrum, 2021; Meyer, 2021).

- February 7, 2021: South Africa halted their rollout of the AstraZeneca vaccines due to its reduced efficacy against the B.1.351 variant (Mueller, Robbins, & Chutel, 2021)
- February 7, 2021: AstraZeneca is developing a 2<sup>nd</sup> generation vaccine that is effective against the B.1.351 variant. This is a response to its recent clinical trials in South Africa where researchers deemed the AstraZeneca to be ineffective against the B.1.351 variant (Wits University, 2021).
- February 4, 2021: Johnson & Johnson is pursuing Emergency Use Authorization (EUA) from the U.S. Food and Drug Administration (FDA) for its single-dose vaccine, Janssen (Johnson & Johnson, 2021b)
- January 25, 2021: Moderna Inc. is looking to study how an additional booster of its vaccine can impact the level of neutralizing titers against the B.1.351 variant. Additionally, the company is also seeking to develop a booster vaccine, mRNA- 1273.351, against the B.1.351 variant (Moderna, 2021b; Wu et al., 2021).

## Key Events

- August 6, 2021: Among those who were infected with SARS-COV-2 in 2020, researchers found that risk of re-infection was 2.34-times higher among those who were unvaccinated than vaccinated (Cavanaugh, Spicer, Thoroughman, Glick, & Winter, 2021).
- March 24, 2021: Data released by the Public Health Agency of Canada (PHAC) showed increased COVID-19 cases among young adults aged 20-39. Daily cases of COVID-19 are predicted to spike to new record levels (Public Health Agency of Canada, 2021a)
- February 27, 2020: FDA approves Johnson & Johnson vaccine for emergency use (FDA NEWS RELEASE, 2021).
- February 19, 2021: The Public Health Agency of Canada (PHAC) released modeling predicting a high resurgence in COVID-19 cases if stringent public health measures are not implemented as vaccine programs expand (Public Health Agency of Canada, 2020).
- February 10, 2021: South Africa replaced its original vaccine candidate, AstraZeneca, with the Johnson & Johnson vaccine, which has not yet been approved by the U.S. Food and Drug Administration and the South Africa's regulatory authority. The South African government intends to provide this vaccine to its front-line health workers in the following week (Meldrum, 2021; Meyer, 2021).
- February 8, 2021: Ontario confirmed Canada's first case of the P.1 variant in Toronto, Ontario. The case was linked to international travel to Brazil (Favaro et al., 2021).
- February 7, 2021: AstraZeneca is developing a 2<sup>nd</sup> generation vaccine that is effective against the B.1.351 variant. This is a response to its recent clinical trials in South Africa where researchers deemed the AstraZeneca to be ineffective against the B.1.351 variant (Wits University, 2021).
- February 7, 2021: South Africa halted their rollout of the AstraZeneca vaccines due to its reduced efficacy against the B.1.351 variant (Mueller et al., 2021).
- January 27, 2021: Researchers declared the P.1 variant as the dominant SARS-CoV-2 strain in

Manaus Brazil (France24, 2021; Medical Xpress, 2021).

- January 25, 2021: Moderna Inc. is looking to study how an additional booster of its vaccine can impact the level of neutralizing titers against the B.1.351 variant. Additionally, the company is also seeking to develop a booster vaccine, mRNA- 1273.351, against the B.1.351 variant (Moderna, 2021b; Wu et al., 2021).
- January 8, 2021: Alberta confirmed Canada's first case of the B.1.351 variant (Heidenreich & Ramsay, 2021).
- December 26, 2020: Ontario confirmed Canada's first cases of the B.1.1.7 variant in two individuals from Toronto (Aziz, 2020; Jabakhanji, 2020; Rocca, 2020).
- December 2020: Emergence of P.1 variant in Brazil.
- October, 2020: Emergence of B.1.351 variant in South Africa.
- September, 2020: Emergence of B.1.1.7 variant in the United Kingdom.

## Variants Under Investigation

As SARS-CoV-2 continues to evolve, there are several variants currently under investigation:

<b>Variant of Under Investigation:</b> B.1.427/B.1.429   Epsilon
<b>Location of Origin:</b> South California, USA
<b>Initial Emergence:</b> July, 2020
<b>Recent Developments:</b> <ul style="list-style-type: none"><li>- March 9, 2021: A pre-print study found neutralizing antibody titres against the B.1.427/B.1.429 variant to be reduced in vaccine recipients and convalescent patients. Researchers estimated a 18-24% increase in transmissibility compared to the wild-type strain (Deng et al., 2021).</li><li>- February 11, 2021: First case of the B.1.429 variant was confirmed from Los Angeles County in July 2020. Cases of B.1.429 remained undetected until October, 2020 (Zhang et al., 2021)</li></ul>

<b>Variant Under Investigation:</b> B.1.525   Eta
<b>Location of Origin:</b> Nigeria
<b>Initial Emergence:</b> December, 2020
<b>Recent Developments:</b> <ul style="list-style-type: none"><li>- March 11, 2021: B.1.525 exhibits similar mutations to other SARS-CoV-2 variants including B.1.1.7, B.1.351, and P.1 (Public Health of England, 2021).</li><li>- February 20, 2021: Since its emergence in Nigeria, the variant has been detected in 26 countries around the world (Banchich &amp; O'Toole, 2021).</li><li>- February 12, 2021: Canada confirmed first case of the B.1.525 variant in British Columbia (Mangione, 2021).</li></ul>

**Variant of Under Investigation:** B.1.526 | Iota

**Location of Origin:** New York, USA

**Initial Emergence:** November, 2020

**Recent Developments:**

- March 1, 2021: In a pre-print study, B.1.526 was found with mutations similar to those in variants B.1.351 and P.1 (i.e. E484K). B.1.526 also exhibits a unique mutation, known as D235G, which is located within the spike protein and is thought to disrupt the efficacy of neutralizing antibodies.

**Variant of Under Investigation:** B.1.617.1 | Kappa

**Location of Origin:** India

**Initial Emergence:** October, 2020

**Variant of Under Investigation:** C.37 | Lambda

**Location of Origin:** Peru

**Initial Emergence:** December, 2020

**Recent Developments**

- July 28, 2021: A pre-print by researchers in Japan identified several mutations in the Lambda variant that were associated with high viral infectivity and resistance to vaccine-induced neutralization (Kimura et al., 2021)
- July 3, 2021: The Lambda spike protein was associated with higher infectivity compared to the wild-type strain in 2020, however, it remained highly susceptible to vaccine-induced neutralization (Tada et al., 2021)



# Global COVID-19 Variants Trackers

## [NextStrain](#)

This phylogeny shows evolutionary relationships of SARS-CoV-2 viruses from the ongoing COVID-19 pandemic. Although the genetic relationships among sampled viruses are quite clear, there is considerable uncertainty surrounding estimates of specific transmission dates and in reconstruction of geographic spread. Please be aware that specific inferred geographic transmission patterns and temporal estimates are only a hypothesis.

## [GSAID](#)

GSAID obtained COVID-19 virus sequence data from several sources in Saudi Arabia (CDC, Hospitals) and worldwide. They process genome isolates to first obtain a fingerprint of mutations appearing in sampled populations across different locations, which helps to understand COVID-19 virus variants and their infection track.

Additional [GSAID COVID-19 variant tracker](#) featuring relative variant genome frequency per region.

## More Information on Variants

[https://www.cdc.gov/mmwr/volumes/70/wr/mm7003e2.htm?s\\_cid=mm7003e2\\_e](https://www.cdc.gov/mmwr/volumes/70/wr/mm7003e2.htm?s_cid=mm7003e2_e)

<https://www.cdc.gov/coronavirus/2019-ncov/more/science-and-research/scientific-brief-emerging-variants.html>

<https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/variant-surveillance/variant-info.html>

[https://cov-lineages.org/global\\_report.html](https://cov-lineages.org/global_report.html)

<https://www.nytimes.com/interactive/2021/health/coronavirus-variant-tracker.html>

<https://covariants.org/>

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