BIOLOGICAL HAZARDS

Hazards associated with exposure to biological agents when working with animals or products of animal origin

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This is a translation of the original French version available at: Programmes de santé au travail pour les établissements | Commission des normes de l'équité de la santé et de la sécurité du travail - CNESST. In the event of any discrepancy or inconsistency between the French and English versions, the French version shall prevail.

1. INTRODUCTION

1.1. Background

This health program is aimed at workplaces that involve the presence of animals, products of animal origin or an environment where they were present. Workers in these environments may be exposed to biological agents such as bacteria, viruses, microscopic fungi (moulds), parasites and prions. A healthy or sick animal can be a carrier of biological agents and can contaminate its environment and work equipment through a variety of means (urine, feces, blood, saliva, etc.). Biological agents are invisible to the naked eye and some are naturally present in the environment. They can come from a variety of sources and can cause health effects. However, the nature, quantity and frequency of exposure to these agents in the workplace are factors that can influence the level of health risk. The main workplaces concerned are presented in table 1 of the High-risk sectors of activity, trades or tasks section.

1.2. Legal obligations

This occupational health program is developed in accordance with section 107 of the *Act respecting occupational health and safety* (AOHS). The employer is required to take it into account in its prevention program (AOHS, s. 59) or in its action plan (AOHS, s. 61.2). This program contains recommendations for the prevention of health problems linked to biological agents. In particular, it sets out the preventive measures to be implemented to protect the health of exposed workers. Thus, the employer must determine which actions of the occupational health program to consider and include in its prevention program or action plan to manage the biological hazards in its workplace.

Section 61 of the AOHS provides that the CNESST may order an employer to submit a prevention program. It may also order the employer to amend the content of the program, in particular to bring it into line with the elements of the occupational health programs it develops. Section 127(1) of the AOHS provides that the public health director may assess the components of a health program, prevention program or action plan and make recommendations to the employer, the CNESST and, where applicable, the health and safety committee.

This health program provides a basic information about biological hazards around animals, and preventive actions that can be adapted and implemented in the workplace. For further information or support, it is strongly recommended to consult the specialists mentioned in sections 7 and 8 and the tools in section Find more information.

2. RISK PROFILE

2.1. Contaminant overview

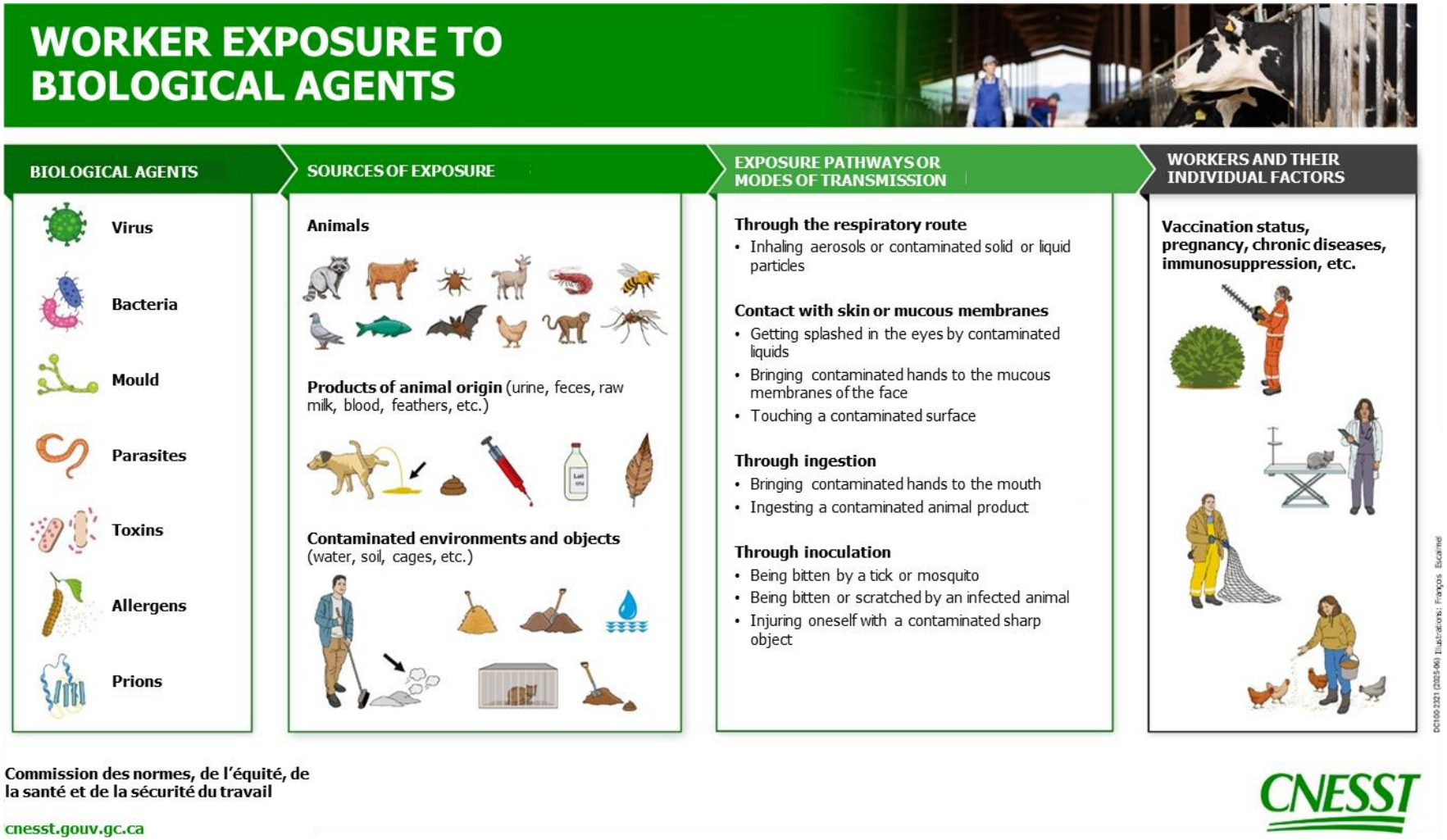
Workers can be exposed to biological agents through contact with animals, products of animal origin and the environment. Biological agents can include microorganisms such as viruses, bacteria and fungi, as well as parasites or prions. Toxins, proteins or mixtures of dust from plants, feed or bedding can also pose a biological hazard. For examples of biological agents, see Appendix 1.

Over the years, climate change has influenced the migration of wild animals and insects from south to north. This is fostering the emergence, development or increase of infectious diseases that can be transmitted from animals to humans (zoonoses). Moreover, greater use of antibiotics in farm animals can contribute to the emergence of resistant bacteria, which in turn can infect workers, reducing the choice of treatment.

2.2. Exposure pathways and modes of transmission

In this health program, the terms “exposure pathway” and “mode of transmission” are used to describe the route taken by the biological agent to enter a person’s body and cause health effects. There are several exposure pathways and modes of transmission. Not all biological agents use the same routes. Figure 1 illustrates the sources of exposure to biological agents and the exposure pathways or modes of transmission most frequently encountered during contact with animals, their by-products or their environment. Individual factors can increase the risk of developing health effects.

Figure 1: Examples of sources of exposure to biological agents and the different exposure pathways or modes of transmission that can affect workers



2.3. Health effects

People working with animals, their by-products and their environment can develop various health problems. Biological agents can cause four types of effects, detailed below.

2.3.1. Infections

During an infection, the microorganism enters and multiplies in the body of the exposed individual. Symptoms can vary widely, depending on the agent involved and the location of the infection. Certain infections resulting from contact with animals can be transmitted from one person to another. Appendix 1 provides some examples of symptoms associated with different infections.

2.3.2. Allergies

Repeated exposure to an allergen can cause the immune system to overreact in some people. These reactions can cause respiratory effects such as rhinitis and sinusitis (e.g. runny or congested nose), occupational asthma and hypersensitivity pneumonitis (e.g. farmers' lung, animal handlers' lung, bird fanciers' lung). Contact with certain allergens can also affect the skin and eyes (e.g. eczema).

2.3.3. Effects resulting from exposure to toxins

Toxins produced by bacteria or moulds can cause breathing difficulties in some workers (e.g. asthma, organic dust toxic syndrome).

2.3.4. Cancers

Cancer is a rare complication that can occur following certain infections or exposure to by-products of biological agents (e.g. toxins, proteins). For example, transmission of the hepatitis B virus from monkeys to humans could lead to liver cancer.

Pregnant or nursing workers

In the presence of certain agents, pregnant or nursing workers may be entitled to preventive assignment or removal measures under the For a Safe Maternity Experience (FSME) program.

2.4. Legislation and best practices

As defined in section 1 of the *Act respecting occupational health and safety* (AOHS), microorganisms and other biological agents (parasites, toxins) are considered contaminants or dangerous substances likely to alter, in any way, the health or safety of workers. Under subsection 51(5) of the AOHS, the employer must use methods and techniques intended for the identification, control and elimination of risks to the safety or health of workers.

The *Regulation respecting occupational health and safety* (ROHS) does not stipulate an exposure value (maximum concentration level in the air that a worker can breathe) for microorganisms. However, air concentration levels are suggested by some recognized organizations. Although these values cannot guarantee the absence of health effects, they do indicate thresholds above which improved preventive measures should be considered. In addition, laboratory activities carried out on animals or their by-products that are infected or suspected of being infected must comply with Public Health Agency of Canada (PHAC) guidelines.

3. HIGH-RISK SECTORS OF ACTIVITY, TRADES OR TASKS

Exposure to biological agents through contact with animals, their by-products or their environment occurs in many sectors of economic activity and affects a wide range of professions and trades. Some examples of work situations are presented in Table 1 below.

Table 1: Main occupational activities, main sectors of activity and examples of tasks, jobs and workplaces at risk of exposure to biological agents involving contact with animals, their by-products or their environment.

Occupational activities	Main sectors of activity	Examples of tasks, jobs and workplaces
Agriculture and animal processing: Animal husbandry and related activities	Farm production Agricultural product and supply and food product businesses Fishing industry Leather industry Food industries Agricultural sciences Transportation and storage	Agronomists Livestock farms (cattle, chicken, pork, etc.) Agricultural training Agricultural fair Grain, feed or fodder handling Agricultural laboratory and research Fish farm Feed preparation Dairy product preparation Food processing: abattoir, butcher shop, rendering plant Processing of fish, shellfish, fish eggs and other marine animals Transport of animals and animal products
Animal care: Working with pets and livestock	Animal retail businesses Veterinary services	Pet shops Training Pet breeding Animal care classes Veterinary institutions Zoos and aquariums Animal shelters Pet care services Grooming Research laboratories (with animals) Zootherapy
Work involving outdoor activities: Working where contact with wildlife and other animals (e.g. insects, ticks) can occur	Hunting and fishing Construction Environmental management, land use planning and development Food and lodging Forest industry Entertainment and leisure services Government services (municipal and provincial) Building and housing services Peatlands	Wildlife agents Camp counsellors Beekeeping Biologists Hunters/trappers (trapping) Animal circuses Municipal inspection (municipal officers) Construction trades Landscaping Hunting and fishing outfitters Dead/stray animal pickup Lifeguards and pool monitors Disinfection and extermination services Park workers Bog workers Forestry work

4. PREVENTION APPROACH

4.1. Identify and analyze high-risk situations

4.1.1. Identify sources of exposure

Identifying high-risk situations involves pinpointing locations, processes and tasks that are likely to expose workers to biological agents in the workplace.

Caution: Biological agents are not visible to the naked eye. Workers may be unknowingly exposed to them.

There is a risk of exposure if a source of biological agents is present, for example:

Live or dead animals

- Livestock: cows, pigs, chickens, sheep.
- Rodents: rats, mice, field mice.
- Birds: pigeons, migratory birds, wild turkeys.
- Wild mammals: bats, foxes, raccoons, skunks.
- Fish, shellfish: salmon, oysters, shrimp.
- Exotic animals: snakes, parrots, lizards.
- Pets: cats, dogs, rabbits, hamsters.
- Ticks: black-legged or other ticks.
- Stinging insects: bees, wasps, mosquitoes.

Animal excrement, body fluids or bedding

- Droppings, manure, urine.
- Blood, saliva, amniotic fluid, cerebrospinal fluid, unpasteurized milk or cream.
- Contaminated dust produced when handling bedding.

Animal parts

- Tissue, placenta, bone, fur, feathers, down.

Foods derived from animal by-products

- Meat, cheese, milk.

Materials contaminated by biological agents in the environment

- Grains, feed, grasses or animal food.
- Soil or water.
- Dust and plant, marine or animal particles or fragments.

4.1.2. Analyze risks

Risk analysis involves determining a level of risk based on the severity of health effects and the probability of these effects occurring. In the case of biological hazards, it is important to analyze high-risk situations, such as tasks, processes and equipment that can expose workers to biological agents that may damage their health. Risk analysis must also take into account the presence of factors favouring the development of biological agents (e.g. humidity), as well as the frequency and duration of exposure to high-risk situations. Worker experience, the various sources of information available (see the section For more information) and occupational health workers (see sections 7 and 8) can help employers carry out this risk analysis.

Examples of situations with a risk of exposure to biological agents:

- Providing support during birthing
- Caring for sick animals
- Cleaning cages, stalls and pens
- Cooking and preparing marine products
- Walking through forests, woodlands and tall grasses

4.2. Correct risks

Once high-risk work situations have been identified, preventive measures must be implemented to protect workers. If the biological hazard cannot be eliminated, the employer must reduce and correct it, ideally using the hierarchy of controls. It is often necessary to combine several preventive measures to prevent harmful effects on workers' health. Workplaces must determine which of the available preventive measures are applicable to their situation, favouring those that are most effective. The tables in Appendix 2 present examples of measures that can be implemented depending on the type of occupational activity.

4.2.1. Elimination at the source or substitution

Elimination at the source ensures the highest level of safety, as biological agents are removed from the workplace. Here are a few examples:

- Eliminate sites conducive to the presence of insects (e.g. stagnant water).
- Eliminate contact with biological fluids, organs and tissues.

4.2.2. Substitution

If eliminating the hazard is not possible, then a source of exposure, process or equipment should be replaced by another with a lower level of risk, in order to reduce the severity of the damage. Exposure to risk can also be reduced by decreasing the frequency of exposure whenever possible. Here are a few examples:

- Replace raw food with feed.
- In a laboratory, promote the use of cell cultures as an alternative to animal testing.
- In a research laboratory, replace a pathogenic strain with a non- or low-pathogenic strain.

4.2.3. Engineering control

Engineering controls make it possible to reduce workers' exposure to biological hazards. Here are a few examples:

- Ensure adequate ventilation and maintain the ventilation system.
- Identify and isolate sick animals.
- Automate certain tasks (e.g. feeding).
- Use source capture if there is a risk of aerosols (e.g. handling in a lab's biological safety cabinet).
- Clean and disinfect surfaces, objects and tools.
- Protect farm animals from contact with wild animals.
- Use a repellent to ward off disease-carrying insects and rodents.
- Vaccinate animals.
- Apply pesticides or insecticides in a safe manner to eliminate insects.
- Replace a regular syringe with a syringe equipped with a safety device to prevent accidental needlesticks.

4.2.4. Awareness-raising

Measures must be taken to highlight the biological hazard, improve workers' ability to detect it and heighten their vigilance. Here are a few examples:

- Delineate the area where high-contamination-risk tasks are carried out.
- Post signs to identify jobs or tasks where personal protective equipment (PPE) must be worn.
- Identify quarantine zones where sick animals are present.
- Use posters to remind workers of hygiene measures.

4.2.5. Administrative controls

Administrative controls help to improve workers' ability to carry out their tasks while controlling their exposure. They make it possible to introduce safe working methods, control accesses and train workers on risk and prevention measures. Here are a few examples:

- Establish a workplace maintenance and hygiene procedure.
- Adopt a purchasing policy for sanitation supplies and disinfectants.
- Use controlled introduction of new animals (e.g. quarantine).
- Prohibit the use of air or pressurized water jets or sweeping for housekeeping.
- Prohibit eating, drinking or smoking in work areas.
- Train and educate workers about hazardous work situations, health effects, safe work methods and personal hygiene measures.
- Have a veterinarian assess sick animals and determine whether preventive vaccination of animals is appropriate.

4.2.6. Personal protective equipment

PPE is the last line of defence to protect the worker when the hazard cannot be eliminated or reduced by other preventive measures, or until effective measures are implemented. It can be combined with one or more other preventive measures.

Depending on the hazards identified and the tasks involved, it may be necessary to wear suitable PPE, such as gloves, protective apparel, eye protection (goggles or visor if there is a risk of splashing) or safety boots.

Respiratory protective equipment (RPE) must be worn in certain situations. Tools provided by the Institut de recherche Robert-Sauvé en santé et en sécurité du travail (IRSST) and the Canadian Standards Association (CSA Group) help in selecting the appropriate respiratory protection against bioaerosols.

RPE must be worn in accordance with **a respiratory protection program (RPP),** in particular to ensure that workers are wearing their RPE properly and are able to clean, inspect and store it correctly. In addition, to ensure that the RPE properly fits the face, a fit test must be carried out. For workers with beards, non-fitted RPE is available, such as a loose-fitting hood, helmet or flexible mask with face shield.

4.3. Control risks

Once preventive measures have been implemented, the employer, in collaboration with the workers, must ensure that they remain in place permanently. Here are some examples of control measures:

- Regularly reassess the possibility of implementing measures to further reduce workers' exposure.
- Identify new work situations where exposure to biological agents presents a risk.
- Specify the frequency for cleaning and maintaining surfaces and ventilation systems, if applicable.
- Assess and update the respiratory protection program (RPP) annually.
- Regularly remind workers of procedures and best work practices.
- Include training for new employees to help them recognize high-risk tasks and properly apply preventive measures.
- Provide supervision to validate that workers are making proper use of preventive measures.
- Determine workers' level of knowledge about their potential exposure to biological agents, then identify and correct risky behaviour.

5. FIRST AID

The organization of first aid must comply with thehttps://www.legisquebec.gouv.qc.ca/en/document/cr/A-3.001, r. 10 *First-aid Minimum Standards Regulation*. An analysis tool for determining the type of first-aid kit needed is available (in French only).

Note the specifics regarding forestry: *Regulation respecting health and safety in forest development work*.

Employers must inform first-aiders that certain types of exposure require specific interventions. It is also important to document events involving stings, bites and scratches, as well as exposures to potentially hazardous biological agents, in the Register of Accidents, Incidents and First Aid.

5.1. Needlestick injuries or accidents with dirty devices and sharp instruments

Call Info-Santé at 811 or consult a healthcare professional. Be sure to mention any contact you may have had with animals or their by-products.

5.2. Exposure to mammalian saliva or cerebrospinal fluid

The rabies virus is found in the saliva and cerebrospinal fluid (CSF) of affected mammals. This disease is present in Quebec in wild animals and can also affect domestic animals. If you have been bitten or scratched, or if you think you may have come into contact with the rabies virus or other biological agents via a mucous membrane or a fresh wound, follow these steps:

- Rinse the wound or mucous membrane thoroughly with plenty of soap and water for 10–15 minutes.
- When available, apply a virucide (e.g. 10% povidone-iodine, iodine tincture or aqueous iodine solution, 70% ethanol, 2% chlorhexidine gluconate), even if a few hours have passed since the incident occurred. The application of virucide should not replace washing with soap, the most effective step in eliminating the virus.
- Avoid scrubbing the wound or causing it to bleed.
- Call Info-Santé 811. The telephone hotline nurses will guide you through the procedure. They will assess the situation and tell you whether the contact represents a risk to your health. If necessary, they will direct you to the appropriate resource to obtain the necessary care.
- There is a rabies vaccine. It must be given within hours of contact. Vaccination is the only way to PREVENT the development of rabies in your body. Even if you have already been vaccinated, the nurses will be able to tell you if you need to be vaccinated again. Every situation is different.
- Keep the animal involved alive for observation.

5.3. Tick bites

If a tick bites you, remove it and save it, then call Info-Santé 811. The nurse will tell you if you need to consult a healthcare professional. Tick bites can cause a number of illnesses, including Lyme disease. Depending on the assessment of the situation, an antibiotic may be prescribed as a preventive measure.

5.4. Stings from venomous insects (bees, wasps and bumble bees)

5.4.1. Local reaction

Following an insect sting, remove the stinger if visible, apply ice or a cold compress and monitor the person.

5.4.2. Severe reaction (anaphylactic)

If signs and symptoms of an allergic reaction are present, check for recent contact with an allergen (insect sting). Administer epinephrine (e.g. EpiPen®) according to the protocol (in French only),call 911 and ensure the person is in a comfortable position. Anyone receiving epinephrine should be referred to the emergency department for medical assessment and monitoring. Use the auto-injection device in accordance with the manufacturer's conditions for use and storage.

In workplaces where there is a risk of severe allergic reaction, it is recommended that an epinephrine auto-injection device be made available to first-aiders near the first-aid kits.

5.4.3. Multiple stings from venomous insects

If a person is stung repeatedly, they may develop a toxic reaction to the insect venom. If an adult is stung 20 times or more, they should go to hospital.

5.5. Reaction to animal venom

If a worker experiences a high-risk exposure (e.g. bite) to a venomous animal (e.g. snake, scorpion), call the Centre antipoison du Québec at 1-800-463-5060 with any questions.

5.6. Exposure to blood from non-human primates (e.g. monkeys)

Non-human primates can transmit hepatitis, human immunodeficiency virus (HIV) and other diseases. In the event of exposure to blood or biological products through a needlestick, an accidental cut, a bite or a scratch, the worker must wash the wound thoroughly with plenty of soap and water for 10–15 minutes and seek emergency medical attention promptly. If there is a risk of exposure to HIV, treatment must be administered within 2 hours of the injury or puncture.

6. PREVENTIVE VACCINATION AND MEDICAL SUPERVISION

Preventive vaccination

Preventive vaccination could be offered to workers **before** a potentially high-risk exposure. Check with your vaccination centre (e.g. local point of service, pharmacy or medical clinic). Here are a few examples of diseases for which vaccination is available: rabies, hepatitis A and B and tetanus.

Medical surveillance

Depending on the situation, medical surveillance may be required. Occupational health nurses or physicians can determine whether surveillance or screening is required, taking into account the worker's exposure and work history. For example, occupational asthma caused by exposure to biological agents can be detected and managed. Screening should always be carried out in conjunction with the necessary preventive measures. It must be based on free and informed consent.

7. SERVICES OFFERED BY RSPSAT TEAMS

The Réseau de santé publique en santé au travail (RSPSAT), together with its partners and in accordance with its legal mandates under the *Act respecting occupational health and safety* (AOHS), the *Public Health Act* (PHA) and the *Act respecting health services and social services* (AHSSS), works to prevent and protect workers' health by supporting workplaces in meeting their obligations to prevent occupational illness. The RSPSAT has multidisciplinary teams (medical, nursing, occupational hygiene, ergonomics, psychosocial risks, etc.) with expertise in occupational health that are entirely funded by the Fonds de la santé et de la sécurité du travail. It has been offering its services free of charge throughout Quebec since the adoption of the AOHS in 1979.

More specifically, with regard to biological hazards, the RSPSAT can:

- help identify work situations involving exposure to biological agents
- help assess and prioritize jobs and tasks to be modified to reduce risks
- support workplaces in the process of implementing corrective, preventive or transformative measures to eliminate or reduce risks
- support workplaces in implementing first aid
- help assess the effectiveness of preventive measures put in place, and ensure that new risks are avoided
- provide information sessions on health effects and preventive measures to raise awareness among workers and employers
- support the mobilization of employers and workers in the implementation of a biological hazard prevention approach
- assess the need for medical surveillance (screening)
- assess whether preventive vaccination is necessary

Contact your occupational health team to find out what services are available in your region at www.santeautravail.qc.ca.

8. SERVICES OFFERED BY OTHER PARTNERS

The CNESST's other partners help support workplaces in their OHS management efforts in many ways. The joint sector-based associations (JSAs) provide their members with services:

- advice and personalized assistance
- training and information
- research and development on the prevention of occupational accidents and illnesses

If you're linked to a JSA, you can find out about the specific services it offers its members.

The Institut de recherche Robert-Sauvé en santé et en sécurité du travail (IRSST) provides instrument loan, calibration and repair services, as well as a bacteria and mould testing service (identification and count).

9. FOR MORE INFORMATION

9.1. Additional information for workplaces

CNESST

- Diseases transmitted by animals | Commission des normes de l'équité de la santé et de la sécurité du travail – CNESST (in French only)

Gouvernement du Québec

- Communicable diseases between animals and humans | Gouvernement du Québec (quebec.ca)

Institut national de santé publique du Québec (INSPQ)

- Informative pamphlets: Lyme disease in the workplace | Institut national de santé publique du Québec
- Zoonoses in the workplace: determining vulnerabilities and identifying needs in Quebec (in French only)

Association paritaire pour la santé et la sécurité du travail, "administration provinciale" sector

- Risks related to working outdoors and in natural environments in Quebec – APSSAP (in French only)

Institut national de recherche et de sécurité pour la prévention des accidents du travail et des maladies professionnelles (INRS)

- Biological risk assessment tool – Publications and tools – INRS (in French only)

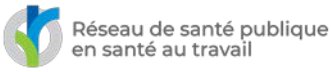
Canadian Agricultural Safety Association (CASA)

- Save Your Breath: Respiratory Health in Agriculture – CASA

9.2. Additional information for specialists

- Zoonosis | Institut national de santé publique du Québec
- Adapting work to climate change | Institut national de santé publique du Québec (in French only)

The CNESST and the MSSS would like to thank the following partners for their participation in the development of occupational health programs:



For general information, contact the CNESST.

APPENDIX 1

The following provides a summary of most of the information available on Quebec government sites: List of animal diseases as well as Health Issues (A to Z). Please note that the information in this table is subject to change as knowledge of zoonoses evolves.

Zoonosis and causative biological agent	Most common sources	Transmission (see Figure 1)	Symptoms and health effects in humans	Examples of sectors and occupations
Bacteria				
Campylobacteriosis *Campylobacter* spp. (e.g. *C. jejuni*)	Poultry, cattle, pigs, sheep, goats, dogs and cats; occasionally reptiles. Through: – excrement – contaminated environment – contaminated food (raw)	Ingestion (hand-to-mouth contact)	Common symptoms: diarrhea, abdominal pain, fever, discomfort, headache, nausea, vomiting and blood in stool. Complications (rare): meningitis, arthritis or Guillain-Barré syndrome. ***Pregnant women: risk of intrauterine infection leading to miscarriage.**	Poultry industry, livestock, abattoirs, butcher shops, food processing, veterinary staff, zoos, laboratories, municipal workers.
Chlamydiosis *Chlamydia psittaci* (Psittacosis), *Chlamydia abortus,* *Chlamydia felis*	Several animal species, including: cattle, pigs, sheep, goats, cats, reptiles and birds. Through: – excrement – secretions – feathers – contaminated environment	– Respiratory tract – Contact with mucous membranes	Psittacosis (*C. Psittaci*), a form of chlamydiosis, can be asymptomatic or cause: fever, headache, chills, muscle aches, loss of appetite, cough, nasal drip or pneumonia, following contact with birds. Chlamydiosis (*C. Abortus*): fever, headache and nausea following direct contact with ruminants (e.g. sheep, goats, cows). Chlamydiosis (*C. Felis*) (rare): conjunctivitis following direct contact with an infected cat.	Abattoirs, livestock, rendering sector, pet shops, veterinary staff, laboratories, construction workers, municipal workers, farm workers, zoos.

Zoonosis and causative biological agent	Most common sources	Transmission (see Figure 1)	Symptoms and health effects in humans	Examples of sectors and occupations
			***Pregnant women: disease that can cause miscarriage, stillbirth or premature birth. Avoid contact with flocks containing ewes infected with *C. abortus*, especially when lambing.**	
E. coli Escherichia coli 0157:H7	Cattle, goats, sheep Through: – excrement – raw milk and meat – contaminated food – contaminated environment	Ingestion (hand-to-mouth contact)	An *E. coli* infection may be asymptomatic or may cause the following symptoms: nausea, low-grade fever, headache, vomiting, sharp stomach cramps, watery or bloody diarrhea. Complications: kidney failure, stroke; in the event of complications, this zoonosis can lead to death.	Livestock, abattoirs, butcher shops, food processing, farm workers, laboratories.
Q fever *Coxiella burnetii*	Domestic ruminants: cattle, goats, sheep. Other mammals: rodents, cats, dogs, rabbits and hares. Through: – excrement – urine – placental or fetal tissue – contaminated dust or microdroplets (e.g. wool shearing) – ticks – raw milk	– Respiratory tract – Ingestion (hand-to-mouth contact)	Q fever can be asymptomatic or flu-like, causing prolonged fever, headache, profuse sweating, chills, cough, muscle aches and joint pain, nausea, vomiting, diarrhea, pneumonia or hepatitis. In rare cases, Q fever can cause neurological damage (e.g. meningitis) and heart problems (endocarditis). ***Pregnant women: disease that can cause miscarriage or stillbirth.**	Livestock, abattoirs, veterinary staff, farm workers, food processing and transport, zoos, laboratories.

Zoonosis and causative biological agent	Most common sources	Transmission (see Figure 1)	Symptoms and health effects in humans	Examples of sectors and occupations
Leptospirosis *Leptospira interrogans*	Dogs, horses, cattle, pigs, cats, goats, sheep, rabbits, rodents and certain wild animals (e.g. mice, rats, raccoons and skunks). Through: – contaminated water – urine – placental or fetal tissue	– Contact with the skin and mucous membranes – Ingestion (hand-to-mouth contact)	Common symptoms: fever, chills, headache, muscle aches and fatigue, rash and eye infection. In 10–15% of cases, leptospirosis causes liver, kidney and blood disorders, leading to jaundice. It can also lead to inflammation of the heart and meningitis.	Livestock, farm workers, veterinary staff, municipal workers (sewage and purification), fish farmers.
Listeriosis *Listeria monocytogenes*	Cattle, goats, sheep, poultry, rabbits and rodents. Through: – raw food – contact with infected animals, especially during birthing.	– Ingestion (hand-to-mouth contact) – Contact with the skin and mucous membranes	Common symptoms: fever, muscle aches, nausea, vomiting, diarrhea or constipation, pain, headache. Possible complications: blood infection, encephalitis (infection of the brain), meningitis (infection of the membranes covering the brain), respiratory distress syndrome and kidney failure. ***Pregnant women: disease that can cause abortion, stillbirth, premature delivery or life-threatening illness in the baby shortly after birth.**	Livestock, abattoirs, butcher shops, food processing, farm workers, veterinary staff.
Streptococcal diseases *Streptococcus suis* (pigs) and *Streptococcus equi ssp.*	Pigs and horses, but also cattle, sheep, goats, cats and dogs. Through: – contact with a sick animal (secretions)	– Contact with the skin and mucous membranes	Rare in humans, but can be serious: neck stiffness, confusion, fever, headache, vomiting, joint pain, meningitis (frequently leading to deafness) and blood infection.	Livestock farms, veterinary staff, butcher shops, abattoirs, rendering sector.

Zoonosis and causative biological agent	Most common sources	Transmission (see Figure 1)	Symptoms and health effects in humans	Examples of sectors and occupations
zooepidemicus (horses)	– contaminated food (animal meat)	– Ingestion (hand-to-mouth contact) – Inoculation		
Lyme disease *Borrelia burgdorferi*	Ticks found on animals, birds or even on vegetation.	Inoculation	Disease that can present various symptoms: ring-shaped (bull's-eye) redness, fatigue, fever, headaches, body aches. If left untreated, the disease can cause the following complications: facial paralysis, limb numbness, neck pain, severe headaches, joint swelling, chest pain, palpitations and dizziness.	Outdoor workers (beekeepers, landscapers, gamekeepers, trappers, wildlife officers, forestry, agricultural or municipal workers, etc.) or those providing direct care to animals that can carry ticks (livestock workers, veterinary staff, etc.).
Salmonellosis *Salmonella spp.*	Poultry, pigs, cattle, cats, dogs, turtles, hedgehogs, snakes and lizards. Through: – excrement – contaminated environment – contaminated food (raw)	Ingestion (hand-to-mouth contact)	Symptoms: diarrhea (sometimes bloody), abdominal cramps, nausea, vomiting (sometimes), fever, chills, headaches. Complications: dehydration, blood infection, arthritis, meningitis (infection of the membranes covering the brain). This infection can also lead to death.	Livestock, abattoirs, butcher shops, rendering sector, food processing, veterinary staff, pet shops, zoos, laboratories, agricultural and construction workers.
Tularemia *Francisella tularensis*	Hares, beavers, muskrats, small rodents, ticks. Also in: cats, dogs, sheep, pigs, horses.	– Respiratory tract	General symptoms: fever, chills, muscle aches, fatigue, headaches. Skin contact: skin ulcers, swollen lymph nodes.	Hunters, trappers, wildlife officers, municipal workers, pet shops, laboratories.

Zoonosis and causative biological agent	Most common sources	Transmission (see Figure 1)	Symptoms and health effects in humans	Examples of sectors and occupations
	Through: – contact with infected animals or their carcasses – contaminated water – contaminated meat	– Ingestion (hand-to-mouth contact) – Inoculation (ticks, fleas or deer flies) – Contact with the skin and mucous membranes	If swallowed: throat inflammation, abdominal pain, vomiting, diarrhea. Respiratory tract: pneumonia. In the event of complications, this zoonosis can lead to death.	
Yersiniosis *Yersinia enterocolitica* **or** *Yersinia pseudotuberculoses*	Cattle, pigs, goats, sheep, dogs, cats, rodents and birds. Through: – excrement – raw animal products (meat/milk) – contaminated environment (water, soil)	– Ingestion (hand-to-mouth contact)	Symptoms: diarrhea, abdominal pain, fever, skin rash and arthritis.	Livestock, abattoirs, butcher shops, food processing, veterinary staff, laboratories, rendering sector.
Viruses				
Eastern equine encephalitis *Eastern equine encephalitis virus*	Mosquitoes Through: – mosquito bite	Inoculation	The disease can be asymptomatic or cause: fever, chills and muscle aches (flu-like symptoms). In some cases, the disease can progress to meningitis or encephalitis. It can cause the following symptoms: headaches, diarrhea, vomiting, disorientation, drowsiness, photophobia, neck rigidity, ataxia, convulsions, coma,	Farm workers and veterinary staff.

Zoonosis and causative biological agent	Most common sources	Transmission (see Figure 1)	Symptoms and health effects in humans	Examples of sectors and occupations
			permanent neurological sequelae or even death.	
Avian influenza **Influenza A virus** (H5N1 and H7N9)	Domestic poultry and wild birds. Through: – nasal secretions – excrement Mammals such as cattle. Through: – raw milk – nasal secretions – urine	– Contact with mucous membranes – Respiratory tract	Avian flu symptoms are similar to those of seasonal flu: sore throat, cough, muscle aches, fever and breathing difficulties. More rarely, gastrointestinal symptoms: nausea, vomiting and diarrhea. These can also cause serious illness, such as pneumonia or respiratory failure. Death is possible as a result of complications. Another possible symptom in humans exposed to avian flu virus in cattle: conjunctivitis.	Poultry/dairy industry workers (livestock farmers, live animal markets), milk processing sector, veterinary staff, animal shelters, zoos, laboratories, hunters, wildlife workers.
Swine influenza **Influenza A virus** (H1N1, H3N2 and H1N2)	Domestic pigs, wild boar, birds. Through: – nasal secretions	– Contact with mucous membranes – Respiratory tract	Symptoms similar to seasonal flu.	Pork industry workers (livestock farmers, live animal markets), commercial poultry farm workers, zoo and pet shop staff, veterinary and laboratory staff.
Rabies	Can affect all mammals (wild or domestic), but mainly bats, raccoons, skunks and foxes.	– Contact with the skin and mucous membranes	The disease develops over several stages. General symptoms: fever, fatigue, headaches, insomnia, anxiety and irritability.	Workers in contact with wild, farmed or domestic animals,

Zoonosis and causative biological agent	Most common sources	Transmission (see Figure 1)	Symptoms and health effects in humans	Examples of sectors and occupations
Rabies virus **(**Rhabdovirus**)**	Through: – saliva and CSF (cerebrospinal fluid)	– Inoculation	Neurological symptoms: confusion, hallucinations, fear of water, difficulty breathing, speaking and swallowing, muscle contractions, agitation and aggressive behaviour, respiratory and cardiac problems, paralysis and coma. The disease is fatal once symptoms appear.	including hunters, trappers, forestry and agricultural workers, veterinary and laboratory staff, wildlife officers, biologists, etc.
Hantavirus pulmonary syndrome Hantavirus (Sin Nombre virus)	Rodents (mice, rats, voles, etc.). Through: – urine – excrement – saliva	– Respiratory tract – Ingestion (hand-to-mouth contact) – Inoculation	Symptoms: fatigue, dizziness, fever and chills, muscle aches and headaches, nausea and vomiting, upset stomach, cough. More serious symptoms may include shortness of breath, a drop in blood pressure, fluid in the lungs and severe respiratory difficulties leading to death.	Agricultural, municipal and forestry workers or workers handling rodents, construction workers, housekeepers.
West Nile virus **West Nile virus**	Mosquitoes Through: – mosquito bite – Autopsy of infected horses (blood or tissue)	Inoculation	No symptoms (80% of cases). In 20% of cases: headache, fever, chills, muscle aches, nausea, vomiting, diarrhea, loss of appetite, skin rashes with pimples, swollen lymph nodes. May progress to meningitis or encephalitis (less than 1% of cases), and more rarely to death.	Farm workers, veterinary or laboratory staff, outdoor workers.

Zoonosis and causative biological agent	Most common sources	Transmission (see Figure 1)	Symptoms and health effects in humans	Examples of sectors and occupations
Parasites				
Cryptosporidiosis *Cryptosporidium parvum genotype 2* **(protozoan)**	Young animals: calves, lambs, kids, piglets and foals. Also young dogs, cats, birds and reptiles. Through: – excrement – contaminated environment	Ingestion (hand-to-mouth contact)	Symptoms: fever, profuse liquid diarrhea sometimes mixed with blood, abdominal pain, nausea and vomiting.	Farm workers, veterinary and laboratory staff, pet shops.
Echinococcosis Echinococcus canadensis **(cystic echinococcosis) and** Echinococcus multilocularis **(alveolar echinococcosis)**	Foxes, wolves, coyotes, rodents, deer, caribou, moose, dogs and, more rarely, cats. Through: – excrement – contaminated environment	Ingestion (hand-to-mouth contact)	Signs and symptoms generally appear 5 to 15 years after infection (rare): loss of appetite, nausea, vomiting, pain (stomach and chest), fatigue, weight loss, cough. Most often affects the liver and lungs (cysts). If left untreated, this zoonosis can lead to death.	Workers in contact with infected animals or contaminated soil and plants, including agricultural workers, hunters and forestry workers.
Giardiasis *Giardia lamblia* **(protozoan)**	Cattle, horses, pigs, sheep, goats, dogs, cats and birds; wild animals like beavers. Through: – excrement – contaminated environment	Ingestion (hand-to-mouth contact)	Generally no symptoms in healthy individuals. Giardiasis can cause diarrhea, nausea, intestinal cramps, abdominal swelling, dehydration and weight loss.	Farm workers, trappers, veterinary and laboratory staff.
Toxoplasmosis ***Toxoplasma gondii*** **(protozoan)**	Many species, but especially: sheep, goats, pigs, cattle, horses and cats Through: – excrement	Ingestion (hand-to-mouth contact)	Usually asymptomatic or may cause: fatigue, fever, headache, muscle aches, swollen lymph nodes and eye damage.	Livestock farmers, farm workers, workers in abattoirs, butcher shops, zoos and

Zoonosis and causative biological agent	Most common sources	Transmission (see Figure 1)	Symptoms and health effects in humans	Examples of sectors and occupations
	– contaminated environment		***Pregnant women: risk of miscarriage and health problems for the unborn child (e.g. intellectual disability, malformation).**	veterinary or laboratory staff.
Fungi				
Histoplasmosis *Histoplasma capsulatum*	Birds: chickens, pigeons, starlings and blackbirds. Bats. Through: – excrement – contaminated environment	Respiratory tract	Acute or chronic lung infection. Signs and symptoms: fever, chills, headache, muscle aches, dry cough, tightness or pain in the chest, joint pain and skin rash. In severe cases of the disease, symptoms resemble those of tuberculosis. Infection can affect of other parts of the body: eyes, liver, spleen, adrenal glands, inside walls of the heart, central nervous system, etc.	Poultry and other farmers, construction workers, municipal workers, zoos, veterinary staff or workers in contact with bats or their habitat.

Main references:

- Diseases transmitted by animals | Commission des normes de l'équité de la santé et de la sécurité du travail – CNESST (in French only)
- Zoonoses in the workplace: determining vulnerabilities and identifying needs in Quebec (in French only)
- Communicable diseases between animals and humans | Gouvernement du Québec (quebec.ca)
- Directory of health risks by occupation (santeautravail.qc.ca) (in French only)
- Diseases and conditions – Canada.ca
- Pathogen Safety Data Sheets – Canada.ca
- Zoonoses. Zoonosis data sheets – Risks – INRS (in French only)

APPENDIX 2

Agriculture and Animal Product Processing

E.g. Agronomists, livestock farms (beef, chicken, pork, etc.), agricultural training, agricultural fairs, grain, feed and fodder handling, agricultural laboratories and research, fish farms, animal feed preparation, dairy product preparation, food processing (abattoir, butchering, rendering), fish product processing (fish, shellfish, fish eggs and other marine animals), transport of animals and animal products, etc.

Examples of high-risk work situations based on exposure pathways and modes of transmission

Respiratory tract:

- Resuspension of biological agents in the air when:
  - handling contaminated bedding
  - using high-pressure water tools
- Inhalation of airborne infectious particles when caring for sick animals

Contact with skin or mucous membranes:

- Handling live or dead infected animals or products of animal origin
- Contact with contaminated tissue or biological fluids
- Contact with an animal infected with ringworm

Ingestion:

- Ingestion of contaminated animal products (e.g. raw milk)
- Hand-to-mouth contact after touching a contaminated surface

Inoculation:

- Mosquito, bee and tick bites
- Animal bites and scratches

Examples of prevention measures according to the hierarchy of controls

Elimination of source:

- Eliminate contact with biological fluids, organs or tissues

Substitution:

- Replace raw food with feed

Engineering controls:

- Protect farm animals from contact with wild animals
- Use source capture if there is a risk of aerosols
- Clean and disinfect surfaces, objects and tools
- Use automated feeding systems
- Ensure adequate ventilation
- Identify and isolate sick animals

Signage:

- Use posters to remind people of personal hygiene measures
- Add signs when personal protective equipment (PPE) is mandatory
- Identify quarantine zones

Administrative controls:

- Implement a preventive maintenance program for ventilation systems
- Establish a workplace maintenance and hygiene procedure
- Train and educate workers

PPE:

Wear PPE that is appropriate to the risk, for example

- long pants and long sleeves
- boots and gloves
- goggles or a visor to protect against splashes
- appropriate respiratory protective equipment

Animal Care

E.g. Pet shops, training facilities, pet breeders, animal care classes, veterinary clinics, zoos, aquariums, animal shelters, animal boarding services, grooming, research laboratories, zootherapy, etc.

Examples of high-risk work situations based on exposure pathways and modes of transmission

Respiratory tract:

- Resuspension of biological agents in the air when:
  - handling contaminated bedding
  - using high-pressure water tools
- Inhalation of airborne infectious particles when caring for sick animals

Contact with skin or mucous membranes:

- Handling live or dead infected animals or products of animal origin
- Contact with contaminated tissue or biological fluids
- Contact with an animal infected with ringworm

Ingestion:

- Ingestion of contaminated products of animal origin
- Hand-to-mouth contact after touching a contaminated surface

Inoculation:

- Cut or needlestick injury with a dirty device or sharp instrument
- Animal bites and scratches

Examples of prevention measures according to the hierarchy of controls

Elimination at the source:

- Eliminate contact with biological fluids, organs or tissues

Substitution:

- In the laboratory, use cell cultures instead of animals

Engineering controls:

- Replace regular syringes with syringes equipped with a safety device to prevent accidental needlesticks
- Clean and disinfect surfaces, objects and tools
- Ensure adequate ventilation
- Isolate sick animals

Signage:

- Use posters to remind people of personal hygiene measures
- Add signs when personal protective equipment (PPE) is mandatory
- Identify quarantine zones

Administrative controls:

- Implement a preventive maintenance program for ventilation systems
- Establish a workplace maintenance and hygiene procedure
- Limit the number of exposed workers
- Train and educate workers

PPE:

Wear PPE that is appropriate to the risk, for example

- long pants and long sleeves
- boots and gloves
- goggles or a visor to protect against splashes
- appropriate respiratory protective equipment

Work involving outdoor activities: work in the presence of animals

E.g. Wildlife officers, camp counsellors, beekeepers, biologists, hunters/trappers (trapping), municipal inspections, construction trades, landscaping, hunting and fishing outfitters, dead/stray animal pickup, lifeguards and pool monitors, disinfection and extermination services, park workers, bog workers, forestry work, etc.

Examples of high-risk work situations based on exposure pathways and modes of transmission

Respiratory tract:
- Inhalation of airborne biological agents:
  - during building demolition (e.g. bird or bat droppings)
  - when at unsanitary sites (e.g. mould)
  - when handling wild animal nests (e.g. rodents, birds, bats)

Contact with skin or mucous membranes:
- Handling live or dead infected animals or products of animal origin
- Working in contact with contaminated soil or water

Ingestion:
- Ingestion of contaminated products of animal origin
- Hand-to-mouth contact after touching a contaminated surface

Inoculation:
- Mosquito, bee and tick bites
- Animal bites and scratches

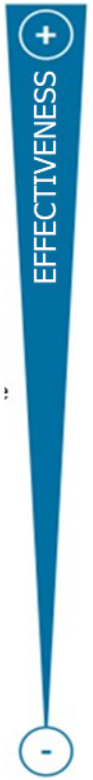
Examples of prevention measures according to the hierarchy of controls

Elimination at the source:
- Eliminate contact with biological fluids, organs or tissues
- Eliminate sources of stagnant water (a breeding ground for mosquitoes)

Engineering controls:
- Clean and disinfect surfaces, objects and tools
- Use methods to repel insects and rodents
- Avoid contact with wild animals (live or dead)

Signage:
- Use posters to remind people of personal hygiene measures
- Add signs when personal protective equipment (PPE) is mandatory
- Identify high-risk areas (e.g. areas at high risk of infected ticks, presence of rabies)

Administrative controls:
- Personal hygiene procedures
- Provide adequate washroom facilities and hygiene products
- Establish a workplace maintenance and hygiene procedure
- Train and educate workers

PPE:

Wear PPE that is appropriate to the risk, for example
- long pants and long sleeves
- boots and gloves
- goggles or a visor to protect against splashes
- appropriate respiratory protective equipment