“There is universal agreement that the first and most important step in eradication of bed bugs is proactive education.” (McDonald and Zavys, 2009)

“Broad awareness of the [bed bug] issue and its solutions, by the general public, before they experience infestations, is the most effective way to encourage early and effective response.” (McDonald and Zavys, 2009)
There are 91 species of bed bugs worldwide!

- Common species include *Cimex lectularius* (the Common Bed Bug) and *Cimex hemipterus* (the Tropical bed Bug)

Left = *C. lectularius*
Right = *C. hemipterus*

Image appears courtesy of Stephen L. Doggett, editor of *A Code of Practice for the Control of Bed Bug Infestations in Australia*, 2010
Appearance:

- Brown, flat, wingless insects (6 legs); adults are about the size of an apple seed, but become larger and rounder after feeding.

Image appears courtesy of the New York City Department of Health and Mental Hygiene.
Diet:

- Blood (humans, animals, birds)
- Adult bed bugs feed every 5-10 days
- Each feeding takes ~3-10 minutes
- Bed bugs can travel up to 15 feet to obtain a blood meal... so they may be found in places other than the bed!
- Female bed bugs can become overwhelmed due to repeated mating attempts, and move away from the males to heal/recover


Image appears courtesy of Stephen L. Doggett, editor of A Bed Bug Management Policy for Accommodation Providers (Draft), 2010
Bed bug fossils have been found dating back as far as 3500 years ago!

In the 1600s, specialized "extermination firms" were developed to deal with bed bugs.

In the 1880s, bed bugs were said to increase with development of central heating, and 75% of all homes in England were infested with bed bugs.

In the 1930s-1940s, 1/3 of all homes in Europe were infested with bed bugs, with 50% of all homes in England still infested (1939).

Bed bugs came to North America with the early European colonists; by 1939, ~30% of all homes in the United States were infested.
Bed bugs had been eradicated from most Western cities by the 1970s:

- Elimination of bed bugs is often credited to the use of DDT and other toxic pesticides, **BUT** bed bugs had started to develop resistance to DDT by 1947

- Evidence exists to support the importance of Integrated Pest Management Programs (ie., United Kingdom Ministry of Health in 1947) in the eradication of bed bugs
Infestations of bed bugs are increasing worldwide:

- **Australia:**
  - 2000 = 158 bed bug treatments done by pest control companies
  - 2005 = 2464 bed bug treatments done by pest control companies

- **Germany:**
  - 1992 = 5 cases of bed bugs
  - 2004 = 76 cases of bed bugs

- **San Francisco, US:**
  - 2004-2006 = Reported infestations of bed bugs doubled

- **New York City, US:**
  - 2004 = NYC staff received 537 bed bug calls
  - 2007 = NYC staff received 6887 bed bug calls

Image appears courtesy of Stephen L. Doggett, editor of A Code of Practice for the Control of Bed Bug Infestations in Australia, 2010
Infestations of bed bugs are increasing **worldwide:**

- **Toronto, Canada:**
  - 2003 = Toronto Public Health received 46 bed bug calls; 1300+ treatments were done by pest control companies
  - 2008 (March-October) = Toronto Public Health received 1500+ bed bug calls

Image appears courtesy of J. L. Gangloff-Kaufmann and C. Pichler, authors of Guidelines for Prevention and Management of Bed Bugs in Shelters and Group Living Facilities, 2008 (Photo taken by P. Stravino)
Bed bugs are resurging for many reasons:
- Bed bugs are developing increasing resistance to pesticides
- Ease of international travel facilitates spread of bed bugs from one location to another
Bed bugs are **resurging** for many reasons:

- Most people have little to no knowledge about bed bugs and how to deal with them:
  - People have difficulty identifying bed bugs and infestations of bed bugs
  - Medical professionals often misdiagnose bed bug bites
  - People use ineffective methods for controlling/treating bed bugs
  - People improperly dispose of items that are infested with bed bugs

Top image appears courtesy of www.bedbugsinfo.ca; bottom image appears courtesy of the New York City Department of Health and Mental Hygiene
Bed bugs secrete pheromones in order to help them find mates quickly; bed bugs often have many partners (genetic diversity → high adaptive capacity).

Bed bugs reproduce by “traumatic insemination” (the male bed bug pierces the abdomen of the female bed bug).

**Life Cycle:**

Egg → Nymph (5 moults) → Adult

- Eggs are small and white, and are anchored to surfaces with a glue-like substance.
- Early nymphal stages are whitish in colour, but become dark when they are engorged with blood.

Bed bugs can multiply very quickly!

- Female bed bugs lay ~5 eggs per day (as many as 200-500 eggs in less than 10 months)
- Bed bug eggs are not destroyed by pesticides
- Bed bug nymphs (1st instar) hatch in ~21 days; the hatching time decreases with increasing temperature

<table>
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<tr>
<th>Temperature (°C)</th>
<th>Hatching Time (Days)</th>
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<tr>
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Chart adapted from Stephen L. Doggett’s A Code of Practice for the Control of Bed Bug Infestations in Australia, 2010; images appear courtesy of www.bedbugsinfo.ca
Bed bugs can multiply very quickly!

- Bed bug nymphs mature (i.e., reach sexual maturity) within ~4-6 weeks
- The average life span of the adult bed bug is ~6-12 months
- Bed bugs can survive up to 1.5 years without feeding (they enter a dormant state)

Image appears courtesy of J. L. Gangloff-Kaufmann and C. Pichler, authors of Guidelines for Prevention and Management of Bed Bugs in Shelters and Group Living Facilities, 2008 (Photo by A. Taisey)
Bed bugs hide in places close to where they feed:

- Beds – bed frames, mattress seams, boxsprings
- Furniture – dressers, couches, chairs, etc.
- Wall mountings – electrical outlet covers, picture frames, draperies
- Cracks in walls, window and door frames baseboards, and floors

Image appears courtesy of Stephen L. Doggett, editor of A Code of Practice for the Control of Bed Bug Infestations in Australia, 2010
Bed bugs are attracted to:

- Carbon dioxide (i.e., human breath) → triggers them to leave their hiding places
- Heat/warmth → helps them to find warm-blooded hosts

Images appear courtesy of J. L. Gangloff-Kaufmann and C. Pichler, authors of Guidelines for Prevention and Management of Bed Bugs in Shelters and Group Living Facilities, 2008 (Left photo taken by J. Gangloff-Kaufmann; right photo taken by P. Stravino)
Bed bugs are an **exposure problem**; they are not necessarily associated with poor sanitation

- Bed bugs can get into dwelling units/apartments that are adjacent to each other (left side, right side, above, below)
- Bed bugs can be brought into dwelling units on used furniture
- Bed bugs have been associated with travel (i.e. hotel rooms, luggage)

Images appears courtesy of www.bedbugsinfo.ca
“... bed bugs are mistakenly associated with low-income communities, because they spread most readily and rapidly in high-density settings with high turnover and find it easier to infest buildings with cracks and crevices to hide in.” (McDonald and Zavys, 2009)
According to pest control companies in the United States and Australia, 1 in 8 bed bug infestations occurs in an office, school, theatre, or public transit setting (McDonald and Zavys, 2009)

- **New York City:**
  - There were 40 reported bed bug incidents at schools in 2005, and 300 reported bed bug incidents at schools in 2007
  - There have been 5 reported infestations of subway stations

- **Toronto:**
  - According to an online survey of non-profit agencies in October 2007, 62/139 agencies that responded had staff that took bed bugs home from work.
Factors that increase risk of exposure to bed bugs:

- Living in densely populated buildings
- Living in buildings that are in need of repair
- Living in buildings with high tenant turnover
- Living in rental properties → tenants lack control over repair decisions
- Taking in second-hand furniture
- Lacking resources (money and time) to manage bed bug infestations

**Being part of a vulnerable population:**

- Elderly people
- People with physical disabilities
- People with mental disabilities
- People living in poverty
Signs of bed bug infestations:

- Finding bed bug eggs and casings, shed bed bug skins, or live bed bugs
- Finding blood and/or fecal stains on sheets/mattresses or on other surfaces
- Smelling an unpleasant, musty odour (with severe infestations)
Bed bug bites:

- Usually occur on the head, neck, and torso (or any other body parts that are exposed while a person is sleeping), often in groups of 3 ("breakfast, lunch, and dinner")
- Often elicit no reaction at all
- Sometimes appear as reddish, raised bumps (similar to mosquito bites)
- Some people can have allergic-type reactions to bed bug saliva
- People can develop infections from scratching bed bug bites
- Anemia and iron deficiency may occur in infants and with extreme cases

Images appear courtesy of www.bedbugsinfo.ca
Are There Any Health Concerns Associated With Bed Bugs?

**Respiratory health concerns:**
- Hatched eggs and shed skins may induce asthmatic-type reactions in some people

**Mental health concerns:**
- Sleep deprivation
- Worrying/stress/anxiety
- Paranoia → delusory parasitosis = the belief that bed bugs are on/in one’s body
- Depression → self-harm, suicide

**Psycho-social concerns:**
- Shame → isolation
- Violent behaviour
Bed bugs are NOT known to be associated with the transmission of disease:

- **Bed bugs and Hepatitis B:**
  - Hepatitis B surface antigen can persist inside bed bugs for 7+ weeks after feeding on an infected source, but viral replication does not occur in bed bugs
  - Hepatitis B has been detected in bed bug feces
  - There has been no artificial demonstration of Hepatitis B transmission in a laboratory setting
Bed bugs are NOT known to be associated with the transmission of disease:

- **Bed bugs and HIV:**
  - HIV can persist inside bed bugs for 8 days after feeding on an infected source, but viral replication does not occur in bed bugs
  - HIV has not been detected in bed bug feces
  - There has been no artificial demonstration of HIV transmission in a laboratory setting
Bed bugs are NOT known to be associated with the transmission of disease:

- Bed bugs and MRSA and VRE:
  - MRSA and VRE have been isolated from bed bugs (1 study); *S. aureus* can persist in bed bug salivary glands for up to 15 days
  - Further research is needed to determine whether or not bed bugs can serve as a vector for MRSA and VRE
Methods for preventing bed bugs from becoming established in dwelling units:

- Eliminate clutter
- Plug holes in ceilings, walls, and floors
- Wrap items in plastic during transport (i.e., when moving, travelling)
- Check hotel rooms when travelling, and wash laundry immediately upon return home

If you work in an environment where you feel that you may be exposed to bed bugs, the following practices may help to prevent them from becoming established in your home:

- Visually inspect any furniture that you intend to sit on or contact for signs of bed bugs, and avoid sitting down when possible.
- Minimize the amount of personal belongings that you bring to work with you, and inspect them for bed bugs upon leaving.
- Bring a change of clothes to wear home at the end of the day; put work clothes and shoes into a plastic bag, and wash laundry immediately upon return home.
Licensed pest control is needed to control bed bug infestations:

- Residents/tenants must prepare the affected room(s) for treatment(s) in order for the treatment(s) to be effective.
Licensed pest control is needed to control bed bug infestations:

- Only licensed, professional pesticides are capable of controlling bed bugs.
- Professional pesticide products may only be applied/used by licensed pest control professionals; it is illegal for the general public to use them.
- Multiple treatments are usually required, because pesticides do not kill bed bug eggs or leave a residual to kill newly-hatched bed bugs (i.e., pesticides must come into direct contact with bed bugs); the first follow-up appointment occurs ~2 weeks after the initial treatment.

Images appears courtesy of [www.bedbugsinfo.ca](http://www.bedbugsinfo.ca)
Licensed pest control is needed to control bed bug infestations:

- Costs of professional bed bug treatments can vary, depending on:
  - The size of the infestation
  - The size of the room(s) to be treated
  - The amount of furniture replacement required

- It is illegal to use over-the-counter pesticides for uses other than those described on the label (i.e., container must say product is intended to be used to control bed bugs)
  - The use of bug sprays and bug bombs may cause bed bugs to discharge alarm/distress pheromones, which induces nearby bed bugs to disperse/relocate

Image appears courtesy of J. L. Gangloff-Kaufmann and C. Pichler, authors of Guidelines for Prevention and Management of Bed Bugs in Shelters and Group Living Facilities, 2008 (Photo taken by Gary Alpert)
Additional bed bug control methods:

- Vacuuming furniture and carpeting, and disposing of the bag when finished
- Steam cleaning of mattresses and other pieces of furniture
  - The temperature of the steam must be 80 °C, and areas must be treated at a rate of no greater than 15 seconds per 30 cm
  - Steam must be applied at low pressure to avoid dispersing bed bugs

Top image appears courtesy of www.bedbugsinfo.ca; image to the left appears courtesy of J. L. Gangloff-Kaufmann and C. Pichler, authors of Guidelines for Prevention and Management of Bed Bugs in Shelters and Group Living Facilities, 2008 (Photo taken by R. Cooper)
Additional bed bug control methods:

- Encasement of mattresses with protective covers
  - Ensure that the cover’s zipper is “bed bug-proof”
  - Monitor the cover frequently for tears and repair them as soon as possible

Image appears courtesy of J. L. Gangloff-Kaufmann and C. Pichler, authors of Guidelines for Prevention and Management of Bed Bugs in Shelters and Group Living Facilities, 2008 (Photo taken by Black Widow Pest Control)

Image appears courtesy of New York City Department of Health and Mental Hygiene
Additional bed bug control methods:

- Washing and drying laundry at high temperature settings
  - Temperatures of 35-60 °C or higher (sources vary) must be maintained for ~20-30 minutes to kill all stages of bed bugs (lower temperatures may not kill bed bug eggs); domestic machines may not be able to achieve these temperatures

- Heating items that cannot be laundered in specialized heating chambers

- Freezing items to -20 °C for ~2 hours (questionable efficacy); longer (up to 10 hours) in household freezers

- Discarding highly-infested items → do not move items unless instructed to do so by licensed pest control professionals, because doing so could spread the problem to other areas
References:


References: