Planting the Seeds of Stewardship: Making Forest Conservation Matter to Urban Communities at Ontario's Royal Botanical Gardens

by

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A capstone paper in conformity with the requirements for the degree of Master of Forest Conservation

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University of Toronto

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Acknowledgments

The author would like to extend her sincerest gratitude to Dr. David Galbraith for his external supervision of this project and for the many hours of engaging conversation and stimulating ideas. Immense thanks are also in order to all of the staff at RBG who took the time to provide detailed and comprehensive interviews: Barb McKeane, Nadia Cavallin, Jennifer Dick, Jon Peter, Karin Davidson-Taylor, Bill Killburn, Kathryn Harrison, Nancy Lee Colibaba, Tys Theysmeyer, Sabrina Hall and Jim Mack. Many thanks as well to Stephanie Morningstar and Ben Porchuk for sharing their expertise on medicinal plants and forest bathing practices. This project could not have been completed without the instruction and support of the entire MFC faculty at U of T, in particular Sally Krigstin who helped to arrange the opportunity at RBG and Dr. Anne Koven who was a thoroughly wonderful supervisor and a genuine guiding light. Special thanks are also in order to Ian Kennedy, Susana Diaz, Deborah Paes, Tony Ung and Amalia Veneziano for their ongoing administrative and technical support throughout the MFC program. Finally, many thanks to the 2014 MFC student cohort for their invaluable support and much appreciated company along the road that led here.
Executive Summary

As urbanization increases, green spaces within urban environments will play an important role in both biodiversity conservation and human health and well-being. It is critical to demonstrate the value of these spaces to the urban public in order to gain their support for urban conservation efforts. This project explores the factors that contribute to environmental stewardship in the urban public. It presents strategies to build environmental stewardship at Ontario's Royal Botanical gardens through novel visitor activities and experiences. The aim of the activities and experiences is to raise awareness of the benefits that urban green spaces confer and to foster feelings of attachment to them. The end goal is to facilitate the formation of pro-conservation attitudes in the urban public.
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1.0 Introduction

Urban forestry is gaining importance in contemporary society as cities expand and urban populations rise. According to the United Nations, as of 2014 fifty-four percent of people worldwide lived in urban areas. This amount is projected to reach sixty-six percent by 2050 (“World's Population Increasingly”, 2014). Rapid urbanization is a major contributing factor to the large-scale biodiversity loss reported in World Wildlife Fund's Living Planet Report (2014), which showed a 52 percent decrease in the world's biodiversity between 1970 and 2010. While large areas of undisturbed natural habitats are decreasing, it has been demonstrated that urban green spaces can contain high levels of biodiversity and it has been argued that urban forestry will play a key role in maintaining biodiversity heading into the future (Alvey, 2006). With ongoing urban expansion, it is critical to demonstrate the value of green spaces within urban environments. While there is much evidence supporting the environmental and societal benefits of urban green spaces (see Maller et al., 2006 for a review), it remains a challenge to draw active support for conservation efforts from the urban public (Ursic et al., 2012). This project explores the psychological dimensions of environmental stewardship at Ontario's Royal Botanical Gardens. A series of activities to be considered for implementation at RBG, intended to make the health and educational benefits of urban green spaces salient and to build psychological attachments to them in the hope of instilling pro-conservation attitudes and behaviour, is presented.

2.0 Background Literature and Rationale

2.1 Overview

The rationale for this project covers several distinctive areas including trends in urban forestry, public health, dynamic health frameworks and alternative therapies, the value of environmental education and outreach at community levels, and the psychology behind attitude formation. While these fields may seem removed from each other, this project attempts to bridge them in a way that engages creative thinking, personal meaning and lasting impressions. Philosophical concepts of nature
are introduced alongside scientific studies on its physical impacts and examples of its therapeutic use to provide a theoretical framework for the importance of green spaces. The idea of immersive experiences is a central theme. Botanical gardens are reviewed as places with the potential to bridge immersive experiences and theoretical education in order to establish highly salient and lasting conservation attitudes.

2.2 The State of Urban Forestry

Authorities in many major cities around the world are becoming aware of a need to reintroduce nature\(^1\) into urban centres, promoting its stewardship and preserving functional ecosystems. Global initiatives such as ICLEI\(^2\) – Local Governments for Sustainability's Urban Biosphere Initiative and BiodiverCity Hotspots are bringing stakeholders from local governments and ministries, international organizations, non-governmental organizations and research institutions together to monitor, inform and improve management of natural resources in and around cities. Urban centres rely heavily on natural resources and the needs of rapidly growing populations pose a major threat to sustainability as well as a risk factor for much biodiversity (World Wildlife Fund, 2014). Many believe humanity is rapidly pushing a global ecosystem toward a critical threshold that could soon cause an irreversible shift in functionality (Barnosky et al. 2012).

In order to promote environmental policy that protects biodiversity, urban forestry initiatives need public support. To stimulate environmental stewardship and support for urban forestry, motivation for conservation must be established in urban communities. Motivation can be built up from attitudes that are likely to influence behaviours. To instill pro-conservation attitudes and thus stimulate helpful behaviours, the benefits of urban green spaces, which are grounded in evolutionary psychology,

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1 The terms “nature”, “natural” or the “natural world” here indicate green areas where elements of the non-synthetic, or non-built, physical environment are more abundant than elements of the synthetic, or built, physical environment. Definitions of what constitutes “nature” may vary by degree of biodiversity present in an ecosystem or by ecosystem functionality (see von Hertzen et al., 2015 for relevant components of biodiversity).

2 International Council for Local Environmental Initiatives
molecular biology, and humanistic philosophy, must be made salient at both the individual and community level.

2.3 Humanity's Connection to Nature

Researchers have suggested that humanity's psychological connection with natural environments hearkens back to pre-civilization times when the natural environment provided food and shelter (van den Berg et al., 2007). It is argued that humans adapted to react favourably to these wayfinding features. Following this predisposition, experiences in nature can connect people to humanity's history, revisiting associations forged through nurturing and utility. In Last Child in the Woods, Richard Louv (2008) speaks of experiences in nature as opening the senses to give people a concept of place, helping them to transcend the self and conceptualize their role in the greater context of the world and its living systems. Louv goes so far as to describe the relationship between humans and nature in terms of psychological attachment theory (pp. 158).

Closely in line with this way of thinking, the Scandinavian cultural attitude of embracing the outdoors, friluftsliv brings together knowledge of self and surroundings, yielding a worldview that bridges philosophy and natural history (Gelter, 2000). This attitude recognizes the shared evolutionary history of all organisms via the same natural processes and holds that understanding these processes is vital to understanding human development. By extension, a sense of place and belonging in nature may serve as a buffer against stressors across the lifespan, helping to maintain a sense of peace and well-being. In line with this ethos, urban centres in Scandinavia have embraced a nature based model for public health and rehabilitation. The Healing Garden in Alnarp at the Swedish University of Agricultural Sciences is cited as an international leader in using nature-based therapies to treat stress related illness, and data from the first seven years of its operation treating patients will stress-related illnesses have demonstrated its effectiveness (Corazon et al., 2010).
2.4 Nature and Holistic Health

Expanding on the example cited above, access to nature has immense implications on human health from an integrated biological, psychological and social perspective. Some researchers have gone so far as to quantify the value of biodiversity in urban areas in terms of perceived health. Using the city of Toronto as their basis, Kardan et al. (2015) placed the perceived healthful value of an additional ten trees in a given block on par with the following: an increase of ten thousand dollars in annual personal income; moving to a neighbourhood whose median income is ten thousand dollars higher; being seven years younger. To understand how such health benefits can be derived, urban nature in context of the bio-psycho-social model of health is presented (figure 1).

![Figure 1: Urban nature in context of the Bio-Psycho-Social model of health (Matsuoka & Sullivan, 2011)](image)

In the model, three major components of health (biological, mental, and social) are intertwined with feedback loops between them. This provides a framework to understand how the benefits of biodiversity in urban communities impact overall health.

Biologically, a recent review article presented at a conference in Helsinki identified biodiversity loss as one of three major risk factors (together with sedentary lifestyle and change in diet) in
developing chronic inflammatory disease (von Hertzen et al., 2015). The researchers noted that environmental diversity is reflected in the diversity of microbiota found on human skin and in mucous. These microbiota help to fortify the immune system and work to prevent chronic inflammatory disease. Thus, on a micro level, green spaces that foster biodiversity are critical components of public health in urban centres.

Bridging biology and psychology, shinrin-yoku – or forest bathing – practices are capitalizing on nature's health benefits. Originating in Japan, this is a type of therapy that involves immersion in a forested area and taking in the atmosphere, either walking or sitting and viewing the landscape. Forest bathing has been demonstrated to have multiple beneficial effects on health and well-being mainly due to relaxation and stress reduction (Lee, Park, Tsunetsugu et al., 2011, Lee, Park, Lee et al. 2011; Li et al. 2011; Tsunetsugu et al., 2013). Regular walking in forest environments has yielded measures of decreased sympathetic nervous activity and increased parasympathetic nervous activity, lower concentrations of noradrenaline in the body, greater concentration of proteins that help prevent metabolic disease, and decreased amounts of cardiac biomarkers that signify heart disease (Li et al., 2011). Forest bathing has further yielded increased natural killer (NK) cell number and activity, as well as increased levels of intracellular anti-cancer proteins (Li, Kobayashi & Kawada, 2008). Such immune system activity boosts can last up to a month after treatment (Lee et al., 2012) and may be attributed in large part to phytoncides (wood essential oils) present in forest air (Li et al., 2006). Further benefits of forest bathing include reduced levels of the stress hormone cortisol, and reduced prefrontal brain activity associated with stress, neither of which has been demonstrated to result from similar walking and watching activities in the city (Park et al., 2007).

At a directly observable level, one of the biggest benefits of urban green spaces is that they get city-dwellers of all ages moving. Indeed, children living close to parks are more physically active that those further away from them (Mowen, 2010) while at the other end of the age spectrum, senior
citizens' longevity is enhanced by access to walkable green spaces (Takano et al., 2002). Correlational findings from a study in Japan even suggest that an area's forest coverage may contribute to decreasing mortality rates from cancer (Li, Morimoto et al., 2008). Such benefits also translate into economic advantages as they reduce the burden on health care budgets, a relationship which researchers are quick to point out as incentive for preserving more urban green spaces (Cicea & Pirlogea, 2011).

From a mental health perspective, perceived closeness with nature is positively correlated with happiness (Howell et al., 2013) and nature exposure has been effectively used to augment therapies for adults suffering from psychiatric disorders (Berger & Tiry, 2012). This is in stark contrast to the long-term cumulative effects of typical urban environments, which include heightened stress and feelings of distress due to crowding and noise, as well as feelings of helplessness and reduced personal control due to limited ability to monitor and regulate use of space (Evans, 2003). Nature experiences have further been demonstrated to have beneficial effects on memory, attention, concentration, impulse inhibition and mood (Bratman et al., 2012). There is also evidence that the degree of psychological benefits reaped from spending time in a green space increases with biodiversity richness (Fuller et al., 2007; Grahn & Stigsdotter, 2010). Not surprisingly then, White et al. (2013) demonstrated that individuals who live in urban areas with more green space demonstrate lower mental distress and higher well-being than their counterparts in areas with little green space.

Nature's mental buffering effects are especially important from a developmental perspective. Findings suggest that children with access to high levels of nature nearby are less impacted by life stress than children with little nearby nature (Wells & Evans, 2003). Cognitive development in schoolchildren has been shown to be enhanced by green spaces in and around school boundaries, at home, and along the way to school with increases in working memory and decreases in inattentiveness (Dadvand et al., 2015). Severity of attention deficit symptoms – a common problem in North American classrooms – have also been found to lessen with increasing greenness of a child's play area (Taylor, et
Further, early contact with nature may help establish a good foundation educational foundation as children grow up. Childhood exploration of the natural environment through foraging has been linked with having a better sense of biodiversity later in life and it has been suggested that opportunities to engage with biodiversity through foraging may help strengthen the impact of conservation education (Chipeniuk, 1995).

From a social perspective, urban green spaces have the potential to bring people together and strengthen community bonds. Given that social stress processing is posited as an underlying factor in the higher risk of mental illness faced by urban dwellers than their rural counterparts (Lederbogen et al., 2011), a means of facilitating social cohesion for city dwellers is beneficial. Nature has traditionally played a prominent role in bolstering cultural identity and social cohesion through shared stewardship of sacred groves, which some researchers believe can be leveraged to enhance conservation efforts in biodiversity hotspots around the world (Bhagwat & Rutte, 2006). Indeed, social and cultural factors are now on the radar of biologists and ecologists as means to promote environmental policy that favours biodiversity and conservation efforts (Mascia et al., 2003; Saunders, 2003). While it is unreasonable to expect most urban dwellers to have regular access to undisturbed natural landscapes with a shared spiritual context, visiting botanical gardens and other such organizations where the cultural significance of nature is salient can help people forge collective spiritual ties to nature and reap the benefits of a close relationship with the natural world.

2.5 The Role of Botanical Gardens

A psychological study focusing on the forest sector in Alberta found that value orientation and belonging to an environmental organization are key factors in promoting environmentally conscientious attitudes; these attitudes predict environmental activism to influence policy and decision-making (McFarlane & Boxall, 2003). Botanical gardens are ideal places to cultivate such large-scale values and attitudes that can facilitate stewardship in urban areas. As combined conservation and
educational institutions, gardens add unique meaningful experience to city living by providing continuity between natural history and human development. With effective management and public programming, they may also foster opportunities for community recreation, health, and well-being. Weber & Stern (2011) note that the public's understanding of environmental issues is limited by lack of experience with scientific methods and communications. They also note, quite logically, that the public typically refers to intermediary sources rather than scientists to gain information on environmental issues. Thus the role of public organizations like botanical gardens, where science can be made accessible, is vital to a conservation minded society.

Beyond the issue of accessibility, the affective value of a visit to a botanical garden can have strong repercussions. Firstly, the general public tends to react to urban forests in a personal and emotional manner and to see forests less in terms of conservation issues than in terms of refuge and pleasure (Hunter, 2003). Secondly, emotional reactions can influence attitude change in response to persuasive information, either in a positive or negative direction depending on the type of emotion evoked (Biggers & Pryor, 1982). Thirdly, when it comes to decision-making, there is evidence that associative and affective processes, which happen quickly and automatically, may carry more weight than rationality (Weber, 2006). Consequently, making the bridge from personal experience to environmental stewardship is a central challenge of public conservation institutions.

Regular visits to botanical gardens and their conservation areas reinforce humanity's relationship with collections of plants that have played valuable economic, nutritional, or medicinal roles in civilization. Getting to know these collections, particularly through physical engagement, gives meaning to the plants that people encounter around their communities and may help to build respect and appreciation for nature. In order to realize their full potential in urban areas and to instill a sense of responsibility for conservation in the visiting public, botanical gardens must be branded and recognized as vital components of the community where people regularly come to learn, to heal and to connect.
3.0 Growing Stewardship from Grassroots: Ontario's Royal Botanical Gardens

“Humans have a deep-seated curiosity that begs to be satisfied. It is meaningful to expand knowledge about humanity and the universe.” - RBG Head of Science, David Galbraith

The vision and mission statement of RBG reads: “We dedicate our expertise in horticulture, conservation, science and education – together with our unique gardens, facilities and natural lands – to inspire and nurture society’s commitment to the environment. Royal Botanical Gardens is a global leader in how we use plants and the natural world to connect people, place and sustainable behaviors.” (Royal Botanical Gardens, 2015) It is expounded that “RBG is the largest botanical garden in Canada, a National Historic Site, and registered charitable organization with a mandate to bring together people, plants and nature.” These statements illustrate a commitment to environmental stewardship as well as human well-being, advocating for more interaction between people and natural spaces. The community at RBG is well aware of its impact and potential as an urban green space. What makes a botanical garden a unique institution according to David Galbraith, Head of Science, is how the garden's resources are utilized for public benefit. To this end, RBG continually strives to find new ways to keep its resources and collections meaningful and relevant for current generations.

A meaningful experience, according to Victor E. Frankl, an early figure in humanistic psychology and the founder of logotherapy, is one that transcends the self (Frankl, 1984). This is echoed in the sentiments of RBG's staff. “Humans have a deep-seated curiosity that begs to be satisfied. It is meaningful to expand knowledge about humanity and the universe,” says Galbraith. The central question is how to do this. According to staff, feedback received from surveys on RBG's public offerings indicate that people value experiences over information in an event or program. RBG thus strives to offer experiential learning opportunities for visitors that leave a meaningful impression and that speak to emotions while communicating the values and developments of the gardens.
Manager of Customer Programs, Sabrina Hall says RBG follows a conservation continuum model to design their visitor experiences. This involves first getting people to come to RBG then making them fall in love, expanding knowledge and instilling a desire to learn more. Following the continuum, learning leads to caring and caring leads to stewardship. Head of Education, Barb McKeane believes relevance makes meaning and that interest in nature must be piqued and related to day-to-day life in order to make people care about it. Interpretation at RBG thus includes a collection of educational display carts placed strategically throughout the gardens detailing the role of plants in technology, culture, and consumer products among other themes, as well as school programs, day camps, horticultural therapy activities and video conference tours. Science outreach at RBG involves visitors in plant and insect identification workshops and guided botanical themed walks, enabling the public to learn about scientific terminology, monitoring and observation practices as they engage first hand with diverse specimens of flora and fauna. Through these activities, RBG hopes to inspire people to make a positive impact on the environment.

Hall notes the importance of engaging the senses to make a real connection to the outdoors. Freedom to engage with nature in an undirected manner is an important point for Bill Kilburn, Manager of RBG's Back to Nature Project. A provincial initiative first inspired by Richard Louv's Children and Nature Network, the aim of the program is for people to see how important nature is to health and well-being. In Kilburn's assessment, the way a meaningful connection with nature can be facilitated is by letting it speak to people on an individual level. He feels it is important to offer opportunities to experience nature but not to define it for anyone, rather to let people find their own meaning in the experience. Head of Natural Lands, Tys Theysmeyer also feels that access to the nature along trails or in natural lands is critical to health. He emphasizes the importance of emotional health, noting how the trails and experiences at RBG are designed to facilitate positive feelings that help mental and emotional
well-being. The broad themes of piquing curiosity, presenting opportunities to derive personal meaning, supporting health and well-being, and forming lasting connections with the public form the basis of this project.

4.0 Objectives

“We have a right to meaningful connections with nature and we have a responsibility to ourselves to make them…” - Bill Kilburn, Manager of RBG's Back to Nature Project

This project is concerned with advancing the status of urban forestry in the general public's awareness. It aims to facilitate environmental stewardship in the urban public in a “bottom-up” manner, by facilitating personal attachment to urban green spaces – using RBG as a test case – while providing opportunities for scientific and cultural education pertaining to biodiversity. From extensive interviews with education and public programming staff at RBG, several aims emerged concerning the garden's public education and outreach strategy. Staff were in agreement to combat the idea that gardens are static unchanging places and to draw in new people who might not typically be interested in or familiar with gardens. To this end, staff support taking more risks and pushing the envelope where necessary in order to attract and retain new visitors. Staff are also interested in presenting playful opportunities to engage the public.

This project attempts to address these aims by designing new public experiences and creating new interpretative material that aligns with the mission and ethos of RBG. A series of seasonal tours focusing on fragrant plants and including an experimental perfumery workshop is proposed. These experiences attempt to incorporate as much as possible the values espoused by RBG staff from their collective experiences bringing people and nature together. Tours combine artistic creativity, embodied psychology and holistic health, scientific education, cultural history and spirituality. They are intended to promote restorative exercises in nature, to stimulate imagination, to endow visits to RBG with
meaningful personal context and to facilitate a sense of community. Sensory immersion, ethnobotanical education and subjective spiritual meaning are taken as starting points to help visitors deepen their appreciation for nature and form an embodied connection to RBG.

5.0 Methods

“[Interpretation is] using materials and things around us to make linkages to people's personal experiences, building connections and personal meaning.” - RBG Interpretation Officer, Jennifer Dick

5.1 Research Approach

This project follows a qualitative research protocol. Research methods employed include interviews, observations and literature searches. From these methods, elements of effective case study research emerged as appropriate for this project. These include generating a plan in which interpretative material can be leveraged in a novel experience, designing a structured activity around the material, collecting the material, analyzing how the experience may impact visitors and, eventually, sharing the experience. The qualitative approach in this instance is most appropriate because the goals are to increase the amount of interpretative material prepared for use by RBG, to increase the amount of activities that can be derived from it and to increase the public's satisfaction with these experiences, with the aim of retaining more visitors. It was not possible to implement the activities generated for a trial period during the course of this project so quantitative data on public satisfaction was not available. However, if the activities are implemented at a future date, assessing the public's response through analysis of feedback would be a useful quantitative approach to explore how to retain new visitors to the garden and how to keep returning visitors engaged. Follow up psychological studies on the physical changes or neural reactions of visitors during tours would be an interesting avenue to pursue if time, resources and ethical considerations permit. These were considered at the outset of the project, however given the constraints of working with an active public institution, qualitative research was the most feasible approach.
5.2 Overview

The aim of the tours and workshops presented as potential new activities at RBG is to bridge science and spirituality through the medium of plants in order to promote personal significance of urban green spaces and foster feelings of stewardship. These activities are further intended to create positive emotional associations with biodiversity and RBG. Visitors will learn the science of scent and fragrant plants while reaping the benefits of time spent immersed in green space, opening themselves to heightened sensory experiences of nature. The goal of sensory immersion is to stimulate a highly salient positive association with nature. The sense of smell is emphasized because of its powerful, but often underappreciated influence on daily experience. The sense of smell readily facilitates emotional memory formation and recall due to the anatomical properties of olfactory perception (Herz, Eliassen, et al., 2004). Research suggests that feeling emotionally connected to places helps facilitate pro-environmental attitudes (Budruk et al., 2009). By engaging the sense of smell during interactive tours, associations may be established between particular smells, learned information and affective experience. The end product of the workshops, a custom scent that visitors to RBG can take home with them, is intended to embody the experience. Through associative memory, the smell of the perfume may trigger memories of the tour experience and the information learned, hopefully reinforcing positive attitudes toward RBG and conservation.

Spirituality in the context of tours is understood as instances or patterns of personal meaning that arise as a result of several factors working together in a way that escapes precise definition. The sense of smell is symbolic of spirituality because much of its influence happens on a level that largely escapes awareness. It has been conceptualized as a physical essence that constitutes and communicates unseen identity, remaining in the wake of its source to impact others (Rozin & Nemeroff, 1990). It is in this way somewhat of an intangible sense, but it is also one that can grow in power and influence with awareness training, which will comprise part of the tours. Spirituality will also be incorporated through
meditative practices involved in forest bathing and through sharing the cultural significance of certain plants as they pertain to symbolism, healing and mythology.

Activities will be scheduled for an afternoon engagement lasting approximately three and a half hours. They will consist of a perfumery workshop in two one-hour parts (theoretical and practical) as well as a one-hour tour of a portion of RBG's grounds. Prior to tours, visitors will participate in a theoretical perfumery workshop that explores the mechanics of the sense of smell, as well as the basic principles and terms of perfumery. Participants will have a chance to practice newly learned fragrance classifications and vocabulary by playing a scent identification game.

Tours will be structured around four seasonal themes: summer in and around the scented and medicinal gardens of Hendrie Park; autumn in and around the vegetable, medicinal, and medieval gardens of Hendrie Park; winter along The Pinetum at RBG's arboretum; and spring around the Avenue of Trees and when the season permits, around the Lilac, Magnolia, Dogwood and Redbud Collections as well as around the flowering cherry trees at the arboretum. Each tour will begin with an introduction to the influence of the sense of smell on emotion and cognition. Each tour will also involve a brief session of meditative exercises to hone awareness of the senses within the garden's grounds.

Interpretation material will be interspersed with touching and smelling plants, sharing impressions of the sensory experience and sharing memories or experiences associated with the plants. Immediately following tours, visitors will take a half hour break in which they can explore more of the gardens on their own. Following the break, visitors will participate in a practical perfumery workshop in which they will use the essential oils of fragrant plants encountered on the tours to create their own custom scents.

5.3 Theoretical Perfumery Workshop

The goal of the theoretical perfumery workshop is to familiarize tour participants with the mechanism of olfaction and to provide some basic perfumery terms and principles as well as
descriptive vocabulary to apply during tours and during the practical workshop. Materials required for this workshop include a bag of jelly beans (or similar candy) and some small paper sampling cups, photocopied handouts, an overhead projector, writing materials and loose-leaf paper, and a powerpoint presentation. At the outset of the workshop, a few jelly beans will be distributed to each participant in the sampling cups to demonstrate the importance of the sense of smell to the subjective experience of flavour. Participants will be invited to sample a jelly bean and to note its flavour. Next, they will be invited to sample another jelly bean, only this time to do so while plugging their nose. On doing so, participants will find that the unique flavour of the jelly bean has disappeared and that they can only detect a generically sweet taste. This experiment is intended to demonstrate how the senses of smell and taste work together to perceive flavour (Small & Prescott, 2005). Taking this relationship as a starting point, it is further intended to demonstrate the complexity of the sense of smell and its influence on day-to-day experiences, as this influence may be easily overlooked.

The mechanism of smell will be presented with the aid of diagrams and their interpretation (see Appendix 1). After the overview of the sense of smell, major fragrance families used in perfumery will be presented via a famous diagram called the Fragrance Wheel, developed in 1983 (Fragrances of the World, 2015) by British fragrance expert Michael Edwards (see Appendix 2). A brief explanation of the social significance of the different perfume types will follow (see Appendix 2). In addition to major categories of fragrance, participants will also learn the ABCs of perfumery (Dowthwaite, 2010) an alphabetically based classification system with various terms and their descriptions (see Appendix 3). This system provides an introduction to some olfactory descriptive terms in a format that is easy to remember. Practicing how to express olfactory sensations is important because of all the senses, smell is the most lacking in distinctive reference terminology across languages (Classen, et al., 1994 cited in Herz, 2011). The ABCs will be followed by relevant glossary terms that will help familiarize participants with the basics of perfumery (see Appendix 4).
After gaining some familiarity with scent vocabulary and perfumery terminology, participants will have a chance to practice their identification skills and to apply their newly learned descriptive terms in a variation on koh-do, a Japanese incense ceremony. Koh-do originated as an art form in the Muromachi period (1336-1573 CE) and eventually came to be played as a game which involves burning incense and trying to identify its fragrance (Rhind, 2014, pp. 40). For the purposes of the workshop, three essential oils that will later be used in the practical workshop will be selected for identification. Blotters will be passed around to each participant and they will be asked to record their impressions of the scent using terms from the ABCs of perfumery. They will also attempt to identify the oil. After three rounds of this game have been played, participants will move outside to the garden grounds to embark on the fragrant tours.

5.4 All Seasonal Tours

The goals for all seasonal tours are as follows: to provide a meaningful experience in the garden that will foster reflection on holistic health; to help forge an ongoing connection between visitors and RBG; to underscore the need for more interaction with green spaces in society. In order to do this, many cultural uses of plants will be discussed including medicinal uses as well as cultural and spiritual relevance.3

Upon entering the garden grounds a guide will provide some information on how the sense of smell subtly influences behaviour, mood and social preferences in day-to-day life (see Appendix 5). A brief explanation of the process by which aromatherapy works will also be provided (see Appendix 5). Additionally, the guide will give a brief description of analytical chemistry methods used to isolate and identify bioactive compounds and aromachemicals in plants (see Appendix 5). After the introduction to

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3 At the beginning of each tour, a disclaimer will be provided that any information discussed is for the purpose of interest and education only, and that RBG is not promoting the aromatherapeutic or medicinal use plants in any fashion as a self-directed practice. It will be made clear before entering the RBG grounds that anyone interested in using plants for healing purposes should contact an appropriate professional such as a naturopathic doctor, certified herbalist or certified aromatherapist.
the science and influence of smell, participants will walk together to the starting point of the tour, stand in a circle and engage in deep breathing exercises with eyes closed to relax and facilitate focus on the senses (as is a common part of forest bathing experiences). Participants will be instructed to pay attention to the senses of sound, touch and smell in turn. They will be asked to pay particular attention to the sense of smell and to what they are smelling at the moment in the garden, to note how they are feeling and if there are any associations that come to mind. Some impressions will be shared and the guide will then explain that the point of the tour is for each person to take away a unique learning experience and participants may wish to take notes on their impressions of the plants encountered for later reference during the practical perfumery workshop.

The guide will also explain that the tour is consciously engaging the sense of smell at a time when society is placing more and more restrictions on scents and scented products in public spaces. A brief description of multiple chemical sensitivity (MCS) will be provided as a syndrome wherein low levels of chemical exposure may cause multiple symptoms of illness (Magill & Suruda, 1998). Tours are meant to help participants embrace the sense of smell rather than avoid it and to appreciate the aroma of the chemical compounds found in nature. Tours will function as an exercise in appreciation of the present as well as an educational experience about plants and fragrance. Appreciation, defined as “acknowledging the value and meaning of something and feeling a positive emotional connection to it” (Adler & Fagley, 2005 cited in Fagley, 2012), has been demonstrated to be a significant contributor to life satisfaction (Fagley, 2012). Thus, tours aim to promote feelings of subjective well-being. From a cultural perspective, spiritual traditions have made heavy use of aromatic plants throughout history and around the world (Ross, 2007), and many traditions are still relevant today. A brief history of perfumery and its importance in various cultures will be provided (see Appendix 5).

Following the information on the history and spirituality of scent, walking tours will commence and the guide will provide interpretative material on each plant designated as part of the tour. Tours will
be designed as loops through their respective areas, beginning and ending in the same places. Tours are designed to be interactive so participants will be allowed time after each plant's interpretation to touch and smell the plant and to record or discuss their impressions. They will be encouraged to use descriptive perfumery terms learned in the theoretical workshop. It will be noted that fragrant components of plants encountered on tours may differ by species, subspecies and cultivar.

5.5 Interpretative Material

Interpretative information on multiple plants is provided to ensure that tours may be different each time, allowing visitors the opportunity to repeat the tour and gain a different experience as many times as they would like. This variation is mirrored in the perfumery workshop where visitors may create a different fragrance every time. Variability speaks to the idea of individual experience and interpretation of the natural world. It reflects a philosophy that every person has a unique sensory experience of the world and a personal interpretation of what it means, molded by familial, societal and cultural context. As a sample of the interpretative material to be provided on each fragrant plant included in any of the tours, the profile for black pepper is presented. All fragrant plant profiles are included in Appendix 6.

**BLACK PEPPER**

**Scientific classification:** *Piper nigrum*

**Perfumery classification:** spicy, middle note

**Contributing fragrant compounds:** α-terpineol (floral); acetophenone (irritant, sharp); hexonal (green apple); nerol (fresh, floral, herbaceous); nerolidol (mild, spicy, rooty); 1,8-cineole (camphor-like); dihydrocarveol (warm, woody); citral (citrus-like); α-pinene (resinous, fresh, pine-like); piperonol (sweet, floral) (Megwhal & Goswami, 2012)

**Medicinal uses:** Smell stimulates sympathetic nervous activity, increases adrenaline concentration (Haze et al., 2002). Properties and uses of pepper include analgesic, antimicrobial, antipyretic (fever
reducing), cancer inhibitor, anti-inflammatory, cough treatment, fever treatment, digestive aid, appetite stimulant, antioxidant (Megwhal & Goswami, 2012)

**Cultural and spiritual significance:** Important plant in Ayurvedic and traditional Chinese medicine; said to have been eaten by Indian monks daily for energy; some use as an aphrodisiac; said to unblock mental energy, facilitate courage and offer sense of protection (Wilson, 2002, pp. 55).

Interpretative material provided for tours is not exhaustive and may be added or altered as guides see fit according to their own expertise, provided there are references for the material. Interpretative material involving ritual use, mythological stories and symbolic associations of fragrant plants is not only intended to provide interest and provoke reflection on spirituality for visitors to RBG but also to mimic a type of nature-based therapy. In the design plan for Nacadia healing garden in Denmark (Corazon et al., 2010), the therapeutic ethos made connections between processes in nature and the life situations of patients at the garden in part through the use of stories, metaphors, poems and symbolism. These connections were intended to promote understanding and relevant insights that could help encourage positive change. The underlying theory behind this is Acceptance and Commitment Theory, which recognizes the value of narrative elements in therapy as important methods of fostering change (Hayes et al., 2004 cited in Corazon et al., 2010). In the tours outlined here as well, stories, symbols and the like are intended to stimulate insights and associations that may be relevant to visitors in order for them to feel connected to nature and to encourage mindfulness in the moment.

**5.6 Practical Perfumery Workshop**

The practical perfumery workshop will begin with an explanation of perfume composition techniques following Herz (2011). The musical composition metaphor for a perfume will be introduced and the three-notes structure of a blend - base notes, body/middle/heart notes and top notes (see glossary terms in Appendix 4) will be explained. Essential oils will also be presented, noting to which category each belongs (see Appendix 6) and it will be explained that due to varying evaporation rates, a
perfume's scent will change as time passes.

Safety information in the form of handouts will be prepared prior to the workshop indicating any precautions participants should consider before choosing to include a particular oil in their blends. Information will be distributed at the beginning of the workshop for participants' reference. Carrier oils will be introduced and guidelines for ratios of each note in the blend and of the blended oils to the carrier oil will be reviewed. Materials involved in the workshop will include an unscented carrier oil such as almond or jojoba (witch-hazel astringent may also be used), several essential oils corresponding to the plants encountered on the tours, small glass or plastic pots, bottles or rolling sticks, several small plastic dishes, paper blotters (see glossary terms), beeswax, apparatus for a marina bath (small pot that fits within a larger pot), a heat source and stick-on paper labels. Participants will then begin experimenting with blending. Once experimentation has finished, participants will blend their chosen oils either with the beeswax and carrier oil in a marina bath to make a solid perfume, or solely with the carrier oil to make an oil based perfume. Participants will then bottle their perfumes in a small pot or rolling stick and affix a label with their chosen name for the blend. In creating a tangible entity from the tour experience, visitors are able to bring the experience home with them and to revisit the memories created from it at any time.

Once all participants have created a signature blend, each in turn will share their creation with the rest of the participants, explaining why they chose the oils they chose and what impressions they get from the blend. Interested participants will have the chance to record their thoughts and inspirations and their preferred fragrance formulas in a guest book that will be displayed at all subsequent tours during the season and in conjunction with other seasonal scent books at a craft fragrance festival the following summer.

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4 Some heavily concentrated fragrant raw materials such as resins or absolutes may require dilution in a carrier oil prior to the workshop in order to ensure safe handling and effective blending.
5.7 Craft Fragrance Festival

The purpose of the festival is threefold: to promote activities at RBG, particularly the fragrant tours; to showcase artisans in the area; and to generate revenue for RBG. It will provide an opportunity for past participants in the fragrance tours and perfumery workshops to return to RBG and to share their scents and stories. In this respect the festival works to create continuity among visitors and to form lasting attachments to RBG. The festival may also bring people to the garden for the first time, allowing them to get an idea of what kind of activities and experiences RBG offers and to tour the grounds.

Local artisans will be invited to sell their wares including perfumes, glassware for bottles, scented candles and cosmetics such as soaps, lotions or lip balms. Artisans may also be offered the opportunity to give workshops where feasible for visitors to make a scented product of their own. Invitations may be extended as well to aromatherapists to provide consultations, and to massage therapists who work with essential oils to offer their services. Guest speakers from McMaster University and partners from Six Nations may be invited to give special lectures on ethnobotany and the economic value of fragrant plants.

In order to generate revenue for RBG, an entrance fee may be charged for visitors to the festival. Artisans and vendors may also be charged a fee to set up their booths. Potential corporate partners that RBG can approach for sponsorship include the Oakville branch of the fragrance house Coty, the Toronto branch of The Body Shop, and the Scarborough-based fragrance and flavour house Aromatics & Flavors Inc. Any sponsoring organization may be invited to address visitors or to give a question and answer session for anyone interested in the fragrance and flavour industry. RBG may also sell fragrant plants commonly featured in perfumes and their seeds or essential oils.

Paying homage to the fragrance/flavour association, a tea station may be set up selling fragrant herbal infusions from the garden. Additionally, special cooking and confectionary arts workshops may
be offered during the festival for participants to experiment with recipes involving flowers or their essences. Products from these workshops such as candies or baked goods flavoured with rose water, lavender essence, vanilla bean and other such edible flowers and fragrant herbs may be sold as well. The Turner Pavilion Tea House at RBG or the cafe in the RBG Centre may offer special “fragrant tea time” menus featuring salads, baked goods and desserts specially flavoured with edible florals and herbs.

With the consent of past participants in the fragrant tours and workshops, their perfumes may be recreated by RBG and made available to the public at the festival or on an ongoing basis at RBG's gift shop. Thank you cards in which festival visitors can write a personal message about their impressions of the perfume may be purchased at the same time; RBG can then send these on to the people who made the blends. Such an activity has the advantage of building a sense of community at RBG, forging connections between visitors and sharing the meaningful value of their experiences.

6.0 Anticipated Significance of the Work

“It is meaningful to plant a tree, watch it grow and see a forest later.” - RBG Species at Risk Biologist, Kathryn Harrison

This is a highly interdisciplinary project that can help to mobilize community support for urban forestry and stimulate conservation efforts at a grassroots level. It is intended to be a first step for many people that will get them to interact with nature and to engage holistically with it. If the project succeeds in drawing more supporters to RBG and retaining them on the basis of meaningful impact, it may inform future activities at RBG and other community conservation organizations that strive to build an emotional link to place. Creating new interpretative material also provides scope for RBG's public offerings. Information on selected fragrant plants and their scientific and cultural significance

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5 A Canadian company from whom RBG can order bottles, oils and other supplies at wholesale rates is Rae Dunphy Aromatics: http://www.raedunphy.ca/. In the event that some oils are too difficult or expensive to obtain, substitutes from plants with similar fragrant profiles may be used.
may be used in interpretation displays and ongoing educational outreach activities (see Appendix 7 for suggestions). Interpretative material on medicinal and cultural use of native Ontario plants may also help to spread awareness of Aboriginal perspectives on forest conservation. This may facilitate more learning opportunities involving Six Nations communitites with ties to RBG.

Suggested activities are bounded experiences but they are highly personal and malleable to participants' interests. In this manner they serve as a strong foundation on which to build meaningful relationships with urban green spaces and environmental organizations. Once relationships are established, they can facilitate the gradual strengthening of an informed and engaged urban public.

There are strong benefits to be derived from public education and awareness. A public with meaningful attachment to conservation institutions is likely to support their conservation efforts and to support pro-environmental policy. Urban conservation efforts cost a lot of money and the public needs to be willing to contribute to them in order to protect biodiversity. An educated and engaged citizenry is also one that is more likely to understand the need for urban forestry and to support it financially. In this sense, the project is attempting to sow the seeds of stewardship in the hope that they grow in time and contribute to a movement.

### 7.0 Conclusion

With effective outreach initiatives that emphasize the role of green space in learning, connecting and health, botanical gardens have much to offer urban communities and can contribute substantially to promoting conservation behaviours in the general public. Whether through innovative activities, partnerships or events, the potential of urban green spaces to instill a love and respect for nature in increasingly urbanized societies is immense. Urban centres continue to grow, whereas consistent access to nature is likely to decrease for much of Canada's population. With increasing urbanization, botanical gardens and urban forests will become more important public spaces and it is vital to cultivate public attitudes that appreciate these spaces and to educate the public on how to care for them. If cultivated
over time and nurtured with the right resources, general interest may turn into caring, which may become passion, which may translate into meaningful action to help local conservation efforts. If afforded recognition and resources, local conservation efforts can grow in scope, link up with other efforts and create a nation-wide network of citizens taking meaningful action for the environment. The global community can benefit from more meaningful action from informed citizens who care about conserving the natural environment and who are willing to work collaboratively to do so. Stewardship may begin in the city but it has the potential to reach all around the world.
8.0 Appendices

8.1 Appendix 1: Diagrams of The Sense of Smell with Interpretative Material

The following diagrams were sourced from the University of Calgary's (2015) Psychology Instruction Project online pages for the course Psyc 369 - Sensation & Perception:

Figure 1.1: Olfactory pathway through the nose
Source: http://ucalgary.ca/pip369/mod8/smell/pathways

Figure 1.2: Scent transduction
Source: http://ucalgary.ca/pip369/files/pip369/panel.jpg
As the first stage in olfaction (figure 1.1), scent molecules enter the system through the nose (or the pharynx as a secondary pathway). Once inside the nose, they travel to the olfactory epithelium in the nasal cavity. Scent transduction (figure 1.2) refers to the process of converting sensory information into neural signals. This occurs in the olfactory epithelium where scent molecules bind to the olfactory receptors (protein molecules) found on cilia at the ends of olfactory receptor neurons. Once scent molecules attach to olfactory receptors, a series of chemical reactions produces an action potential (electric signal) in the cilia. The signal travels through the axons of the neurons to structures called glomeruli, which are found on the left and right olfactory bulbs. The exact mechanism of transduction is not known but the perception of sensory information is influenced by several characteristics of scent.

Figure 1.3: Olfactory pathway through the brain
Source: http://ucalgary.ca/pip369/files/pip369/pathway2.jpg
molecules. These include their physical and chemical properties, electrical charge, chemical reactivity and molecular structure. Molecular structure complicates attempts to characterize scent molecules because some molecules with a similar structure can smell very different, and likewise molecules with different structures can smell very similar. The way olfactory receptor neurons respond to scent molecules further complicates characterization. One neuron may respond to a variety of scent molecules while another may only fire in response to a select few. Moreover, some neurons may fire in response to molecules with similar structures while others may not appear to follow any distinct pattern. Olfactory receptor neurons in the same areas of the olfactory epithelium have similar properties that are distinct from neurons in other areas. Receptors found in the same area send their information to the same glomeruli on the olfactory bulbs. The final stage in olfaction is the pathway through the brain (figure 1.3). From the olfactory bulbs, information travels via the lateral olfactory tract to the primary olfactory cortex. Next it passes through the thalamus which acts as a relay centre, and then on to the orbito-frontal cortex, where smell is consciously perceived. In primates there is a pathway running from the thalamus to the amygdala and then on to the hypothalamus. The amygdala is situated in the limbic system, which perceives emotion. This connection helps to explain the emotional impact of smells.
8.2 Appendix 2: The Fragrance Wheel

The Fragrance Wheel depicts the major fragrance categories and their sub-families with key ingredients that can turn one family into another. Addition signs indicate transformative ingredients. For example, an oriental fragrance becomes a woody oriental fragrance with the addition of sandalwood, patchouli, or other such woody materials. This process can be traced around the wheel through all of the major families.

Figure 2.1: The Fragrance Wheel (Edwards, 2015)

The Fragrance Wheel illustrates sub-categories of fragrance and the overlap between them to
create nuanced fragrance types. In this way it is a helpful guide to blending. Different types of fragrances have become associated with different demographics. For example, men's fragrances typically involve woody and fresh, herbaceous characters whereas floral, fruity and oriental characters are predominantly the domain of women's fragrances (Zarzo & Stanton, 2009). This distinction was made around the mid-nineteenth century; prior to then, neither the act of wearing perfume nor the type of perfume worn were prescribed by gender (Herz, 2011). During the mid-nineteenth century however, smells became associated with illness and attitudes toward all types of scents turned negative; western perfume culture became more conservative and perfume wearing became gender stereotyped in a manner than still pervades today (Herz, 2011). The spring and summer perfumery tours at RBG encompass mainly plants that are commonly used in women's fragrances while the fall and winter tours encompass mainly plants that are common in men's fragrances. However, it will be noted that any particular scent derived from the plants encountered on any tour may be incorporated into blends suitable for either gender. While the Fragrance Wheel is not an exhaustive representation of all types of fragrances, it is a good indicator of the general consensus on perfume categories. Fragrances are categorized on the basis of several characteristics including concentration level, scent family and characteristic notes (individual fragrant components) in the scent (Herz, 2011).
8.3 Appendix 3: Dowthwaite (2010)'s The ABCs of Perfumery

<table>
<thead>
<tr>
<th>A-Z</th>
<th>Classification</th>
<th>Common Description</th>
<th>Key Reference Materials/Sub-groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>ALI-FAT-IC</td>
<td>Fatty, Waxy, Soapy, Clean</td>
<td>Aliphatic Aldehydes, Alcohols</td>
</tr>
<tr>
<td>B</td>
<td>B – iceBERG (Cool)</td>
<td>Cooling, Borneol, Mint, Camphor</td>
<td>Menthol, Camphor, Eucalyptol</td>
</tr>
<tr>
<td>C</td>
<td>CITRUS</td>
<td>Sour, Sharp, Citrus peel</td>
<td>Citral, Orange, Lemon, Lime</td>
</tr>
<tr>
<td>D</td>
<td>DAIRY</td>
<td>Milky, Cream, Butter, Cheese</td>
<td>Diacetyl, Butyrate, Lactone, Valerate</td>
</tr>
<tr>
<td>E</td>
<td>EDIBLE</td>
<td>Vegetable, Nut, Fish, Meat</td>
<td>Thiazoles, Pyrazines, Sulphides</td>
</tr>
<tr>
<td>F</td>
<td>FRUIT</td>
<td>Sour, Sweet fruits, Strawberry</td>
<td>Allyl caproate, Verdox</td>
</tr>
<tr>
<td>G</td>
<td>GREEN</td>
<td>Cut-grass, Leaves</td>
<td>cis-3-Hexenol, Triplal</td>
</tr>
<tr>
<td>H</td>
<td>HERB (Neutral)</td>
<td>Cool Herbaceous notes</td>
<td>Lavender, Sage</td>
</tr>
<tr>
<td>I</td>
<td>IRIS</td>
<td>Orris, Violet</td>
<td>Ionones, Methyl Ionone</td>
</tr>
<tr>
<td>J</td>
<td>JASMINE</td>
<td>Fruity, Oily, Narcotic, Jasmine</td>
<td>HCA, Benzyl Acetate</td>
</tr>
<tr>
<td>K</td>
<td>KONIFER</td>
<td>Pine, Pine needle</td>
<td>Terpineol, Bornyl Acetate</td>
</tr>
<tr>
<td>L</td>
<td>LIGHT Chemical Floral</td>
<td>Fresh light floral chemical, Metallic</td>
<td>Linalool, Vertenex, DMBC</td>
</tr>
<tr>
<td>M</td>
<td>MUGUET</td>
<td>Lily of the Valley, Green, Fresh</td>
<td>Hydroxy, Lilial, Lyral</td>
</tr>
<tr>
<td>N</td>
<td>NARCOTIC</td>
<td>Heavy, Sweet florals, Absolutes</td>
<td>Narcissus, Ylang Ylang, Tuberose</td>
</tr>
<tr>
<td>O</td>
<td>ORCHID</td>
<td>Aromatic, Deep floral</td>
<td>Salicylates, Benzoates</td>
</tr>
<tr>
<td>P</td>
<td>PHENOL</td>
<td>Phenol, Medicinal, Honey</td>
<td>p-Cresol, Ethyl Phenyl Acetate</td>
</tr>
<tr>
<td>Q</td>
<td>Queen of the ORIENT</td>
<td>Resin, Balsam</td>
<td>Benzoin, Tolu, Terpenes</td>
</tr>
<tr>
<td>R</td>
<td>ROSE</td>
<td>Rose Otto, Absolute, Geranium</td>
<td>Citronellol, PEA, Rhodinol</td>
</tr>
<tr>
<td>S</td>
<td>SPICE (Hot)</td>
<td>Hot Culinary, Spice</td>
<td>Clove, Cinnamon, Thyme</td>
</tr>
<tr>
<td>T</td>
<td>TAR Smoke</td>
<td>Smoke, Tar, Burnt</td>
<td>Cade, Birch Tar</td>
</tr>
<tr>
<td>U</td>
<td>URINE Fecal Animal</td>
<td>Animal, Fecal, Leather</td>
<td>Civet, Castoreum, Ambergris</td>
</tr>
<tr>
<td>V</td>
<td>VANILLA</td>
<td>Sweet, Edible, Vanilla</td>
<td>Vanillin, Coumarin, Heliotropin</td>
</tr>
<tr>
<td>W</td>
<td>WOOD</td>
<td>Wood, Oily</td>
<td>Cedar, Santal, Vetiver, Patchouli</td>
</tr>
<tr>
<td>X</td>
<td>X-rated musk</td>
<td>Sexy, Musk, Sensual, Sweet</td>
<td>Musk Ketone, Galaxolide</td>
</tr>
<tr>
<td>Y</td>
<td>EARTHY MOSSY</td>
<td>Yeast, Fungal, Moss, Marine</td>
<td>Oakmoss, Calone</td>
</tr>
<tr>
<td>Z</td>
<td>ZOLVENTS</td>
<td>Low odour solvents, Solubilizers</td>
<td>DEP, DPG, IPP, Ethanol, PG</td>
</tr>
</tbody>
</table>

*Adapted from source: [http://www.perfumersworld.com/perfumery-resources/the-abcs-of-perfumery.html](http://www.perfumersworld.com/perfumery-resources/the-abcs-of-perfumery.html)*
Absolute – A highly concentrated aromatic extract obtained by alcoholic extraction of the concrete, which is obtained by the process of solvent extraction (or enfleurage) of aromatic plant material.

Accord – In perfumery, a combination of aromatics that combine to give a particular fragrance effect.

Agrestic – An odour that is reminiscent of the countryside.

Amber – A perfume note that is powdery and reminiscent of vanilla.

Aromachemical – An odorous chemical, which is used in the flavour and fragrance industry.

Aromatic – This can mean two things – either describing a substance that has an odour (usually pleasant), or with reference to a molecule that has a 'benzene ring' as part of its structure. For example, an 'aromatic aldehyde' is a molecule with an aldehyde functional group (a small group of carbon and oxygen atoms arranged in a way that defines the molecule with the specific structure and properties of the chemical family known as aldehydes) attached to an aromatic ring structure.

Base note – An aromatic of relatively low volatility, or an odour that persists after the top and middle notes have evaporated; usually given by constituents with low volatility. Also refers to the dryout note, of the drydown.

Blotter – A thick absorbent strip of paper or card, used to sample liquid aromatic extracts; the blotter or 'smelling strip' allows an even and unhindered evaporation of the volatile constituents, giving an accurate impression of the odour over a period of time.

Body note – Also known as the middle note, this is the sensory impact of the moderately volatile constituents of an aromatic material of perfume, with traces of the top notes and the emergence of the base noes becoming apparent; intermediate lasting power.

Chypre – François Coty created the first modern chypre fragrance in 1917. It is a perfume type containing a base accord of oakmoss, labdanum, sandalwood and musk (and often including patchouli and clary sage) and a floral heart (often rose and jasmine), with a bergamot top note.

Concrete – An aromatic solid or semi-solid extract containing essential oil, waxes and pigments, obtained by solvent extraction of aromatic plant material.

Cross-modal – A term used to denote an interrelationship across the senses; for example, smells may have associations with tastes and flavours, foods, sounds, music, words, images, shapes, colours, textures, etc.

Enfleurage – The process of absorbing the fragrance from fresh flowers of a single species into a purified fatty medium over a period of time, to produce a pomade.

Essential oil – A volatile product obtained by a physical process from a natural source of a single botanical species, which corresponds to that species in name and odour.
**Extract** – The soluble matter obtained from an aromatic plant by washing with a solvent that is then recovered by vacuum distillation. Extracts include concretes, absolutes and resinoids.

**Exudate** – A resinous substance produced by the cambium of some woody plants; aromatic exudates include benzoin, frankincense and myrrh.

**Fougère** – A perfume type, literally 'fern', usually containing coumarin (a hay-scented aromachemical) and lavender oil; derived from the scented soap *Fougère Royale* (Houbigant 1882).

**Geosmin** – An organic chemical – a bicyclic alcohol – responsible for the earthy taste and smell of beets, also for the smell in the air after rain has fallen on dry ground.

**Middle note** – A scent impression given by constituents of intermediate volatility, and often the main contributor to the 'heart' or main theme of a fragrance.

**Odorant** – A substance that possesses an odour.

**Oleo-gum resin** – A plant exudate composed of water-soluble gum resin and volatile oil.

**Oleoresin** – A plant exudate consisting of resin and volatile oil.

**Pomade** – A product of the enfleurage process – a fragrance-saturated fat.

**Resinoid** – The product of solvent extraction of an oleo-gum resin or an oleoresin, which contains the odorous constituents.

**Solvent** – A liquid substance into which another substance can dissolve.

**Solvent extraction** – The separation soluble matter from a natural source of plant material, oleo-gum resin or oleoresin, using a pure, volatile solvent. At the end of the process the solvent is recovered by vacuum distillation, leaving behind the product containing the odorous portion of the material. The product is a concrete, which can be further treated to produce an absolute or a resinoid, which in some cases may be distilled to produce a volatile oil.

**Temporal lobes** – Part of the cerebrum, located behind the temporal bones, responsible for hearing and also smell. This is where memories and emotions are stored; the left lobe is associated with language.

**Thalamus** - Located at the top of the brain stem, this sorts, processes and directs signals from the spinal cord and the mid-brain up to the cerebrum, and from the cerebrum down to the spinal cord and nervous system.

**Top note** – The immediate impact of an aromatic material of fragrance, given by its most volatile constituents and some of the slightly less volatile ones; sometimes fleeting, or lacking in persistence.

**Trigeminal** – The trigeminal nerve is the fifth cranial nerve, with three branches (ophthalmic, maxillary and mandibular), and is the principal sensory nerve of the face. The trigeminal component of olfaction
is the sensation of hot, cold, tingling or irritation; for example, menthol has a smell that is perceived as 'cooling'.

Volatile – Descriptive of a substance which evaporates when exposed to air. The term also applies to the low boiling-point constituents of natural aromatic materials; for example, plant volatile oils.

Volatility – The rate at which a substance evaporates. The concept of volatility has led to the classification of essential oils and aromatic extracts as top, middle and base notes.
8.5 Appendix 5: Background Interpretative Material for all Seasonal Tours

The Influence of the Sense of Smell

Mere exposure to a scent with a strong behavioural association can be enough to induce some degree of the behaviour. For example, in one study, mere exposure to the smell of a cleaning product facilitated cleaner behaviour when eating compared to no scent exposure (Holland et al., 2005). In another study, a frustrated mood was induced in the presence of an odour. Upon later exposure to the odour, frustration was perceived again and participants gave up on a puzzle solving task earlier than participants who were not exposed to the odour (Herz, Schankler & Beland, 2004). This demonstrates how associative learning can link a mood with a particular smell and induce the former in the presence of the latter with according effects on behaviour. Smell can further influence the way people perceive others, providing cues to sexual compatibility. Studies have demonstrated that the sense of smell guides mate selection by offering olfactory cues about genetic compatibility and fertility and by eliciting endocrinological responses (Thornhill et al., 2003; Miller & Maner, 2010). Accordingly, both men and women have been shown to value the smell of natural body odour as an indicator of attractiveness in the opposite sex (Herz & Inzlicht, 2002). Interestingly, people also tend to prefer fragrances with chemicals similar to their own genetic make up and it has been suggested that perfume wearing is an attempt to amplify the chemical blueprint of one's own immune system and thereby help to attract a mate with a different immune system (Milinski et al., 2013).

The Process by which Aromatherapy Works (following Lahlou, 2004)

Aromatic compounds in essential oils cross the blood brain barrier and exert observable effects on biological processes. Once volatile molecules of fragrant compounds reach cells, they are integrated into the cell membranes at special sites according to their molecular shapes and chemical properties. After integration, the molecules influence enzymes carriers, ion channels and receptor proteins,

6 The participants in the study cited were all women.
provoking responses that bring about physical effects. Learned associations through repeated exposure to an aroma may also contribute to physical regulation (e.g., immune system response) by conditioning a specific response to the aroma (Alexander, 2002).

**Relevant Methods of Analytical Chemistry**

Investigation processes include separation of biochemical entities from a complex substance, collection of the separated fractions (fractionation), and detection of the fractions using methods of identification, structural analysis and quantification (Weller, 2012). Biological assessments of target fractions may be performed on cells or tissues to gauge their effects. Common separation techniques include distillation and chromatography. Distillation involves converting a liquid into vapour and then condensing it back into liquid form to separate it from a nonvolatile substance (Encyclopædia Britannica, 2015). Chromatography involves dissolving a mixture in a moving fluid stream (either a gas or liquid) and running it through a stationary phase (a solid or liquid). Different solutes in the mixture will be distributed unevenly between the stream (mobile phase) and the stationary phase and can be thus separated (Encyclopædia Britannica, 2015). Structural analysis and quantification is typically done through spectroscopic methods, which investigate the way a compound responds to electromagnetic radiation, as well as the interactions between particles in the compound on the basis of their energetic properties (Encyclopædia Britannica, 2015).

To isolate specific aromachemicals from a substance, fractional distillation and crystallization are the most common methods (Baines & Seal, 2012, page 214). Fractional – or differential – distillation is used when the boiling points of different liquids are close together and can not be efficiently separated by simple distillation. Fractional distillation is a process wherein the vapours from a distillation are continually condensed and re-evaporized in an insulated vertical column, which allows some of the condensed vapour to return toward the still as liquid and only allowing the most volatile material to reach the receiver in the form of vapour (Encyclopædia Britannica, 2015). Crystallization
involves adding a solid substance to a liquid so that it dissolves until it produces a solution that is saturated with the solid (at which point no more can be dissolved). Temperature can be adjusted to influence the concentration of the solution (i.e. cooling a saturated solution causes the dissolved substance to separate – or crystallize – until the solution becomes saturated at a lower temperature). If two or more solid compounds are dissolved in a solution, temperature can be adjusted to make the less soluble compound crystallize, thus isolating it (Encyclopædia Britannica, 2015).

*History of Perfumery (following Herz, 2011)*

History will begin with the origin of the word 'perfume', which comes from the Latin phrase “*per fumum*”, meaning *through smoke*. The oldest records of perfume date back to the Mesopotamian practice of burning incense (typically herbs and spices). When perfumery reached Egypt, it was first used exclusively in rituals of religious or royal significance. The Egyptians were the first to employ personal use of perfume. Perfume was so important to Etruscan society that women were buried with brass mirrors engraved with the image of a spirit carrying a perfume bottle to accompany them to the afterlife. With the rise of Christianity, perfume lost its revered status due to negative attitudes toward adornment. However, it underwent a revival in the fourteenth century when it came to Europe. This is when the first blend of scented oils and alcohol was produced for Queen Elizabeth of Hungary. The blend came to be known as “Hungary Water.” European cities at the time were pervaded by malodorous air and so perfume grew in popularity, with France emerging as the hub. Perfume became a defining feature of high fashion by the end of the eighteenth century and the quality of a perfume denoted the social standing of its wearer. By the mid-nineteenth century, however, perfume had fallen out of fashion due to associations between odour and illness (as noted earlier) and it was no longer seen as respectable for people to wear strongly scented perfumes. American attitudes in particular would not shift until the 1950s with the creation of *Chanel No. 5*, which has been the most famous perfume in the world since its launch. This perfume revolutionized the fragrance industry since it was the first fragrance created
out of synthetic chemicals. Prior to the use of synthetics, perfumes lacked staying power and needed to be reapplied frequently. At present, there are many perfumes on the market that combine natural and synthetic ingredients. In recent years however, there has been a rising preference among consumers for natural aromatic ingredients (Dimitrova et al., 2009) and many independent artisan perfumers that specialize in natural blends now co-exist in the market next to several dominant fragrant houses.
8.6 Appendix 6: Fragrant Plant Interpretative Material

Summer

BERGAMOT

Scientific classification: *Citrus aurantium* subspecies *bergamia*

Perfumery classification⁷: citrus, top note

Contributing fragrant compounds⁸: l-linalool (mild, floral, woody); linalyl acetate (floral, fruity, fresh, herbaceous); d-limonene (fresh, citrus); α-pinene and β-pinene (resinous, fresh, pine-like); γ-terpinene (terpeney, sweet, citrus with lime nuance) (Rhind, 2014, pp. 108)

Medicinal uses: Used as a digestive aid, sedative, muscle/joint pain relief agent, skin tonic (Roberts, 2000, pp. 7). Aromatherapeutic use decreases stress, as evidenced by lower salivary cortisol levels (Watanabe, E. et al., 2015).

Cultural and spiritual significance: Oil associated with the third chakra (solar plexus) in body energy systems theories; used to strengthen life energy and confer self-assurance and self-confidence (Sharamon & Baginski, 2000, pp. 91).

BLACK PEPPER

Scientific classification: *Piper nigrum*

Perfumery classification: spicy, middle note

Contributing fragrant compounds: α-terpineol (floral); acetophenone (irritant, sharp); hexonal (green apple); nerol (fresh, floral, herbaceous); nerolidol (mild, spicy, rooty); 1,8-cineole (camphor-like); dihydrocarveol (warm, woody); citral (citrus-like); α-pinene (resinous, fresh, pine-like); piperonol

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⁷ Information regarding the perfumery classification of various fragrant plants in interpretative material was obtained largely through informal internet searching as a guide rather than an industry standard since no official standard was found.

⁸ Fragrant compounds included in the interpretative material for each plant do not comprise a comprehensive list; they are intended to provide a general idea of how each plant's characteristic fragrance is produced. Information regarding the fragrant characters of aromachemicals in interpretative material was not consistently available from official sources cited. When unavailable from official sources, fragrant character information was obtained through informal internet search resources.
Medicinal uses: Smell stimulates sympathetic nervous activity, increases adrenaline concentration (Haze et al., 2002). Properties and uses of pepper include analgesic, antimicrobial, antipyretic (fever reducing), cancer inhibitor, anti-inflammatory, cough treatment, fever treatment, digestive aid, appetite stimulant, antioxidant (Megwhal & Goswami, 2012).

Cultural and spiritual significance: Important plant in Ayurvedic and traditional Chinese medicine; said to have been eaten by Indian monks daily for energy; some use as an aphrodisiac; said to unblock mental energy, facilitate courage and offer sense of protection (Wilson, 2002, pp. 55).

CEDAR (RED/WHITE)

Scientific classification: Juniperus virginiana (essential oil source: wood), Thuja occidentalis (essential oil source: leaf)

Perfumery classification: woody, base note

Contributing fragrant compounds9: α-cedrol (woody, cedar); α-cedrene, β-cedrene (woody, cedar, camphor); thujopsene (cedar); β-caryophyllene (light, spicy, clove, woody); γ-eudesmol (sweet, woody) (Rhind, 2014, pp. 58).

Medicinal uses: White cedar (Thuja occidentalis) properties include astringent, diuretic, emmenagogue; used in treatment of fevers, rheumatism, coughs, scurvy (Grieve, 1931). Cedar berries traditionally used by Ontario Six Nations communities to treat arthritis, asthma, cough, congestion, hepatitis, stiff muscles; aid pancreatic insulin production (Six Nations Farmers Market and Garden, 2012).

Cultural and spiritual significance: A sacred medicine in North American Aboriginal traditions. Used widely in smudging (ritual cleansing) ceremonies where herb is burned to make fragrant smoke. (University of Ottawa Faculty of Medicine, 2009). Associated with the South compass point on the

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9 Fragrant compounds here refer to those found in the oil of wood from Juniperus virginiana.
Medicine Wheel and with the emotional aspect of health; symbolic of childhood and intellectual growth; attracts positive energy and emotions, exacts balance (University of Ottawa Faculty of Medicine, 2009). Used by Six Nations communities in Ontario to purify homes; also used in many ceremonies as protection and used in baths for healing (Six Nations Farmers Market and Garden, 2012).

**CHAMOMILE**

**Scientific classification:** *Matricaria chamomilla/recutita* (German/Blue); *Chamaemelum nobile/Anthemis nobilis* (Roman)

**Perfumery classification:** fruity/aromatic herb, middle note

**Contributing fragrant compounds:** *iso*-butyl angelate (herbal, fruity); tiglic acid (herbal, fruity); bisabolol (sweet, woody, floral); farnesene (citrus, green, woody) (Rhind, 2014, pp. 105; Das, 2015, pp. 160)

**Medicinal uses:** Plant traditionally used by Ontario Six Nations communities as a sedative, a mouthwash, and an eye bath; used to treat for anxiety, insomnia, sore throat, gastritis and indigestion (Six Nations Farmers Market and Garden, 2012). Other traditional uses include treatment of wounds, ulcers, eczema, gout, skin irritation and bacterial infection, chicken pox, ear and eye infections, nasal inflammation, bruises, burns, canker sores, hemorrhoids, colic, croup, fevers (Srivastava et al., 2010). Extracts have also demonstrated has anti-cancer properties (Srivastava et al., 2010).

**Cultural and spiritual significance:** Believed by early Anglo-Saxons to be one of nine sacred herbs bestowed on humanity by God (Singh et al., 2011). Used in Ancient Egypt for religious worship and ritual (Dufault et al., 2001).

**COMMON SAGE**

**Scientific classification:** *Salvia officinalis*

**Perfumery classification:** aromatic herb, middle note
Contributing fragrant compounds: α-thujone and β-thujone (sharp green, menthol-like); camphor (cool, medicinal, sweet) (Rhind, 2014, pp. 70)

Medicinal uses: Tea used to treat digestive and circulation issues, cough, asthma, angina, mouth and throat inflammation, depression, sweating. Essential oil used to treat nervous system diseases, respiratory and digestive system problems, metabolic and endocrine diseases. Oil is astringent, antiseptic, antispasmodic and carminative (Hamidpour et al., 2014).

Cultural and spiritual significance: A sacred medicine in North American Aboriginal tradition. Used widely in smudging (ritual cleansing) ceremonies where herb is burned to make fragrant smoke. (University of Ottawa Faculty of Medicine, 2009). Associated with the West compass point of the Medicine Wheel and with the physical aspect of health; symbolic of adulthood and introspection; associated with women and with strength, wisdom and clarity (University of Ottawa Faculty of Medicine, 2009). Considered a cleanser for home and sacred items; used to relieve mental troubles and remove negative energy (Six Nations Farmers Market and Garden, 2012).

ECHINACEA

Scientific classification: Echinacea genus, Asteraceae family

Perfumery classification: floral, middle note

Contributing fragrant compounds: camphene (pungent, woody); β-pinene (resinous, fresh, pine-like); limonene (fresh, citrus) (Horbonne & Williams, 2005, pp. 65)

Medicinal uses: Plant traditionally used to treat cold, cough, bronchitis, respiratory inflammation; also strengthens immune system (Percival, 2000); oil has anti-inflammatory properties (Yu et al., 2013).

Cultural and spiritual significance: Associated with the direction West in Cherokee culture encompassing physicality and introspection (Harding, 1998).

GERANIUM

Scientific classification: Pelargonium genus, Geraniaceae family
Perfumery classification: floral/green, middle note

Contributing fragrant compounds: geraniol (sweet, rosy, floral); rose oxide (floral, green); citronellol (warm, rosy); menthone (minty) (Rhind, 2014, pp. 100; Handong et al., 1985; Rana et al., 2002)

Medicinal uses: Oil used to treat diarrhea, gallstones, kidney stones, urinary tract infections, respiratory problems, sore throat, tonsilitis, skin disorders; used to balance hormones and boost immune systems function; stimulates lymphatic and circulatory systems; speeds healing of bruises, burns and cuts (Wilson, 2002, pp. 76).

Cultural and spiritual significance: Aroma reduces stress and negative affect; said to enhance self-expression and self-confidence, promote harmony in intimate relationships, and facilitate creativity and imagination (Wilson, 2002, pp. 76).

HELIOTROPE

Scientific classification: Heliotropium arborescens; Boraginaceae family

Perfumery classification: floral, middle note

Contributing fragrant compounds: heliotropin/piperonal (balsamic, powdery, vanilla almond) (Sell, 2009, pp. 129)

Medicinal uses: indicum species of plant used to treat eye inflammation, skin diseases; treatment for ulcers, sores, wounds insect stings, cough, fever, anemia during pregnancy; diuretic properties, (Pattanayak et al., 2012).

Cultural and spiritual significance: In Greek mythology, heliotrope came about from the story of Klytie, a mistress of the sun god Helios, who alienated him when she sabotaged his affair with the Persian king's daughter. Pining away for Helios, she eventually changed into the flower heliotrope, which still bears witness to her love by following the movement of the sun (Hard, 2003, pp. 45).

LAVENDER
Scientific classification: *Lavendula angustifolia*

Perfumery classification: aromatic herb, top or middle note

Contributing fragrant compounds: l-linalool (mild, floral, woody); linalyl acetate (fresh, herbal, bergamot-like) (Rhind, 2014, pp. 72)

Medicinal uses: Smelling oil increases anti-oxidation activity, decreases levels of stress hormone cortisol (Atsumi & Tonosaki, 2007); evidence of effective use as anti-fungal agent and pain relieving agent (Cavanagh & Wilkinson, 2002).

Cultural and spiritual significance: Plant used historically by Arabs, Egyptians and Phoenicians as perfume and in mummification rituals; Greeks considered lavender holy and used it to prepare holy essences in temples; Greeks also used it medicinally; widely used for cosmetic purposes during Roman era (Largo, 2014, pp. 203-204).

*LILY OF THE VALLEY/MUGUET*

Scientific classification: *Convallaria majalis*

Perfumery classification: floral, middle note

Contributing fragrant compounds: benzyl alcohol (floral), citronellol (warm, vibrant, rosy); citronellyl acetate (rosy, fruity, sweet) (Clery, 1999, pp. 205) nerol (fresh, herbaceous); cinnamyl alcohol (sweet, balsam, green, powdery) (Wakayama & Namba, 1965).

Medicinal uses: Although a poisonous plant, some medicinal value is recognized and includes purgative properties as well as use as a diuretic and cardiac tonic (Grieve, 1931).

Cultural and spiritual significance: In English lore, lily-of-the-valley appeared where the blood of St. Leonard fell to commemorate his slaying a dragon in the woods named St. Leonard's Forest in West Sussex; the smell of lily-of-the-valley was also believed to lead nightingales to mate (Grieve, 1931).

*LOTUS*

Scientific classification: *Nelumbo nucifera*
Perfumery classification: floral, middle note

Contributing fragrant compounds: caryophyllene oxide, β-caryophyllene (light, spicy, clove-like, woody); cis-jasmone (fruity, celery-seed like; jasmine-like when diluted) (Rhind, 2014, pp. 99)

Medicinal uses: Antibacterial and antimicrobial properties in flower and leaf extracts (Venkatesh & Dorai, 2011; Arjun et al., 2012).

Cultural and spiritual significance: Sacred flower in Hinduism and Buddhism, representing beauty, purity, divinity; represents the sun and mother goddess with fertility connotation in Hinduism (Kew Royal Botanical Gardens, n.d.).

MARIGOLD

Scientific classification: Tagetes genus, Asteraceae family

Perfumery classification: fruity, top note

Contributing fragrant compounds: cis-tagetone, trans-tagetone, dyhydrotagetone (warm, herbal); l-linalool (mild, floral, woody); ocimene (light, warm, herbaceous) (Rhind, 2014, pp. 106).

Medicinal uses: Medicinal properties of essential oil include antibacterial, fungicidal, antispasmodic, diaphoretic, anthelmintic, emmenagogue, stomachic, carminative (Lawless, 2013, Tagetes para. 7).

Cultural and spiritual significance: French marigold (Tagetes patula) is mixed with sandalwood to produce the popular Indian perfume, attar genda (Lawless, 2013, Tagetes para. 5); flower used in Mexico and Central America in death ceremonies and in All Saints' Day/All Souls' Day celebrations (Kaplan, 1958).

PEPPERMINT

Scientific classification: Mentha x piperita

Perfumery classification: green/aromatic herb, top note

Contributing fragrant compounds: l-menthol (fresh, cooling, pungent, minty); l-menthone (fresh, minty, woody); menthyl acetate (mild, sweet, herbaceous, minty); menthyl iso-valerate (sweet,
herbaceous, minty, rooty) (Rhind, 2014, pp. 77)

**Medicinal uses:** Effective pain relief treatment for irritable bowel syndrome when oil is ingested
(Kline et al., 2001), scent stimulates mental activity/attention (Barker et al., 2003). Aids digestive and

**Cultural and spiritual significance:** Mints derived their name from Greek mythology, in which Hades
loved a nymph named Mentha and his jealous wife Persephone turned her into a plant, however,
unfortunately for Persephone, Mentha's smell became sweeter the more she was walked on (de
Carvalho & da Fonseca, 2006). Ancient Greeks and Romans used peppermint to flavour sauces and
wines at feasts; they also decorated tables and made crowns to adorn themselves with it (Grieve, 1931).

**ROSE**

**Scientific classification:** *Rosa* genus, *Rosaceae* family

**Perfumery classification:** floral, middle note

**Contributing fragrant compounds:** geraniol (sharp rosy); citronellol (warm, vibrant rosy);
phenylethanol (soft, petal-like, rosy); nerol (harsh, fresh rosy) (Rhind, 2014, pp. 100)

**Medicinal uses:** aroma facilitates relaxation by decreasing adrenaline and sympathetic activity,
including decreased breathing rate, blood oxygen saturation and systolic blood pressure (Haze et al.,
2002; Hongratanaworakit, 2009).

**Cultural and spiritual significance:** Symbolic of love and suffering in Christianity, associated with
Mary and Christ; connected to love potions in magical tradition (Touw, 1982). Specific associations for
different coloured roses include love, beauty and romance for red roses; innocence and purity for white
roses; grace and elegance for burgundy roses; happiness and friendship for yellow roses; enthusiasm,
passion and excitement for orange roses; enchantment and love at first sight for lavender coloured roses
(Largo, 2014, pp. 311).

**ROSEMARY**
**Scientific classification:** *Rosmarinus officinalis*

**Perfumery classification:** green/aromatic herb, middle note

**Contributing fragrant compounds:** $\alpha$-pinene and $\beta$-pinene (resinous, fresh, pine-like); borneol (camphor-like, woody); camphor (cool, medicinal, sweet); camphene (pungent woody); 1,8-cineole (fresh, eucalyptus); limonene (fresh, citrus) (Jiang et al., 2011; Ozcan & Chalchat, 2008; Salido et al, 2003)

**Medicinal uses:** Smelling increases anti-oxidation activity, decreases levels of stress hormone cortisol (Atsumi & Tonosaki, 2007), aroma is a cognitive stimulant (Moss & Oliver, 2012). Plant traditionally used to relieve stomachaches and headaches; used in throat and lung treatments (Grieve, 1931).

**Cultural and spiritual significance:** Historically used as a symbol of love and loyalty at weddings, burned to make incense at religious rituals, used in magical spells, considered safeguard from evil in Spain and Italy, thrown over graves at Welsh funerals (Grieve, 1931).

**SPEARMINT**

**Scientific classification:** *Mentha spicata*

**Perfumery classification:** green, top note

**Contributing fragrant compounds:** Carvone, $cis$-carveol (sweet, minty) (Hussain et al., 2010)

**Medicinal uses:** Essential oil applicable to treatment of headache, cold and flu, aches and pains; aids respiratory and digestive systems (Lawless, 2013); also an antioxidant (Hussain et al., 2010).

**Cultural and spiritual significance:** Mints derive their name from Greek mythology, in which Hades loved a nymph named Mentha and his jealous wife Persephone turned her into a plant, however, unfortunately for Persephone, Mentha's smell became sweeter the more she was walked on (de Carvalho & da Fonseca, 2006). Spearmint is known as a herb of hospitality and symbolic of wisdom (Hanrahan & Frey, 2005); Alternative names “Our Lady's mint” and “sage of Bethlehem” (Hanrahan & Frey, 2005), suggest Christian associations.
**SWEET BASIL**

**Scientific classification:** *Ocimum basilicum*

**Perfumery classification:** green/aromatic herb, top note

**Contributing fragrant compounds:** eugenol (spicy, warm, clove-like); linalool (sweet floral); estragole (anise-like); methyl cinnamate (strawberry); 1,8-cineole (fresh, eucalyptus); geranial (sharp rosy); neral (lemony); caryophyllene oxide (spicy) (Lee et al., 2005; Sajjadi, 2006)

**Medicinal uses:** Plant traditionally used to treat headaches, coughs, diarrhea, constipation, warts, worms, kidney malfunction; considered antispasmodic and carminative (Simon, 1995). *Ocimum* extracts contain insecticidal, nematicidal (anti-parasitic), fungistatic, antimicrobial properties (Simon et al., 1999). Volatile chemical constituents have antioxidant properties (Lee et al., 2005).

**Cultural and spiritual significance:** Closely related *Ocimum tenuiflorum* ("holy basil" or "tulsi") considered a sacred plant in Hinduism, with its religious uses linked to its medicinal uses (Kew Royal Botanical Gardens, n.d.).

**WATER LILY**

**Scientific classification:** *Nymphaea* genus, *Nyphaeaceae* family

**Perfumery classification:** floral, middle note

**Contributing fragrant compounds**\(^{10}\): anisole (anise-like); benzene (strong and sweet); methyl hexanoate and methyl 2-methylbutanoate (fruity) (Maia et al., 2014).

**Medicinal uses:** Oil used as a topical sedative to treat headache and sleep disturbance in medieval Persia (Gorji & Ghadiri, 2002); root and leaves used in traditional Sudanese medicine as treatment for dysentery and tumours; also considered antibacterial (Elegami et al., 2003); traditionally used by Ontario Six Nations communities for swollen abdomen, heart trouble, protection medicine, ghost medicine (Six Nations Farmers Market and Garden, 2012).

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\(^{10}\) Identified in night-blooming varieties of water lilies
Cultural and spiritual significance: Ancient Egyptians also had a God of Perfume called Nefertem, whose legend and whose association with blue water-lily raised him to divine status (Herz, 2011). Blue water lily associated with multiple gods in ancient Egypt and with shamanic practices due to narcotic properties (Emboden, 1989); motif found in funeral art of ancient Egyptians and Mayans (Emboden, 1978).

WITCH-HAZEL

Scientific classification: Hamamelis genus, Hamamelidaceae family

Perfumery classification: aromatic herb, carrier agent (astringent)

Contributing fragrant compounds: carvacrol (oregano), eugenol (spicy, warm, clove-like), hexenol (green, grassy) (Kapoor & Saraf, 2011).

Medicinal uses: Plant traditionally used by Ontario Six Nations communities to treat insect bites, varicose veins, hemorrhoids, bruises, cuts, swelling, skin rashes and inflammation, sunburn, blemishes, diarrhea, dysentery (Six Nations Farmers Market and Garden, 2012; Largo, 2014, pp. 376).

Cultural and spiritual significance: Old superstitious practice (water dowsing) in the U.S. involved use of twigs to locate sources of water underground (Randolph, 1964, pp. 85).

WORMWOOD

Scientific classification: Artemisia absinthium

Perfumery classification: green, top note

Contributing fragrant compounds: α-thujone, β-thujone (sharp green, menthol-like); myrcene (sweet, balsamic) (Khalilov et al., 2001)

Medicinal uses: Plant supports liver and gallbladder function to aid digestion aid; treatment for parasites, circulation dysfunction, swelling and irritation; antioxidant (Group, 2015); extracts have analgesic and anti-inflammatory properties (Ahmad et al., 1992). Evidence of plant's neuroprotective
properties and supplemental use in treatment of stroke (Bora & Sharma, 2010).

**Cultural and spiritual significance:** Main component in absinthe and thought to cause hallucinations and other severe effects of habitually drinking absinthe. Suggested thujone was responsible for these effects however evidence does not support this claim (Lachenmeier et al., 2006). Mexican festival of the Goddess of Salt celebrated by a ceremonial dance in which women wore garlands of wormwood on their heads (Grieve, 1931).

*Fall*

**BLUE SPRUCE**

**Scientific classification:** Picea pungens

**Perfumery classification:** woody, middle note

**Contributing fragrant compounds:** limonene (fresh, citrus); α-pinene and β-pinene (resinous, fresh, pine-like); camphene (pungent woody); car-3-ene (sweet, turpentine-like) (von Rudloff, 1975).

**Medicinal uses:** Plant traditionally used by the Navajo community in the southwestern United States as an emetic (Wyman & Harris, 1941).

**Cultural and spiritual significance:** Popularly used as a Christmas tree in North America (Nesom, 2003); the current species of the United States National Christmas Tree in Presidents' Park outside the White House (United States National Park Service, 2015).

**CARROT SEED**

**Scientific classification:** Daucus carota

**Perfumery classification:** spicy, middle note

**Contributing fragrant compounds:** α-pinene and β-pinene (resinous, fresh, pine-like); geraniol

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11 It should be noted that thujone in *Artemisia absinthium* is a neurotoxin and dosage thresholds for ill effects are uncertain (Lachenmeier, 2010). To err on the side of caution, wormwood essential oil should be left out of practical perfumery workshops.

12 In addition to the fragrant plants profiled in this section, fall tours may also feature lavender, rosemary, cedar, sage, wormwood and sweet basil as profiled in the summer section.
(rosy); geranyl acetate (sweet, rosy, fruity); \(\ell\)-limonene (weak citrus); caryophyllene (woody, spicy, clove-like) (Rhind, 2014, pp. 61).

**Medicinal uses:** antioxidant properties in essential oil (Yu et al., 2005); applicable to treatment of colic, indigestion, arthritis, rashes, dermatitis, eczema, psoriasis (Lawless, 2013).

**Cultural and spiritual significance:** Included in a list of aromatic herbs grown in royal garden of Babylon in the 8th century BC; thought to have been grown for its fragrance (Kew Royal Botanical Gardens, n.d.).

**CHERRY BIRCH**

**Scientific classification:** *Betula lenta*

**Perfumery classification:** woody, top note

**Contributing fragrant compounds:** methylsalicylate (minty, wintergreen) (Le Grand et al., 2005)

**Medicinal uses:** Bark is edible and has stimulant, diaphoretic and astringent properties; effective against dysentery and female urinary tract obstructions (Grieve, 1931); steeped twigs and sap both used as drinks in Iroquoian culture; cherry birch also used as traditional medicine in cultures of Ojibwe, Cree, Algonquins of Eastern Canada used to treat pneumonia, diarrhea, pulmonary trouble and disease (Arnason et al., 1981).

**Cultural and spiritual significance:** Birch (*Betula genus*) trees considered sacred in Siberian shamanic traditions (Hageneder, 2005, pp. 11); birch twigs used by Celts to light ceremonial fires on Beltane (a festival held May 1st to celebrate the beginning of Celtic summer); couples went to birch forests to make love during this celebration (Hageneder, 2005, pp. 30).

**CORIANDER**

**Scientific classification:** *Coriandrum sativum*

**Perfumery classification:** spicy, middle note

**Contributing fragrant compounds:** linalool (mild, floral, woody); neryl acetate (floral, fruity); \(\alpha\)-
pinene (resinous, fresh, pine-like); γ-terpinene (terpeney, sweet, citrus) (Nejad Ebrahimi et al., 2010).

**Medicinal uses:** Oil has anti-bacterial, anti-fungal and antioxidant properties (Mandal & Mandal, 2015). Other properties of plant include diuretic, anti-diabetic, sedative, anti-microbial, anti-convulsant, anthelmintic (expels parasites), anti-mutagenic; traditionally used to treat joint pain, rheumatism, nausea, diarrhea, gastritis; used as a carminative, stomachic, spasmyloytic (relieves muscle spasms), digestive stimulant (Nadeem et al., 2013).

**Cultural and spiritual significance:** Believed by Chinese in fourth century that eating coriander seeds during spiritual trance could achieve immortality; used in Victorian England as aphrodisiac (Charles, 2012, pp. 256).

**HYSSOP**

**Scientific classification:** *Hyssopus officinalis*

**Perfumery classification:** aromatic herb, top or middle note

**Contributing fragrant compounds:** 1,8-cineole (camphor); β-pinene (resinous, fresh, pine-like) (Vallejo et al., 1995)

**Medicinal uses:** Essential oil applicable to treatment of respiratory ailments, skin conditions, fatigue, tension, colic, indigestion (Lawless, 2013); plant's medicinal properties include expectorant, diaphoretic, stimulant, pectoral, carminative (Grieve, 1931).

**Cultural and spiritual significance:** Used by ancient Greeks for purification and cleansing of sacred places and ill people (Roberts, 2000, pp. 45); symbolic of cleansing in Christian tradition, appearing in psalm 51 of the Bible (Roberts, 2000, pp. 45; Grieve, 1931).

**PEPPER/CHILI PEPPER**

**Scientific classification:** *Capsicum annum/frutescens*

**Perfumery classification:** spicy/green, top note

**Contributing fragrant compounds:** 1-penten-3-one (pungent/spicy); hexanal (grassy); 3-carene
(sweet, pungent); (Z)-β-ocimene (floral, herbal, sweet); octanal (fruity); 2-isobutyl-3-methoxypyrazine (green) (Luning et al., 1994).

**Medicinal uses:** Strong antioxidant properties among various cultivars of the plant (Deepa et al., 2006); evidence that key ingredient, capsaicin, effectively relieves symptoms of sinus conditions including nasal congestion, sinus pain, headache, sinus pressure (Bernstein et al., 2011).

**Cultural and spiritual significance:** Used in parts of Italy and Brazil to ward off the evil eye (Hodges & Bennett, 2006; Kawa, 2012).

**TANSY**

**Scientific classification:** *Tanacetum vulgare*

**Perfumery classification:** aromatic herb, middle note

**Contributing fragrant compounds:** *trans*-chrysanthene and *trans*-chrysanthenyl acetate (floral); 1,8-cineole (camphor-like); α-pinene and β-pinene (resinous, fresh, pine-like); 6-camphenone (camphor); β-thujone (sharp green, menthol-like); (Raal et al., 2014)

**Medicinal uses:** Plant has anthelmintic, tonic, stimulant and emmenagogue properties; traditionally used to treat worms, weak kidney, fever, hysterical and nervous disorders, skin conditions, gout (Grieve, 1931)

**Cultural and spiritual significance:** Name derived from Greek word, “athanasia”, meaning immortality; associated with Venus; associated with “bitter herbs” of Passover; dedicated to Saint Athanasius in Catholic Church and used to flavour cakes during Lent; people in Sussex England used to wear tansy leaves in their shoes to ward off ague (fever illnesses); traditionally associated with insult in Italy (Folkard, 1884, pp. 561).

**THYME**

**Scientific classification:** *Thymus vulgaris*

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13 As with wormwood, due to the thujone concentration, *Tanacetum vulgare* may be toxic and thus its essential oil must be used with caution or left out of practical perfumery workshops.
**Perfumery classification:** aromatic herb, middle note

**Contributing fragrant compounds:** thymol (strong, herbal, medicated); carvacrol (tar-like); *paracymene* (fresh, herbal, citrus); *α*-terpinene (lemon-like); camphene (oily, camphor-like); linalool (woody, floral); geraniol (sweet, rosy, floral) (Rhind, 2014, pp. 73).

**Medicinal uses:** Plant traditionally used as antiseptic, anti-spasmodic, carminative and tonic (Grieve, 1931); anti-fungal agent (Šegvić Klarić et al., 2007); traditionally used to treat cough and colds, sore throat, asthma, pneumonia and hayfever, to relieve insect bites and stings, and to ease rheumatism and muscle spasms (Roberts, 2000, pp. 76); scent mentioned as a treatment for epilepsy by Roman historian Pliny (Classen, et al., 1994).

**Cultural and spiritual significance:** Said to have derived from Helen's tears in Greek mythology; burned by ancient Greeks at altars to honour deities; used by ancient Egyptians in embalming rituals; presented to knights in medieval times as rewards for courage (Wilson, 2002, pp. 126).

**TOBACCO (LEAF)**

**Scientific classification:** *Nicotiana tabacum*

**Perfumery classification:** aromatic herb/green, base note

**Contributing fragrant compounds:** *para*-cresol (tar, narcissus); *para*-ethyl phenol; guaiacols (phenolic, smoky); eugenol (spicy, warm, clove-like); tobacco acids and esters (Rhind, 2014, pp. 87).

**Medicinal uses:** Plant used historically in South America and later Europe as antiseptic/disinfectant, pain reliever, treatment for skin disorders, wounds and burns (Charlton, 2004).

**Cultural and spiritual significance:** A sacred medicine in North American Aboriginal tradition. Used widely in smudging ceremonies where it is burned to make fragrant smoke. Associated with the East compass point of the Medicine Wheel and with the spiritual aspect of health; associated with birth and early years; connects people and their prayers to the spirit world and used to show gratitude to Creator; used in pipe ceremonies to facilitate prayer (University of Ottawa Faculty of Medicine, 2009).
Considered a fundamental means of communication between people and Creator among First Nations communities (Six Nations Farmers Market and Garden, 2012).

**SWEET GRASS**

**Scientific classification:** Hierochloë odorata

**Perfumery classification:** aromatic herb, middle note

**Contributing fragrant compounds:** coumarin (sweet, hay-like); 3-methyl-butanal (fruity, almond); 3-methylbutanol (green, sweet); furfural (almond-like), aliphatic acid ethyl esters (sweet, fruity) (Ueyama et al., 1991).

**Medicinal uses:** Plant used historically by Plains Indians to treat many minor illnesses including coughs, sore throats, eye irritations, skin conditions, venereal infections and bleeding after childbirth (Agriculture and Agri-Food Canada, 2012).

**Cultural and spiritual significance:** A sacred medicine in North American Aboriginal tradition. Used widely in smudging ceremonies where it is burned to make fragrant smoke. Associated with the North compass point of the Medicine Wheel and with the mental aspect of health; symbolic of old age, wisdom and spirituality; associated with virtue; used in pipe ceremonies for purification (University of Ottawa Faculty of Medicine, 2009). Plant represents teaching of kindness and is symbolic of sacred hair of Mother Earth; aroma associated with Mother Earth's love (Six Nations Farmers Market and Garden, 2012).

Winter

**BLACK CHERRY**

**Scientific classification:** Prunus serotina

**Perfumery classification:** fruity/woody, middle note

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14 Due to limited variety of fragrant plants in RBG's pinetum, additional seasonally appropriate fragrances are included in this tour to provide more interpretive material and to aid blending during practical workshops.

15 In addition to the fragrant plants profiled in this section, winter tours may also feature cedar, blue spruce and cherry birch (due to its likeness to wintergreen) as profiled in the summer and fall sections.
Contributing fragrant compounds\textsuperscript{16}: benzyl alcohol (floral); benzaldehyde (almond-like); cinnamyl alcohol (sweet, balsam, green, powdery); cinnamaldehyde (cinnamon-like) (Ibarra-Alvarado et al., 2009)

Medicinal uses: Essential oil from leaves found to induce vascular smooth muscle relaxation (Martínez, 1991 and Argueta et al., 1994 cited in Ibarra-Alvarado et al., 2009); plant traditionally used by Ontario Six Nations communities as a blood medicine and also to treat tuberculosis, cuts, headaches, colds, fevers, bronchitis, lung inflammation, excessive bile and body sores (Six Nations Farmers Market and Garden, 2012); teas made from leaves traditionally used in Mexico to treat hypertension, upset stomach, mouth infections, diarrhea, paludism, bronchitis and cough; fruits also used in Mexico to treat coughs and diarrhea (Ibarra-Alvarado et al., 2009); bark traditionally used by Iroquois, Ojibwa, Malecite and Delaware peoples in boreal regions of Canada to treat diabetes (McCune & Johns, 2007).

Cultural and spiritual significance\textsuperscript{17}: Branches of cherry trees were traditionally cut for the Feast of St. Barbara in the former Czechoslovakia and brought into houses so that they could blossom at Christmas; cherry blossoms historically used to decorate churches at Easter in some parts of England (Kendall, 2015); cherry blossoms symbolic of spring, renewal and the fleeting nature of life in Japan (Takeda, 2014).

CINNAMON

Scientific classification: \textit{Cinnamomum} genus, \textit{Lauraceae} family

Perfumery classification: spicy, middle or base note

Contributing fragrant compounds: cinnamaldehyde (characteristic cinnamon); eugenol (spicy, warm, clove-like) (Mathew & Abraham, 2006)

Medicinal uses: Plant extract has demonstrated anti-fungal properties (Duraipandiyan & Ignacimuthu,

\textsuperscript{16} The compounds mentioned here were found in the essential oil of \textit{Prunus serotina} leaves. Bark and fruit of \textit{P. serotina} can also be sources of essential oil.

\textsuperscript{17} Cherry trees mentioned here are of the genus \textit{Prunus} but differ by species due to a lack of information on \textit{Prunus serotina} specifically.
Cultural and spiritual significance: Cinnamomum cassia and Cinnamomum zeylanicum species used in ancient Egyptian embalming practices (Abdel-Maksoud & El-Amin, 2011).

CLOVE

Scientific classification: Syzygium aromaticum

Perfumery classification: spicy, middle or base note

Contributing fragrant compounds: eugenol (spicy, warm, clove-like) (Rhind, 2014, pp.62)

Medicinal uses: Clove has anti-microbial, anti-fungal, anti-viral, anti-inflammatory properties (Kew Royal Botanical Gardens, n.d.) and its constituent eugenol is an antibiotic (Rahim & Khan, 2006). Clove buds traditionally used to treat toothache and evidence suggests clove extracts are effective at fighting tooth decay (Rahim & Khan, 2006); clove buds also traditionally used by Ontario Six Nations communities to treat skin conditions, aid digestion, ease coughs, relieve muscle spasms and is said to be a stimulant for the mind that helps improve memory (Six Nations Farmers Market and Garden, 2012).

Cultural and spiritual significance: In European traditions, cloves are combined with oranges to make a decorative pomander at Christmas (Princeton University Library, 2010); due to its prominent use at Christmas, the scent of clove is frequently associated with the holiday season (Seo, Buschhüter & Hummel, 2009).

COMMON JUNIPER

Scientific classification: Juniperus communis

Perfumery classification: fruity/green, top note

Contributing fragrant compounds: α-pinene and β-pinene (resinous, fresh, pine-like); limonene (fresh, citrus); sabinene (spicy); p-cymene (fresh, herbal, citrus); terpinen-4-ol (herbal, pepper, earthy,
woody); geraniol (rosy); β-phyllandrene (peppermint, citrus); nerol (fresh floral, herbaceous); bornyl acetate (pine, camphoraceous, herbal, balsamic) (Filipowicz et al., 2003)

**Medicinal uses:** Essential oil of berries has anti-bacterial and anti-fungal properties (Filipowicz et al., 2003); oil traditionally used as a diuretic, stomachic, and carminative and used to treat diseases of the kidney and bladder (Grieve, 1931).

**Cultural and spiritual significance:** Considered purifying for body body and spirit; incense historically used in religious ceremonies by Babylonians, Egyptians, Tibetans and American indigenous peoples; oil used in ancient Egyptian mummification processes; incense burned by ancient Romans at funerals and still burned for purification in Tibet; juniper branches burned in ancient Greece as protection against epidemics (Ross, 2007).

**DOUGLAS FIR**

**Scientific classification:** *Pseudotsuga menziesii*

**Perfumery classification:** woody/balsamic, middle note

**Contributing fragrant compounds:** α-pinene and β-pinene (resinous, fresh, pine-like); limonene (mint-like); sabinene (spicy) (Schindler & Kotzias, 1989)

**Medicinal uses:** Infusions or decoctions of bark and oleoresin traditionally drunk by the (Saanich and Cowichan Coast) Salish peoples of Vancouver Island to treat colds, tuberculosis, stomach ailments, ulcers and venereal disease (Turner & Hebda, 1990).

**Cultural and spiritual significance:** Traditionally held in very high regard by the (Thompson and Lillooet) Salish peoples of British Columbia; preferred plant for use in puberty rites (Turner, 1988).

**GINGER**

**Scientific classification:** *Zingiber officinale*

**Perfumery classification:** spicy, middle or base note

**Contributing fragrant compounds:** geranial (sharp, rosy); eugenol (spicy, warm, clove-like);
zingerone (pungent, spicy) (Singh et al., 2008)

**Medicinal uses:** Root has anti-oxidant, anti-inflammatory, anti-tumorigenic, anti-hyperglycemic, anti-apoptotic, anti-lipidemic, anti-emetic properties; also helps to regulate immune system (Ali et al., 2008).

**Cultural and spiritual significance:** Traditionally used as an aphrodisiac in Arabic medicine (Moghaddasi & Kashani, 2012). Aromatherapeutic use of essential oil said to promote clarity, insight, motivation and strength of soul (Holmes, 1996).

**MANDARIN ORANGE**

**Scientific classification:** *Citrus reticulata*

**Perfumery classification:** citrus, top note

**Contributing fragrant compounds:** *d*-limonene (fresh, weak citrus); *γ*-terpinene (sweet, citrus with lime nuance); *α*-pinene and *β*-pinene (resinous, fresh, pine-like); myrcene (sweet, balsamic) (Rhind, 2014, pp. 110)

**Medicinal uses:** Extract from peel demonstrated anti-proliferative effects on cancer cells (Kim et al., 2005); essential oil applicable to treatment of acne, scars and stretch marks, loose skin, indigestion, insomnia, water retention, obesity and congestion (Lawless, 2013).

**Cultural and spiritual significance:** Symbolic of good fortune in China; prominently used during Chinese New Year celebrations (Thujala, 2005).

**MAPLE**

**Scientific classification:** *Acer* genus, *Sapindaceae/Aceraceae* family

**Perfumery classification:** woody, top/middle note

**Contributing fragrant compounds:** sabinene (spicy), camphene (pungent, woody), *δ*-3-carene (sweet, lemony) (Geron et al., 2000)

**Medicinal uses:** Bark traditionally used medicinally by First Nations peoples; extract has demonstrated antimicrobial properties (Omar et al., 2000); bark of *Acer rubrum* (Red Maple) traditionally used to
treat sore eyes (Grieve, 1931).

**Cultural and spiritual significance:** Maple leaf is symbolic of Canada and maple trees were recognized as emblems in 1996; maples leaves appeared in the 1868 Ontario and Quebec coats of arms and also in the 1921 Canadian coat of arms; also used on regimental badges in the First and Second World Wars; the maple leaf became an official national symbol with the proclamation of the national flag in 1965 (Historica Canada website, 2015).

**NORWAY SPRUCE**

**Scientific classification:** *Picea abies*

**Perfumery classification:** woody, middle note

**Contributing fragrant compounds:** \( \alpha \)-pinene and \( \beta \)-pinene (resinous, fresh, pine-like); limonene (fresh, citrus); camphene (pungent, woody); \( \beta \)-Caryophyllene; bornyl acetate (pine, camphoraceous, herbal, balsamic); humulene (woody, spicy, hoppy); \( \alpha \)-terpineol (floral, lilac-like); germacrene-D (woody, earthy, spicy) (Kartnig et al., 1991)

**Medicinal uses:** Essential oil has demonstrated antimicrobial properties and in traditional Austrian folk medicine, a syrup is made from young shoots to treat respiratory tract diseases (Kartnig et al., 1991); salve made from tree's resin widely used in Finnish folk medicine to heal wounds and skin infections (Sipponen et al., 2007).

**Cultural and spiritual significance:** Considered the traditional Christmas tree in Europe (Salo, 1995).

**NUTMEG**

**Scientific classification:** *Myristica fragrans*

**Perfumery classification:** spicy, middle note

**Contributing fragrant compounds:** myristicin (sweet, warm, spicy) (Hallström & Thuvander, 1997; Rhind, 2014, pp. 63); camphene (pungent, woody); \( \alpha \)-pinene and \( \beta \)-pinene (resinous, fresh, pine-like); \( \alpha \)-terpineol (floral, lilac-like); borneol (camphor-like, woody); geraniol (sweet, rosy, floral); linalool
(floral, woody); eugenol (spicy, warm, clove-like) (Rhind, 2014, pp. 63)

**Medicinal uses:** Used in traditional Indian medicine to manage male sexual disorders; evidence suggests extract has aphrodisiac properties (Tajuddin et al., 2005); traditionally used as a stomachic and carminative; powdered nut traditionally used in China to treat dysentery, stomach cramps and rheumatism; powdered seeds traditionally used in southeast Asia to treat anorexia and colic; oil also used to treat malarial weakness (Perry, 1980 cited in Janssens et al., 1990).

**Cultural and spiritual significance:** Myristicin and elemicin found in nutmeg said to contain psychoactive properties (Keel, 2015).

**SCOTS PINE**

**Scientific classification:** *Pinus sylvestris*

**Perfumery classification:** woody/balsamic, middle note

**Contribution fragrant compounds:** \(\alpha\)-pinene and \(\beta\)-pinene (resinous, fresh, pine-like); \(l\)-limonene (weak citrus, mint-like); \(\delta\)-3-carene (sweet, lemony) myrcene (sweet, balsamic); ocimene (light herbaceous); bornyl acetate (camphoraceous, pine-like); 1,8-cineole (eucalyptus-like) (Rhind, 2014, pp. 66)

**Medicinal uses:** Essential oil applicable to treatment of cuts and sores, excessive sweating, neuralgia, tension and stress, cystitis and scabies (Lawless, 2013); American Aboriginal peoples made a drink from branches to prevent scurvy (Ross, 2007).

**Cultural and spiritual significance:** Incense made from Scots pine considered purifying and is popularly used in meditation (Ross, 2007).

**VANILLA**

**Scientific classification:** *Vanilla planifolia*

**Perfumery classification:** aromatic aldehyde/balsamic, base note

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18 Fragrant material from vanilla commonly comes in the form of an absolute.
**Contributing fragrant compounds:** vanillin (aka 4-hydroxy-3-methoxybenzaldehyde - characteristic vanilla aroma) (Rhind, 2014, pp. 53)

**Medicinal uses:** vanilla historically to treat hysteria and depression in Europe; also used in early twentieth century America as a nerve stimulant and to treat stomach upset and hysteria (Bythrow, 2005). Vanillin has been demonstrated to inhibit sickling of red blood cells in patients with sickle cell disease; vanillin also has demonstrated antimutagenic and antimicrobial properties as well as anticarcinogenic effects (Bythrow, 2005).

**Cultural and spiritual significance:** Long considered an aphrodisiac; used for this purpose by early Mesoamerican cultures and Aztecs, who also used it to adorn sacred places; popular perfumery ingredient since the eighteenth century and one of the most common fragrant/flavour ingredients used in cosmetics in the U.S. (Bythrow, 2005); some evidence for aphrodisiac effects of vanillin (Maskeri et al., 2012)

**WHITE PINE**

**Scientific classification:** *Pinus strobus*

**Perfumery classification:** woody/mossy, middle note

**Contributing fragrant compounds:** α-pinene and β-pinene (resinous, fresh, pine-like); germacrene-D (woody, earthy, spicy) (Krauze-Baranowska et al., 2002)

**Medicinal uses:** Syrup from plant used as expectorant, demulcent and diuretic; used to treat cough and cold, good for bladder and kidneys (Grieve, 1931); traditionally used by Ontario Six Nations communities to treat weakness in infants and breathing difficulties in overweight people; also used to cleanse stomach and treat rheumatism, cramps, stiffness, cuts, wounds, scabs; used to prevent typhoid, venereal disease and tuberculosis; used as emetic and used to make powder for babies (Six Nations Farmers Market and Garden, 2012).

**Cultural and spiritual significance:** Symbolic of peace and unification for Iroquois peoples in North
America; associated with the founding of the Iroquois League\textsuperscript{19} consisting of the Mohawk, Onondaga, Oneida, Cayuga, Seneca nations (Schroeder, 1992).

\textit{Spring}\textsuperscript{20}

**CLOVER**

\textbf{Scientific classification:} \textit{Trifolium} genus, \textit{Fabaceae} family

\textbf{Perfumery classification:} floral, middle note

\textbf{Contributing fragrant compounds}\textsuperscript{21}: maltol (caramel/butterscotch-like); linalool (mild, floral, woody); phenol (sweet, honey-like); phenylethyl acetate (floral, rosy, honey-like) (Buchbauer et al., 1996)

\textbf{Medicinal uses:} Extract of red clover traditionally used as an antispasmodic; infusion used to treat whooping cough; used in poultices to counteract cancerous growths (Grieve, 1931). Also traditionally used as antiseptic, analgesic and expectorant, as well as in treatment of asthma, bronchitis, psoriasis, eczema, constipation and menopause symptoms (Sabudak & Guler, 2009). Extract of white clover used to treat rheumatism (Sabudak & Guler, 2009). Extracts from different species demonstrate anti-inflammatory, antioxidant, anticeestodal, cytostatic, cytotoxic and estrogenic activity (Sabudak & Guler, 2009).

\textbf{Cultural and spiritual significance:} Shamrock (young sprigs of clover) became the national emblem of Ireland in 1801; it is also said to have been emblematic of the spring equinox for the Druids and was used by Saint Patrick as a demonstration of the Holy Trinity (Coleraine Borough Council, n.d.).

**DOGWOOD**

\textsuperscript{19} The “Iroquois League” or “Haudenosaunee Confederacy” was also known as the “Five Nations” and became “Six Nations” later when the Tuscarora nation joined (Historica Canada website, 2015).

\textsuperscript{20} Focal material for spring tours may depend on what is in bloom throughout the season. Due both to blooming constraints and the spatial layout of focal plants for spring tours, this section contains less continuously applicable interpretative material than the summer, fall and winter sections. It may therefore be supplemented with any material from these sections involving plants found around spring collections and along or around the Avenue of Trees for tour purposes, as well as plants that are associated with the spring season for workshop purposes.

\textsuperscript{21} Compounds listed here were obtained from samples of the flowers of both red clover (\textit{Trifolium pratense}) and white clover (\textit{Trifolium repens}).
Scientific classification: *Cornus florida*

Perfumery classification: floral, middle note

**Contributing fragrant compounds:** E-β-ocimene (floral, herbal, sweet); linalool (mild, floral, woody); nonanal (waxy, rosy, citrus); ketoisophrone (musty, woody, sweet); decanal (sweet, waxy, citrus, floral) (Zhuang et al., 2008)

**Medicinal uses:** Decoctions made from roots or bark traditionally used by Aboriginal peoples in the United States to treat fever, malaria; bark also used to treat flux and in poultices to treat sores (Vogel, 1970, pp. 300-301).

**Cultural and spiritual significance:** Folktales about Dogwood Tree associate it with Christ's crucifixion and hold that the tree is small and grows crookedly because it was used to make the cross; the bitter red berries are said to represent Christ's blood and suffering (Bowman, 2003). Such tales also link the appearance of Dogwood flowers to the crucifixion, noting the red spots on the petals to represent nail prints (University of Kentucky Department of Horticulture, 2015).

FLOWERING CHERRY

Scientific classification: *Prunus serrulata* and other *Prunus* species

Perfumery classification: fruity/spicy, middle note

**Contributing fragrant compounds**: 6-10-14-trimethyl-2-pentadecanone (floral); α-acorenol (fruity, sweet, powdery, floral); (Z)-α-bisabolene (balsamic,spicy); benzaldehyde (almond-like), isopropyltiglate (green, minty); terpinen-4-ol (herbal, pepper, earthy, woody) (Utsunomiya et al., 2005)

**Medicinal uses:** Extract from the blossoms of *Prunus serrulata* variation *spontanea* have demonstrated antioxidative and anti-cancer activities (Lee et al., 2007). *Prunus mume* flowers have also demonstrated antioxidant activities (Shi et al., 2009).

**Cultural and spiritual significance:** *Prunus mume* an important species in Chinese gardens,

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22 Fragrant compounds included here come from the essential oil of *Prunus mume* woods.
representing renewal and strength of will, and associated with spiritual harmony; branches that bloom indoors represent friendship; (Missouri Botanical Garden, n.d.). *Prunus serrulata* blossoms symbolic of spring, renewal and the fleeting nature of life in Japan (Takeda, 2014).

**LILAC**

**Scientific classification:** *Syringa vulgaris*

**Perfumery classification:** floral, middle note

**Contributing fragrant compounds:** E-ocimene (floral, herbal, sweet); 1,4-dimethoxybenzene (strong, sweet, floral); indole (animalic) (Lis-Balchin, 2006, pp. 346); benzaldehyde (almond-like); benzyl methyl ether (fruity, green, floral); phenylacetaldehyde (green, sweet, floral); lilac aldehyde (floral, characteristic lilac); *p*-Anisaldehyde (sweet, powdery, floral, woody, spicy) (Oh et al., 2008)

**Medicinal uses:** Traditionally used to treat parasites and fever; also used as a tonic and anti-periodic; applicable to treating malaria (Grieve, 1931). Traditionally used by Ontario Six Nations communities to treat sore mouth (Six Nations Farmers Market and Garden, 2012).

**Cultural and spiritual significance:** Associated with Greek mythology, from which the genus name derives; based on a myth in which the nymph Syrax was turned into a hollow willow reed to get away from Pan, the field and forest god who desired her. (Missouri Botanical Garden, n.d.)

**LINDEN**

**Scientific classification:** *Tilia* genus, *Tiliaceae* family/*Tilioideae* sub-family of *Malvaceae* family

**Perfumery classification:** floral/green, middle note

**Contributing fragrant compounds**²³: farnesol (delicate, sweet, green, floral) (Rhind, 2014, pp. 94)

**Medicinal uses:** Flower infusions traditionally used to treat indigestion, hysteria, palpitation (Grieve, 1931); tea made from *Tilia* flowers commonly used to treat coughs (Kew Royal Botanical Gardens, n.d.) and also perspiration, diarrhea, stomach spasms and insomnia (Jarić et al., 2007); plant

²³ Fragrant compounds here refer to those found in the absolute of *Tilia vulgaris* flowers.
traditionally used by Ontario Six Nations communities to treat burns and scalds, urinary issues and pain; also used by Six Nations communities as a mood enhancer (Six Nations Farmers Market and Garden, 2012).

**Cultural and spiritual significance:** Linden trees associated with social gatherings and weddings, also associated with gatherings for judiciary purposes; old belief that lies can not be told under linden trees; mythological significance includes association with Germanic goddess of truth and love, Freya; in Greek mythology, Zeus and Hermes transform an elderly couple, Baucis and Philemon, into intertwining oak and linden trees after their deaths as thanks for hospitality (Young, 2015).

**MAGNOLIA**

**Scientific classification:** *Magnolia* genus, *Magnoliaceae* family

**Perfumery classification:** floral, middle note

**Contributing fragrant compounds**\(^{24}\): linalool (sweet, floral, woody); methyl benzoate (sweet, fruity, heavy floral); benzyl acetate (fruity, jasmine-like); phenylethanol (honey, rosy); \(\alpha\)-ionone (violet-like); \(\beta\)-ionone (violet-like); methyl anthranilate (orange-flower-like, harsh); indole (animalic) (Rhind, 2014, pp. 90)

**Medicinal uses:** Bark of *Magnolia acuminata* (Cucumber Tree) traditionally used by Iroquois peoples in United States to treat toothache; bark infusions of *Magnolia acuminata* and *Magnolia macrophylla* traditionally used by Cherokee peoples in United States to treat stomachache; *Magnolia virginiana, Magnolia acuminata* and *Magnolia tripetala* included in the United States pharmacopeia as treatment for rheumatism (Schühly et al., 2001). Bioactive compounds found in seed oil, bark and leaves of various *Magnolia* species have demonstrated anti-bacterial and anti-fungal activities (Schühly et al., 2001). *Magnolia* bark constituents have further demonstrated anti-cancer activities, anti-stress, anti-anxiety and anti-depression activities, as well as anti-oxidant and anti-inflammatory activities (Lee, 2001).

\(^{24}\) Fragrant compounds here refer to those found in the absolute of *Magnolia champaca* flowers.
Cultural and spiritual significance: Associated with the Southern United States, magnolia is the official state tree of Mississippi and the official state flower of both Mississippi and Louisiana; abundance of Magnolias in Mississippi have garnered its nickname “the Magnolia State” (Largo, 2014, pp. 221).

REDBUD

Scientific classification: *Cercis* genus, *Fabaceae* family

Perfumery classification: floral, middle note

Contributing fragrant compounds\(^{25}\): pentadecane (waxy); linalyl acetate (floral, herbal, green, citrus); eicosane (waxy); limonene (fresh, citrus) (Dayeni & Omidbaigi, 2006)

Medicinal uses: Early American folk healers used Eastern Redbud (*Cercis canadensis*) bark to treat common illnesses such as diarrhea, and sometimes leukemia (The Arbor Day Foundation, 2015; University of Kentucky Department of Horticulture, 2015).

Cultural and spiritual significance: Legend has it that Judas Iscariot hung himself from a Redbud (*Cercis siliquastrum*) tree and that the tree's originally white flowers turned pink in shame; this legend underlies the tree's nickname, “Judas Tree” (Björkman, 1998).

TULIP TREE

Scientific classification: *Liriodendron tulipifera*

Perfumery classification: floral/spicy, middle note

Contributing fragrant compounds\(^{26}\): germacrene-D (woody, earthy, spicy); beta-elemene (herbal, waxy, fresh); (Z)-beta-ocimene (floral, herbal, sweet) (Miller et al., 2009)

Medicinal uses: Essential oil from leaves as well as extracts from heartwood have demonstrated antimicrobial activity (Miller et al., 2009; Hufford et al., 1975); oil from leaves has also demonstrated

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\(^{25}\) Fragrant compounds here refer to those found in the oil of *Cercis siliquastrum* flowers.

\(^{26}\) Fragrant compounds here refer to those found in the oil of leaves from *Liriodendron tulipifera*. 
anti-cancer activity (Miller et al., 2009).

**Cultural and spiritual significance:** The wood from this tree traditionally used by Native Americans and early settlers of the United States to make canoes; it is said that Daniel Boone used a canoe made from the trunk of a tulip tree to carry his family from Kentucky to the western frontier (The Arbor Day Foundation, 2015).
For interpretation carts

Perfume making can be implemented on a smaller scale as part of a display on an interpretation cart. Several premixed essential and carrier oils can be provided at the cart with empty roller sticks. Interpretation on each source plant of the essential oil can be displayed on the carts and visitors encouraged to mix their own blends. Material can follow rotating themes such as plants with mythological significance (eg. heliotrope, peppermint, spearmint, thyme etc.), plants associated with love (rose, mints, rosemary, etc.), holiday and celebration plants (marigold, birch, spruce, clove, etc.), edible plants (mints, herbs, spices, etc.) and so on. As with the idea of a craft fragrance festival, consenting visitors may allow RBG to recreate their blends for sale at the gift shop. Following this idea, as an alternative to oils, dried flowers, herbs and spices may be provided with small sachets and visitors may be encouraged to mix their own pot pourris. Some basic recipes or guidelines of which fragrances blend well together may be displayed on the carts and experimentation encouraged.

Scent identification games can be presented with premade solid perfumes in small pots. Clues from interpretative material can be provided and visitors encouraged to smell and guess the fragrance(s) included in simple blends. Similarly, common descriptive terms used in perfumery may be provided and visitors encouraged to apply them to the blends or to dried specimens of fragrant materials. Taking this a step further, molecular structures of common aromachemicals (see Appendix 8) may be displayed on interpretation carts via drawings or 3-D models. Interpretative material on their fragrance, their biological function and the plants in which they are found may be provided and plant oils or dried specimens available for reference. Visitors would have the opportunity to see how different molecular compounds combine and how these combinations add different fragrant dimensions to plants.
Focusing on edible plants, traditional recipes for foods and beverages incorporating fragrant plants may be displayed along with dried specimens of the fragrant materials or their essential oils. Visitors may be invited to smell the various materials and rewrite some of the recipes according to their preferences on blank cards that they can take home. Provided an interpreter is available to be present at the cart, a small selection of herbal teas made from fragrant plants may be given out as samples with interpretative material on the medicinal use of such herbal teas.

Bringing in some emphasis on forest bathing, dried specimens or light oil blends of plants that feature $\alpha$-pinene and $\beta$-pinene in their chemical compositions may be displayed along with a brief description of some studies on their beneficial effects in the context forest bathing. A few basic meditative exercises could be outlined on take away cards and visitors encouraged to employ them when walking through target areas of RBG's grounds where they are likely to encounter these molecules in the air. Similar mindfulness activities and key fragrances could be suggested for trips throughout various areas of the gardens, accompanied by relevant interpretative material for reflection.

*For school activities*

When schools come to visit RBG, students may undertake a fragrant scavenger hunt assignment in which they are presented with several recurring themes from interpretation material and they must find, smell, sketch and record the scientific names of the plants that correspond to them. Students may be asked to record their impressions of the plants (how they look, feel, smell, etc.) and to come up with novel ways to apply the plants to their theme. Themes may include traditional medicine, cooking ingredients, celebratory symbols, etc. Once plants have been located and explored, students may swap lists with their peers and work together to identify new plants, explore them, and generate new ideas together.

Similar to the display cart activities, students may explore scent blending with pre-mixed oils or with dried ingredients for pot pourris. This is an easy art-based activity that may serve as a follow up to
the scavenger hunt assignment. To bring in a scientific element, students can also build 3-D models of common aromachemicals in fragrant plant materials using arts and crafts materials. Provided interpretation material on how various compounds combine in different fragrant plants, students can attempt to recreate the molecular structure of some fragrant plants. For older groups, if a laboratory setting is available, students may engage in an esterification lab that produces fruity smelling substances characteristic of fragrance and flavour applications.
8.8 Appendix 8: Molecular Structures of Common Aromachemicals

Figure 8.1: Camphor chemical structure

**Chemical formula:** C10H16O

**Chemical type:** cyclic monoterpenic ketone

**Other names:** Formosa camphor, gum camphor, Japan camphor, Kampfer, laurel camphor, root bark oil, spirit of camphor

**Biological roles:** plant metabolite

**Source:** The European Bioinformatics Institute, 2015

(https://www.ebi.ac.uk/chebi/searchId.do?chebiId=CHEBI:36773)

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27 Synonyms provided for chemicals listed in this appendix are not exhaustive, rather they are intended to provide an idea of the diversity applied in chemical nomenclature.
Figure 8.2: 1,8-cineole chemical structure

Chemical formula: C10H18O

Chemical type: cyclic ether; monoterpenoid

Other names: 1,8-Cineol, 1,8-epoxy-p-menthane, 1,8-oxido-p-menthane, cineole, cajeputol, eucalyptol, Zineol

Biological roles\(^2\): plant metabolite, volatile oil component, flavouring agent

Source: The European Bioinformatics Institute, 2015

(htp://www.ebi.ac.uk/chebi/searchId.do?chebiId=CHEBI:27961)

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\(^2\) 1,8-cineole is also suggested to be an antimicrobial agent (Mazzanti et al., 1998).
Figure 8.3: Citral chemical structure

Chemical formula: C10H16O

Chemical type: enal, pair/mixture of terpenoids geranial and neral

Other names: cis,trans-Citral

Biological roles: metabolite, aldehyde oxidase inhibitor

Source: The European Bioinformatics Institute, 2015

(http://www.ebi.ac.uk/chebi/searchId.do?chebiId=CHEBI:23316)
Figure 8.4: Citronellol chemical structure

Chemical formula: C10H20O

Chemical type: monoterpenoid

Other names: β-Citronellol, Cephrol, Elenol

Biological roles: plant metabolite

Source: The European Bioinformatics Institute, 2015
(http://www.ebi.ac.uk/chebi/searchId.do?chebiId=50462)
Figure 8.5: Eugenol chemical structure

Chemical formula: C10H12O2

Chemical type: phenylpropenoid

Other names: Allylguaiacol, p-Allylguaiacol, Caryophyllic acid, Eugenic acid, p-Eugenol

Biological roles: allergen; plant metabolite

Source: The European Bioinformatics Institute, 2015

(http://www.ebi.ac.uk/chebi/searchId.do?chebiId=CHEBI:4917)
Figure 8.6: Geraniol chemical structure

Chemical formula: C10H18O

Chemical type: monoterpenoid

Other names: geranyl alcohol, lemonol, t-geraniol

Biological roles: plant metabolite, volatile oil component, allergen

Source: The European Bioinformatics Institute, 2015

(http://www.ebi.ac.uk/chebi/searchId.do?chebiId=CHEBI:17447)
Figure 8.7: Limonene chemical structure

*Chemical formula:* C10H16

*Chemical type:* monoterpane

*Other names:* Cajeputene, Dipentene, dl-Limonene, Kautschin

*Biological roles*: human metabolite

*Source:* The European Bioinformatics Institute, 2015

(http://www.ebi.ac.uk/chebi/searchId.do?chebiId=CHEBI:15384)

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29 Limonene is also suggested to be an antimicrobial agent (Mazzanti et al., 1998).
Figure 8.8: Linalool chemical structure

Chemical formula: C10H18O

Chemical type: monoterpene

Other names: β-linalool, linalyl alcohol,

Biological roles: plant metabolite, volatile oil component, antimicrobial agent

Source: The European Bioinformatics Institute, 2015
(http://www.ebi.ac.uk/chebi/searchId.do?chebiId=CHEBI:17580)
Figure 8.9: Menthone chemical structures of + and – enantiomers (mirror images)

Chemical formula: C10H18O

Chemical type: terpene/monoterpene

Other names: (+)-menthone, (-)-menthone, l-menthone, p-Menthan-3-one

Biological roles: plant metabolite, volatile oil component

Source: The European Bioinformatics Institute, 2015
(http://www.ebi.ac.uk/chebi/searchId.do?chebiId=CHEBI:31; http://www.ebi.ac.uk/chebi/searchId.do?chebiId=CHEBI:15410)
Figure 8.10: Myrcene chemical structure

Chemical formula: C10H16

Chemical type: monoterpane

Other names: beta-Myrcene, β-myrcene

Biological roles: plant metabolite, anabolic agent, volatile oil component, flavouring agent

Source: The European Bioinformatics Institute, 2015

(http://www.ebi.ac.uk/chebi/searchId.do?chebiId=CHEBI:17221)
*Figure 8.11: Nerol chemical structure*

*Chemical formula:* C10H18O

*Chemical type:* monoterpane

*Other names:* cis-geraniol, neryl alcohol

*Biological roles:* plant metabolite, volatile oil component

*Source:* The European Bioinformatics Institute, 2015

([http://www.ebi.ac.uk/chebi/searchId.do?chebiId=CHEBI:29452](http://www.ebi.ac.uk/chebi/searchId.do?chebiId=CHEBI:29452))
Figure 8.12: \( \beta \)-ocimene chemical structure

*Chemical formula:* C10H16

*Chemical type:* ocimene; monoterpene

*Other names:* contains sub-types with similar names, for example \((Z)\)-\( \beta \)-ocimene, \((E)\)-\( \beta \)-ocimene

*Biological roles:* plant metabolite

*Source:* The European Bioinformatics Institute, 2015

(http://www.ebi.ac.uk/chebi/searchId.do?chebiId=CHEBI:10436)
Figure 8.13: \(\alpha\)-pinene chemical structure

Chemical formula: C10H16

Chemical type: terpene; alkene

Other names: 2-pinene, acintene A

Biological roles\(^{30}\): plant metabolite

Source: The European Bioinformatics Institute, 2015

(http://www.ebi.ac.uk/chebi/searchId.do?chebiId=CHEBI:36740)

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\(^{30}\) \(\alpha\)-pinene has also demonstrated anti-inflammatory activity (Lorente et al., 1989).
**Figure 8.14: β-pinene chemical structure**

*Chemical formula:* C10H16

*Chemical type:* monoterpene

*Other names:* nopinene, pseudopinene, 2(10)-pinene

*Biological roles*: plant metabolite

*Source:* The European Bioinformatics Institute, 2015 (http://www.ebi.ac.uk/chebi/searchId.do?chebiId=CHEBI:50025)

31 β-pinene has also demonstrated anti-inflammatory activity (Lorente et al., 1989).
Figure 8.15: Sabinene chemical structure

Chemical formula: C10H16

Chemical type: bicyclic monoterpene

Other names: 4(10)-thujene, Sabinen

Biological roles\textsuperscript{32}: plant metabolite

Source: The European Bioinformatics Institute, 2015

(http://www.ebi.ac.uk/chebi/searchId.do?chebiId=CHEBI:50027)

\textsuperscript{32} Sabinene has also demonstrated anti-inflammatory activity (Yao & Chiou, 1993).
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