



## INTERNATIONAL JOURNAL OF PHARMACEUTICAL RESEARCH AND BIO-SCIENCE

### LOVE: THE MAGIC OF NEUROCHEMICALS

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Accepted Date: 09/12/2013; Published Date: 27/12/2013

**Abstract:** The present study reviews and summarizes the role of various neurochemicals in the most coveted emotion called love. Love can exist in different forms, but the most interesting and perhaps the most complex one is romantic love. During many years scientists, psychiatrics and anthropologists have suggested involvement of various hormones and biochemicals in this. Scientifically "romantic love" can be divided into three stages and different neurochemicals governs each stage. Surprisingly the first stage is "lust" which is controlled by testosterone and estrogen, the second and third stage is "attraction" and "attachment" respectively. While adrenaline, noradrenaline, dopamine, PEA and serotonin are responsible for characteristic features of attraction stage, oxytocin along with vasopressin and endorphins govern attachment stage. This review paper discusses the individual role of each neurochemicals in each stage and typical characteristic activities due to them.

**Keywords:** Neurochemicals, dopamine, adrenaline, serotonin, love



PAPER-QR CODE

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Access Online On:

[www.ijprbs.com](http://www.ijprbs.com)

How to Cite This Article:

Sudipta Chakraborty, IJPRBS, 2013; Volume 2(6): 440-451

## INTRODUCTION

The English word "love" can refer to a variety of different feelings, states, and attitudes, ranging from interpersonal affection to pleasure. It can also be a virtue representing human kindness, compassion, and affection. Love usually refers to interpersonal love, an experience felt by a person for another person. <sup>[1]</sup> Psychologists have argued that love has different components like attraction, attachment, intimacy, commitment, and passion. <sup>[2,3]</sup>

Romantic love, on the other side, celebrated throughout the ages as one of the most overwhelming of all affective states, has been the inspiration for some of the loftiest achievements of mankind. It is characteristically directed towards a single person, it is a complex sentiment involving erotic, cognitive, emotional and behavioral components. <sup>[4-6]</sup>

Poets and authors have tried to define love for centuries, whereas scientists have started thereafter. Even Albert Einstein said ...“Let’s talk about love”!! <sup>[7]</sup>

Many of scientists, Psychiatric and anthropologists have worked on and explained various scientific bases behind love. <sup>[8-11]</sup> In this present work, an attempt has been made to review some of these knowledge and neurochemical basis behind the romantic love.

## STAGES OF LOVE

There are three phases to fall in love and different neurochemicals are involved at each stage. <sup>[12]</sup>

The phases are as follows.

1. Lust.
2. Attraction.
3. Attachment.

### 1. LUST

This is the first stage of love. Many early relationships are fueled by lust. This phase is characterized by the craving for sexual gratification and is often directed towards many partners. It is associated primarily with the estrogens and testosterone. Together these two chemicals produce elation, intense energy, sleeplessness, craving and loss of appetite. <sup>[13-16]</sup>

In this phase one is totally focused on a person's looks and body, interested in having sex, but not in having conversations. One may find himself on a fantasy level, incapable of rational thought. <sup>[17,18]</sup>

Lust, like love, is truly blind. This is why, especially at the beginning of a relationship many of us don't know whether he/she is in love or it is merely a passing fancy that will have our blood boiling for only a short while.<sup>[19]</sup>

These effects rarely last more than a few weeks or months. This phase is driven by the hormones testosterone and estrogen.<sup>[11]</sup>

### Testosterone

Raw lust is accompanied by a surge in testosterone levels. Testosterone is a naturally occurring hormone in both men and women.<sup>[20,21]</sup> It is a steroid hormone from the androgen group. In mammals, testosterone is primarily secreted in the testes of males and the ovaries, liver and adrenals in women, but it is 10 times higher in males.<sup>[21-23]</sup>

It is the principal male sex hormone in male but women may be more sensitive to the hormone.<sup>[24-27]</sup>

Testosterone, the starring androgen, along with its chemical cousins dihydrotestosterone and androstenedione, sparks sexual arousal and stirs fundamental physical attraction. Even no wonder that when lust pans out into kissing contact, testosterone is exchanged in lovers' saliva.<sup>[28-30]</sup>

It truly controls this phase as study has shown that administration of testosterone can increase sexual desire, sexual thoughts, activity and satisfaction in men and women, but do not increase romantic passion or increased attachment to their partners.<sup>[31]</sup>

Studies also have shown that as this phase passes testosterone levels in male gets decreased while increase in female, it is explained as "Falling in love" that is slowly the characteristics of "lust" disappear and people now become "lovers". Men who start to produce less testosterone are more likely to be in a relationship and/or married, and men who continue to produce more testosterone are more likely to be alone.<sup>[30, 32-36]</sup>

### Estrogen

It is present in both females and males, but much higher in women of reproductive age. It promotes the development of female secondary sex characteristics and functioning as the primary female sex hormone.<sup>[26-27, 32]</sup>

When women fall in love, their testosterone levels spike but they produce less estrogen. The hormone levels return to their normal state about one to three years into the relationship.<sup>[36]</sup>

## 2. ATTRACTION

This is the amazing truly love-struck phase in which one is biologically driven to focus on one person. <sup>[13,16]</sup> This phase is characterized by increased energy, focused attention on one potential mate accompanied by feeling of exhilaration intrusive thinking about a mate and the craving for emotional union with this mate. <sup>[37]</sup>

When people fall in love they can think of nothing else. They might even lose their appetite and need less sleep, preferring to spend hours at a time daydreaming about their new lover. <sup>[12]</sup> The neurochemicals playing role in attraction phase are as follows.

1. Adrenaline
2. Noradrenaline
3. Dopamine
4. Phenylethylamine
5. Serotonin

### Adrenaline/Epinephrine

It is secreted by the medulla of the adrenal glands and also produced at the ends of sympathetic nerve fibres and chromaffin cells. <sup>[38-40]</sup>

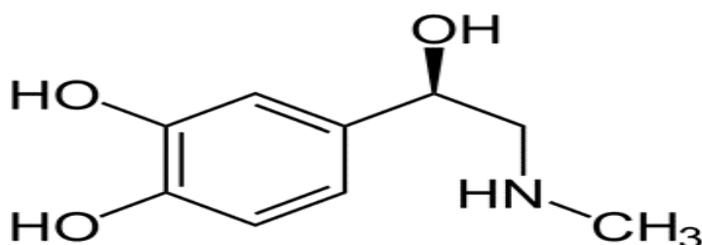
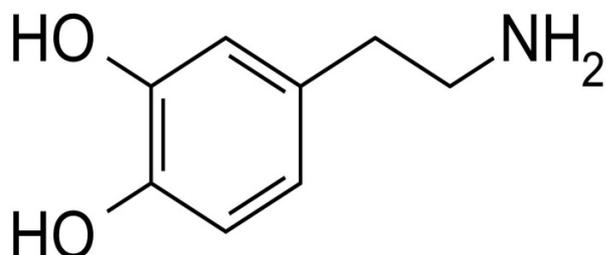


Fig. 1: Chemical structure of adrenaline

The initial stages of falling in love activate stress response, increasing blood levels of adrenalin and cortisol. This has the charming effects that when someone unexpectedly bumps into his/her new love, he/she starts to sweat, heart races and mouth go dry. <sup>[13,41]</sup>

## Dopamine



**Fig. 2: Chemical structure of dopamine**

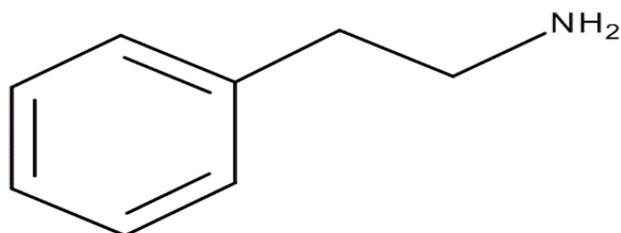
It is the hormone responsible for the "high" one feels when one is in love. Dopamine is addictive in nature and is our body's personal reward system. A neurotransmitter by nature, dopamine is produced in various parts of the brain by the hypothalamus. Due to its addictive properties, when dopamine is released during intimacy with a partner, one becomes addicted to it. <sup>[40, 42]</sup>

Dopamine is thought to be the "pleasure chemical", producing a feeling of bliss. The attraction stage is the biological drive to focus on one person. It is a chemical that is responsible for "love at first sight"! When we see our loved one, even a photo of them, the dopamine areas of the brain light up. This hormone is responsible for the feeling of clinging and jealousy that we experience in love. High levels of dopamine are also associated with short-term memory, hyperactivity, and goal-oriented behavior. <sup>[16, 27, 42-43]</sup>

It also makes people more "talkative" and excitable. It affects brain processes that control emotional response, movement, ability to express pleasure, but also pain. <sup>[43-44]</sup>

It has been proved that newly 'love struck' couples have high levels of the neurotransmitter dopamine in their brains. This chemical stimulates 'desire and reward' by triggering an intense rush of pleasure. It has the same effect on the brain as taking cocaine and nicotine. <sup>[12-13]</sup>

### Phenylethylamine/PEA

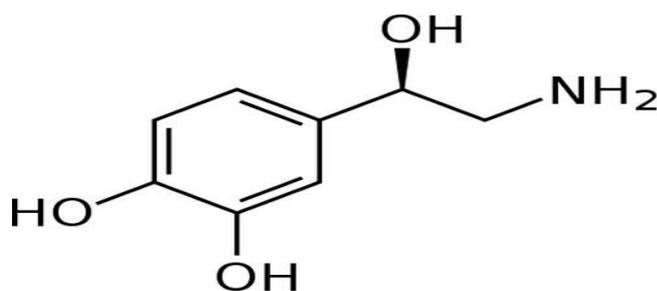


**Fig. 3: Chemical structure of phenylethylamine**

The first attraction causes us to produce more PEA which results in those dizzying feelings associated with romantic love! Large quantities of PEA increase both physical and emotional energy. It also acts as a releasing agent of norepinephrine and dopamine. <sup>[40, 43, 45]</sup>

It is a feel-good substance and deserves a special attention because it is famous for being found in chocolates. It gives the feeling of happiness and increases confidence level, no wonder why chocolates are gifted when someone is in love!!! <sup>[32, 39, 43, 46]</sup>

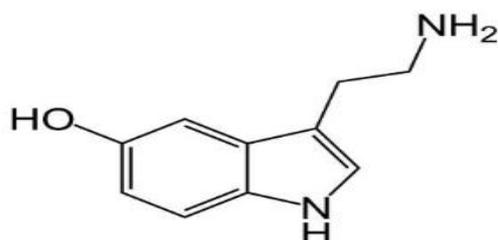
### Norepinephrine



**Fig. 4: Chemical structure of norepinephrine**

It is also called "Noradrenaline". It stimulates the production of adrenaline, which makes our heart race, and the palms sweat. Norepinephrine is released from nerve cells in the brain, which are called noradrenergic neurons. High level of norepinephrine in the brain increases the experience of joy and reduces appetite. <sup>[40, 43]</sup>

## Serotonin



**Fig. 5: Chemical structure of serotonin**

One of love's most important chemicals that may explain why when we fall in love, our new lover keeps popping into our thoughts. <sup>[12-13, 40]</sup>

Serotonin is responsible for constant thinking about the lover, wanting to spend every moment with them, looking forward to your next meeting. <sup>[27]</sup> It is the hormone responsible for loss of appetite during love. Serotonin levels help understand intimacy and romance. Higher serotonin levels lead to faster healing of wounds as well. That is why it is beneficial to be with our loved ones during injuries and pain. <sup>[26, 39]</sup>

In love there is a lower level of serotonin and also that neural circuits associated with the way we assess others are suppressed. These lower serotonin levels are the same as those found in people with obsessive-compulsive disorders, possibly explaining why those in love "obsess" about their partner. <sup>[16]</sup>

Newly smitten lovers often idealise their partner, magnifying their virtues and explaining away their flaws. New couples also exalt the relationship itself. Psychologists think we need this rose-tinted view which makes us want to stay together to enter the next stage of love – attachment. <sup>[13]</sup>

### 3. ATTACHMENT

This is the period in which the bond between one and his/her paramour solidifies, and is known to researchers as the attachment phase.

When phase three strikes, partners will be joined at the hip, they finish each other's sentences, and make those around them gag with their lovey-dovey antics. <sup>[18]</sup>

This stage of love has to be strong enough to withstand many problems and distractions. Studies have shown that the more we idealize the one we love, the stronger the relationship during the attachment stage. <sup>[47]</sup>

Psychologist John Bowlby was the first attachment theorist, describing attachment as a "lasting psychological connectedness between human beings."<sup>[48]</sup>

Hormones playing an important role in this phase are oxytocin, vasopressin and endorphins.

### **Oxytocin - The cuddle hormone**

It is sometimes called the love hormone.<sup>[49]</sup> This is released by the hypothalamus gland during child birth and also helps the breast to express milk.<sup>[12/50]</sup>

Oxytocin, a powerful hormone released by both men and women during touching, hugging and when they are intimate, promotes bonding.<sup>[12-13, 20, 32, 39, 51-52]</sup>

It is thought that it probably deepens the feelings of attachment with positive emotions and healthy psychological boundaries which makes couples feel much closer.<sup>[13,31,53]</sup> Oxytocin also seems to help cement the strong bond between mother and baby.<sup>[54-55]</sup>

### **Vasopressin**

Vasopressin, the "the monogamy chemical", is an important controller of the kidney.<sup>[12,47,56]</sup> It is also called as anti-diuretic hormone and have potential role in long-term monogamous relationship and in producing feelings of satisfaction and attachment.<sup>[13,16,57]</sup>

Studies have shown that passionate love fades quickly and is nearly gone after two or three years. The chemicals responsible for "that loving feeling" (adrenaline, dopamine, norepinephrine, phenylethylamine etc.) dwindle. Suddenly the lover has faults; one may wonder why he or she has changed! Actually, the partner probably hasn't changed at all; it's just that we are now able to see him or her rationally, rather than through the blinding hormones of infatuation and passionate love. At this stage, the relationship is either strong enough to endure, or it ends. Endorphins, for example, are still providing a sense of well-being and security.<sup>[16]</sup>

### **Endorphins**

These "endogenous morphines" are opioid peptides that work as neurotransmitters. Produced by the pituitary gland, the vertebrae and the hypothalamus, it is released during intimacy, excitement, pain, exercise, consumption of spicy food, etc.<sup>[39,58]</sup>

Endorphins block pain, but they're also responsible for our feelings of pleasure. It's widely believed that these feelings of pleasure exist to let us know when we've had enough of a good thing -- like food, sex or even companionship and also to encourage us to go after that good thing in order to feel the associated pleasure.<sup>[59,60]</sup>

After the initial rush of love, endorphins help the body settle into a comfortable and constant relationship. Where phenylethylamine helps fall in love, endorphins help stay in love. <sup>[39,58]</sup>

## CONCLUSION

Love is a wonderful feeling and every one experiences it some time in our life. Poets and authors have discussed about this from time immemorial!! But scientists also have taken this seriously to explain its reasons. It is believed that heart is involved in love and other emotions but it's actually the "brain" where it all gets start!! Various complex neurochemicals spark love into us. Many of them control the phases through which we are going on and are responsible for turning a mere "infatuation" into long lasting relationship. But we never feel that so many complex chemical changes are being happening inside our brain and body and that's why it is told "love" is great and it smoothen the pathway of our life!!

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